UNIT - 1
INTRODUCTION TO ECONOMICS

PART-A

1. **What is meant by economics?**   **(April 2015)**

   Economics is a study of economic problems of the people concerning production, consumption, exchange and distribution of wealth.

2. **What is micro economics?**

   Micro economics is the study of a particular household, individual price, a firm or an industry.

3. **What is macro economics?**

   Macro economics analyses the behaviour of broad economic aggregate like national income, general income, and general price level etc.

4. **What sort of relationship exists between the demand for goods and the price of complementary goods?**   **(Nov 2014)**

   The relationship between the demand for goods and the price of complementary goods is inverse. When the price of complementary goods falls its demand would increase. It would increase the demand for goods as they are going to be used along with the complementary goods.

5. **State the law of diminishing marginal utility.**

   It states that with successive increase in the units of consumption of a commodity, every additional unit of that commodity gives lesser satisfaction to the consumer. Consumption beyond point of safety

6. **What are the assumptions of law of demand?**
   a. Price of related goods remains constant.
   b. Income of the consumer does not change
   c. Taste and preferences of the people remain unchanged.

7. **What are the factors which affect the price elasticity of demand for a commodity?**

   Nature of the commodity

   Availability of substitutes

   Share in the total expenditure

   Different uses of a commodity

8. **State the assumption of the law of supply.**

   Price of related goods remains unchanged.

   Technology of production should not changed

   Cost of factors of production should remain the same

   Goals of the firm should not change

9. **Give any three factors affecting elasticity of supply.**

   Nature of commodity

   Cost of production

   Time element

10. **Define market demand.**

    Market demand is the total quantity demanded by all the purchasers together.

11. **State the law of supply.**   **(Nov 2014)**

    The law of supply states that the quantity of a commodity supplied varies directly with the price, other determinants of supply remaining constant.

12. **What is fixed cost?**

    Fixed costs are the cost which does not change with change in the level of output.

13. **Define marginal cost.**   **(April 2015)**

    Marginal cost is the change in the total cost by producing an additional unit of output.

14. **What is meant by incremental cost?**

Incremental cost is the additional cost due to a change in the level or nature of business activity.

15. **State & explain the law of demand.**   **(Nov 2014/ 2015)**

The law of demand states that other things being equal demand expands when price falls and contracts when price rises.

Other things remaining the same, the amount demanded increases with a fall in price and diminishes with a rise in price.

16. **Why does the demand curve slope downwards to the right?**

A normal demand curve slopes downwards from left to right and it means that more units of a good are brought when price falls and less number of units are brought when rises. That is, when price falls, demand expands. So the demand curve as a rule, slope downwards from left to right.

17. **Define cross elasticity of demand.**

Cross elasticity of demand is the responsiveness of demand for a commodity say X to a given change in the price of a related say Y.

18. **Classify wants.**   **(Nov 2014)**

Necessaries

Comforts

Luxuries

19. **Name the factors influencing demand.**

Changes in the price of other goods

State of trade

Changes in the taste and fashion

Advertisement expenditure

20. **What is demand forecasting?**

Demand forecasting is the estimate of level of demand to be expected for goods or services for some period of time in the future.

21. **What is meant by supply in economics?**

Supply is the amount of commodity which will be offered for sale at a given price per unit of time.

22. **Differentiate engineering efficiency and economic efficiency (May / June 2012)**

Economic efficiency is the ratio of output to input of a business system. 'Worth' is the annual revenue generated by the way of operating the business and 'cost' is the total annual expenses incurred in carrying out the business. Economic efficiency is also called 'productivity'.

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

Engineering efficiency refers to the physical amount of some single key input that is used in production. It is measured by the ratio of that input to output. For example, the engineering efficiency of an engine refers to the ratio of the amount of energy in the fuel burned by the engine to the amount of usable energy produced by the engine

23. **Illustrate the effect of prices on demand and supply: Illustrate with the help of a diagram, (Nov/ Dec 2012)**

The law of supply and demand is an economic theory that explains how supply and demand are related to each other and how the relationship affects the price of goods and services

There is an direct relationship between the supply and prices of goods and services when demand is unchanged.

The same inverse relationship holds for the demand of goods and services.

The four basic laws of supply and demand are:

1. If demand increases and supply remains unchanged, then it leads to higher equilibrium price and higher quantity.

2. If demand decreases and supply remains unchanged, then it leads to lower equilibrium price and lower quantity.

3. If supply increases and demand remains unchanged, then it leads to lower equilibrium price and higher quantity.

4. If supply decreases and demand remains unchanged, then it leads to higher equilibrium price and lower quantity.
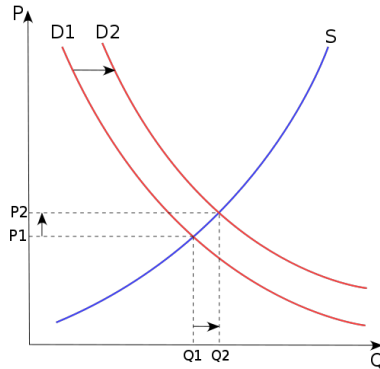
Supply and demand rise and fall until an equilibrium price is reached.

Equilibrium is defined as the price-quantity pair where the quantity demanded is equal to the quantity supplied, represented by the inter-section of the demand and supply curves.

24. What are the ways by which economic efficiency can be improved? (Nov/ Dec 2012)

There are several ways of economic efficiency.

- Increased output for the same input
- Decreased input 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

25. Differentiate technical efficiency and economical efficiency (Nov/ Dec 2013)

Technical efficiency

1. It is the ratio of the output to input of a physical system. The physi-cal system may 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:

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

2. 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

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

$$\text{Economic efficiency}(\%) = \frac{\text{output}}{\text{input}} \times 100 = \frac{\text{Worth}}{\cos t} \times 100$$

'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.

4. For the survival and growth of any business, the economic efficiency should be more than 100%.

26. **Define Break Even Point (Nov/ Dec 2013)**
   Breakeven point is defined as that level of sales at which total revenue is equal to total costs and the net income is equal to zero.

The intersection point of the total sales revenue line and the total cost line is called the break-even point.

$$\text{BEP} = \frac{\text{FC}}{\text{Selling price / unit} - \text{Variable cos t / unit}}$$

The Break-even point is, therefore, the volume of output at which neither a profit is made nor a loss is incurred. It is a point where the total sales are equal to total cost.

27. **What is Margin of Safety? (Nov 2014)**

Margin of safety is used in break-even analysis to indicate the amount of sales that are above the break-even point. In other words, the *mar-*

gin of safety indicates the amount by which a company's sales could decrease before the company will become unprofitable.

Another definition: In Break even analysis (accounting), **margin of safety** is how much output or sales level can fall before a business reaches its breakeven point

28. What is Economic Efficiency? (NOV/DEC 2015)

Economic efficiency is the ratio of output to input of a business system. 'Worth' is the annual revenue generated by the way of operating the business and 'cost' is the total annual expenses incurred in carrying out the business. Economic efficiency is also called 'productivity'.

$$\text{Economic efficiency}(\%) = \frac{\text{output}}{\text{input}} \times 100 = \frac{\text{Worth}}{\cos t} \times 100$$

29. What is sunk cost? (MAY/JUNE 2012)

The past cost of an equipment/asset is known as sunk cost. 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 termed as Sunk Cost.

30. What are the ways by which the economic efficiency can be improved? (NOV/DEC2012)

- ⌐ Increased output for the same input
- ⌐ Decreased input 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.

31. How is cost-volume-profit relationship determined?

The most important method of determining cost-volume -profit relationship is Break even Analysis.

32. What is Break even Analysis?

The method of determining the cost-volume -profit relationship is known as Break even Analysis. Break even Analysis the study of

revenue and costs of a firm in relation to its volume of sales and specifically the determination of that volume at which the firms costs and revenue will be equal

33. What is the usefulness Break even Analysis?
Break even Analysis is valuable for project appraisal executives, business students, accountants etc.

34. What is breakeven point?
Breakeven point is defined as that level of sales at which total revenue is equal to total costs and the net income is equal to zero.

35. Write the relationship between breakeven point and variable cost? (Nov 2014)

$$\text{Breakeven point} = \frac{\text{Fixed cost}}{\text{Price per unit - variable cost}}$$

36. Write the formula for breakeven point and contribution per unit?

$$\text{Breakeven point} = \frac{\text{Fixed cost}}{\text{Contribution per unit}}$$

37. What is break even chart?
Break even chart is defined as "a graphical presentation of fixed costs, variable costs and sales revenue for various volumes of operations. It illustrates the profits or losses incurred at different volumes of operations, the breakeven point and margin of safety".

38. Define (P/V) Ratio. (May/ June 2013)
It is the ratio of contribution to sales, which is expressed in terms of percentages. It is also called as "Contribution Ratio".

39. What are the uses of BEA?   (Nov 2014)
It predicts the effects of change in price on sales.

It predicts the effects of change on profitability of changes in costs and efficiency.

40. **Write down the limitations of break even Analysis?**

BEP Analysis assumes costs and revenue to be linear in function. This practice is not true.

Break Even Chart is useful only for single product companies.

41. **How is BEP determined In terms of physical units?**   **(Nov 2014)**

$$BEP = \frac{Fixed\ cos ts}{Copntribution\ margin\ par\ unit}$$

42. **How is BEP determined In terms of money?**

$$BEP = \frac{Fixed\ cos ts}{Contribution\ ratio}$$

43. **State the law of supply and demand.**   **(April/May-2017)**

Ans- The law of supply states that the quantity of a commodity supplied varies directly with the price, other determinants of supply remaining constant. The law of demand states that other things being equal demand expands when price falls and contracts when price rises. Other things remaining the same, the amount demanded increases with a fall in price and diminishes with a rise in price.

44. **What is sunk cost?**   **(April/May-2017)**

Ans- The past cost of an equipment/asset is known as sunk cost. 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 termed as Sunk Cost.

45. **What is engineering efficiency and economic efficiency?**

(April/May-2018)

Ans- Technical or engineering **efficiency and economic efficiency** are two types of concepts that differ from one another in many ways. Technical **efficiency** happens when there is no possibility to increase the output without increasing the input. **Economic efficiency** happens when the production cost of an output is as low as possible.

46. Difference between marginal cost and total cost. (April/May-2018)

Ans- There is a difference between average cost and marginal cost. The average cost of a product is the total cost of making a product divided by the total number of products made. Marginal cost is change in total costs which occur when an additional unit of the product is made by the company.

47. What is law of supply? (Nov/Dec-2018)

Ans-The *law of supply* is the microeconomic *law* that states that, all other factors being equal, as the price of a good or service increases, the quantity of goods or services that suppliers offer will increase, and vice versa.

48. What is break even chart? (Nov/Dec-2018)

Ans- A **break even chart** is a **chart** that shows the sales volume level at which total costs equal sales. The chart plots revenue, fixed costs, and variable costs on the vertical axis, and volume on the horizontal axis.

49. Write the formula to calculate engineering efficiency and economic efficiency. (April/May-2019)

Ans-

The technical efficiency of a diesel engine is as follows:

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

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

50. Give example of opportunity cost and sunk cost. (April/May-2019)

Ans-This distinction gives rise to two **types of opportunity cost**-- explicit and implicit. Explicit **Cost**: This is an **opportunity cost** that involves a money payment and usually a market transaction. ... Implicit **Cost**: This is an **opportunity cost** that DOES NOT involves a money payment or market transaction

The past cost of an equipment/asset is known as sunk cost. 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 termed as Sunk Cost.

1. Explain in detail about flow in an economy?

The circular flow of income or circular flow is a model of the economy in which the major exchanges are represented as flows of money, goods and services, etc. In its most basic form it considers a simple economy consisting solely of businesses and individuals, and can be represented in a so-called "circular flow diagram." The circular flow diagram illustrates the interdependence of the "flows," or activities, that occur in the economy, such as the production of goods and services (or the "output" of the economy) and the income generated from that production. The circular flow also illustrates the equality between the income earned from production and the value of goods and services produced. An economy involves interactions between not only individuals and businesses, but also Federal, state, and local governments and residents of the rest of the world

Households

The primary economic function of households is to supply domestic firms with needed factors of production - land, human capital, real capital and enterprise. The factors are supplied by factor owners in return for a reward. *Land* is supplied by landowners, *human capital* by labour, *real capital* by capital owners (capitalists) and *enterprise* is provided by entrepreneurs. Entrepreneurs combine the other three factors, and bear the risks associated with production.

Firms

The function of firms is to supply private goods and services to domestic households and firms, and to households and firms abroad. To do this they use factors and pay for their services.

Factor incomes

Factors of production earn an income which contributes to national income. Land receives rent, human capital receives a wage, real capital receives a rate of return, and enterprise receives a profit.

Members of households pay for goods and services they consume with the income they receive from selling their factor in the relevant market.

Production function

The simple production function states that output (Q) is a function (f) of: (is determined by) the factor inputs, land (L), labour (La), and capital (K), i.e.

$$Q = f (L, La, K)$$

Two Sector Economy

Circular Flow of Income
(Two Sector Economy)
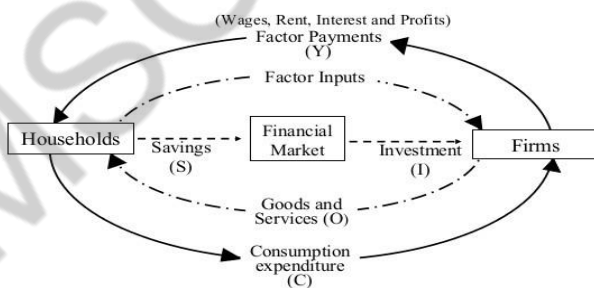
In the equilibrium Y=E=O

In the lower part of the figure, money flows from households to firms as consumption expenditure made by the households on the goods and services produced by the firms, while the flow of goods and services is in opposite direction from business firms to households.

Thus we see that money flows from business firms to households as factor payments and then it flows from households to firms. Thus there is,

in fact, a circular flow of money or income. This circular flow of money will continue indefinitely week by week and year by year. This is how the economy functions. It may, however, be pointed out that this flow of money income will not always remain the same in volume.

In other words, the flow of money income will not always continue at a constant level. In year of depression, the circular flow of money income will contract, i.e., will become lesser in volume, and in years of prosperity it will expand, i.e., will become greater in volume.

This is so because the flow of money is a measure of national income and will, therefore, change with changes in the national income. In year of depression, when national income is low, the volume of the flow of money will be small and in years of prosperity when the level of national income is quite high, the flow of money will be large

But savings by households need not lead to reduced aggregate spending and income if they find their way back into flow of expenditure. In free market economies there exists a set of institutions such as banks, insurance companies, financial houses, stock markets where households deposit their savings. All these institutions together are called financial institutions or financial market. We assume that all the savings of households come in the financial market. We further assume that there are no inter-households borrowings.

It is business firms who borrow from the financial market for investment in capital goods such as machines, factories, tools and instruments, trucks. Firms spend on investment in order to expand their productive capacity in future.

Circular Income Flow in a Three Sector Economy with Government:

In our above analysis of money flow, we have ignored the existence of government for the sake of making our circular flow model simple. This is quite unrealistic because government absorbs a good part of the incomes earned by households. Government affects the economy in a number of ways.

Here we will concentrate on its taxing, spending and borrowing roles. Government purchases goods and services just as households and firms do. Government expenditure takes many forms including spending on capital goods and infrastructure (highways, power, communication), on defence goods, and on education and public health and so on. These add

to the money flows which are shown in Fig. 6.3 where a box representing Government has been drawn. It will be seen that government purchases of goods and services from firms and households are shown as flow of money spending on goods and services.
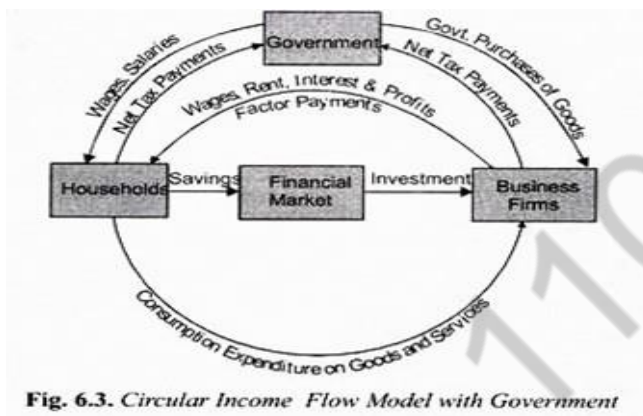

Fig. 6.3. *Circular Income Flow Model with Government*

Government expenditure may be financed through taxes, out of assets or by borrowing. The money flow from households and business firms to the government is labelled as tax payments in Fig. 6.3 This money flow includes all the tax payments made by households less transfer payments received from the Government. Transfer payments are treated as negative tax payments.

Money Income Flows in the Four Sector Open Economy: Adding Foreign Sector:

We now turn to explain the money flows that are generated in an open economy, that is, economy which have trade relations with foreign countries. Thus, the inclusion of the foreign sector will reveal to us the interaction of the domestic economy with foreign countries. Foreigners interact with the domestic firms and households through exports and imports of goods and services as well as through borrowing and lending operations through financial market. Goods and services produced within the domestic territory which are sold to the foreigners are called exports.

On the other hand, purchases of foreign-made goods and services by domestic households are called imports. Figure 6.4 illustrates additional money flows that occur in the open economy when exports and imports also exist in the economy. In our analysis, we assume it is only the business firms of the domestic economy that interact with foreign countries and therefore export and import goods and services.
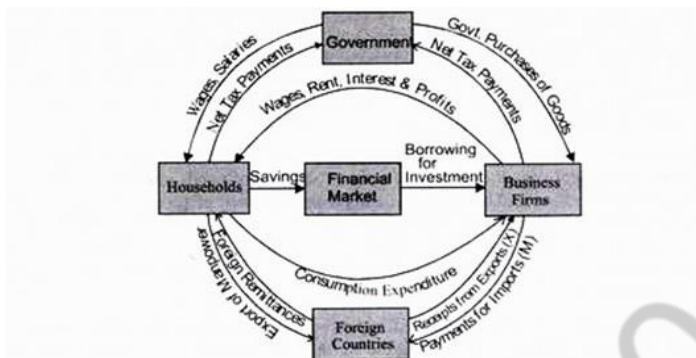
Fig. 6.4. *Circular Flow of Income in an Open Economy with Government and Foreign Sector*

A flow of money spending on imports have been shown to be occurring from the domestic business firms to the foreign countries (i.e., rest of the world). On the contrary, flow of money expenditure on exports of a domestic economy has been shown to be taking place from foreign countries to the business firms of the domestic economy.

If exports are equal to the imports, then there exists a balance of trade. Generally, exports and imports are not equal to each other. If value of exports exceeds the value of imports, trade surplus occurs. On the other hand if value of imports exceeds value of exports of a country, trade deficit occurs.

2. **Explain the concept of law of supply and demand with suitable example? (April 2015)**

The Law Of Supply And Demand

The law of supply and demand is the theory explaining the interaction between the supply of a resource and the demand for that resource. The law of supply and demand defines the effect the availability of a particular product and the desire (or demand) for that product has on price. Generally, a low supply and a high demand increases price, and in contrast, the greater the supply and the lower the demand, the lower the price tends to fall.

Example :

The business anticipated selling more units, but due to lack of interest, it has warehouses full of the product. Due to its high supply, the business lowers the price. Demand increases, but as the business's supply dwindles, it raises the price until it finds the perfect price to balance its supply with consumer demand.

In the above example**, supply** only takes into account the supply created by a single business. In real economies, supply is predicated on many other factors. Production capacity, production costs such as labor and materials, and the number of competitors directly affect how a much supply businesses can create

Demand is affected by the quality and cost of a product. The number of available substitutes, advertising and shifts in the price of complementary products also affect its demand

3.   Briefly explain about element of cost and its classification? (April/May 2018)

In today's competitive scenario, the main aim of every organization is to earn maximum profit.

The organization's decision of maximizing profit depends on the behavior of its costs and revenues.

In general terms, cost refers to an amount to be paid or given up for acquiring any resource or service.

In economics, cost can be defined as a monetary valuation of efforts, material, resources, time and utilities consumed, risks incurred, and opportunity forgone in the production of a good or service.

An organization incurs a number of costs, such as opportunity costs, fixed costs, implicit costs, explicit costs, social costs, and replacement costs. On the other hand, revenue is the income earned by an organization from the sales of goods or services. It excludes deductions of tax, interest, and dividend paid by an organization. The level of profitability of an organization can be determined by analyzing its costs and revenue.

Cost analysis involves the study of total costs incurred by an organization to acquire various resources, such as labor, raw materials, machines, land, and technology. It helps an organization to make various managerial decisions, including determination of price and level of current production.

Apart from this, it enables an organization to decide whether to opt for the available alternative or not. On the other hand, revenue analysis is a process of estimating the total income earned by an organization from different' sources. An organization is said to be profitable if its total revenue is more than costs incurred by it.

Concept of Cost:

Cost, a key concept in economics, is the monetary expense incurred 'by organizations for various purposes, such as acquiring resources, producing goods and services, advertising, and hiring workers. In other words, cost can be defined as monetary expenses that are incurred by an organization for a specified tiling or activity.

According to Institute of Cost and Work Accountants (ICWA), cost implies "measurement in monetary terms of the amount of resources used for the purpose of production of goods or rendering services." In terms of manufacturing, costs refer to sum total -of monetary value of resources used in producing or manufacturing a product. These resources can be raw material, labor, and land.

A cost comprises a number of elements, which are shown in Figure-1:
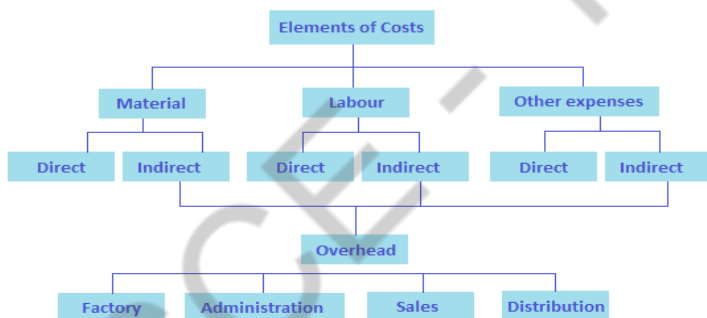
The different elements of cost (as shown in Figure-1) are explained as follows:

i. Material:

Helps in producing or manufacturing goods. Material implies a substance from which a product is made For example, an organization requires materials, such as bricks and cement for constructing a building.

Material is divided into two categories, which are as follows:

a. Direct Material:

Refers to a material that is directly related to a specific product, job, or process. Direct material becomes an integral part of the finished product.

Some of the examples of direct material are as follows:

     1. Timber is raw material for making furniture

2. Sugarcane for making sugar.

3. Textile for garment industry

4. Gold for making jewellery

5. Cans for tinned food and drink

b. Indirect Material:

Refers to a material that is not directly related to a particular product or activity. Such materials cannot be easily identified with the product.

The examples of indirect material are as follows:

1. Oils for lubricating machines

2. Printing and stationary items for publishing books

3. Nails for making furniture

4. Threads for manufacturing garments

ii. Labor:

Acts as an important part of production. An organization requires labor to convert raw materials into finished goods. Labor cost is the main element of cost.

Labor can be of two types, which are discussed as follows:

a. Direct Labor:

Refers to labor that takes an active part in manufacturing a product. This type of labor is also known as process labor, productive labor, or operating labor. The costs related to direct labor are called direct labor costs. These costs vary directly with the change in the level of output, thus it is referred as a variable expense.

b. Indirect Labor:

Refers to labor that is not directly related to the manufacturing of a product. The indirect labor cost may or may not vary with the change in the volume of output. This type of labor is used in the factory, office, and selling and distribution department.

iii. Expenses:

Refer to costs that are incurred in the production of finished goods other than material costs and labor costs.

Expenses are further divided into two parts:

a. Direct Expenses:

Imply the expenses that are directly or easily allocated to a particular cost center or cost units. These expenses are called chargeable expenses. Some of the direct expenses of an organization include acquiring machinery for special processes, fees paid to architects and consultants, and costs of patents and royalties.

b. Indirect Expenses:

Refer to expenses that cannot be allocated to specific cost center or cost units. For example, rent, depreciation, insurance, and taxes of building.

Fixed Costs Vs. Variable Costs

Fixed costs are costs which remain constant within a certain level of output or sales. This certain limit where fixed costs remain constant regardless of the level of activity is called relevant range. For example, depreciation on fixed assets, etc.

Variable costs are costs which change with a change in the level of activity. Examples include direct materials, direct labor, etc.

Sunk Costs Vs. Opportunity Costs

The costs discussed so far are **historical costs** which means they have been incurred in past and cannot be avoided by our current decisions. Relevant in this regard is another cost classification, called sunk costs. Sunk costs are those costs that have been irreversibly incurred or committed; they may also be termed unrecoverable costs.

In contrast to sunk costs are opportunity costs which are costs of a potential benefit foregone. For example the opportunity cost of going on a picnic is the money that you would have earned in that time.

Overhead 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) Direct material costs + Direct labour costs + Direct expenses = Prime cost

(b) Prime cost + Factory overhead = Factory cost

(c) Factory cost + Office and administrative overhead = Costs of production

(d) Cost of production + Opening finished stock – Closing finished stock = Cost of goods sold

(e) Cost of goods sold + Selling and distribution overhead = Cost of sales

(f) Cost of sales + Profit = Sales

(g) Sales/Quantity sold = Selling price per unit

4. Explain the concept of break even analysis with clear diagram? (May 2013)

The Break-even analysis or cost-volume-profit analysis (c-v-p analysis) helps in finding out the relationship of costs and revenues to output. Breakeven analysis is an important tool of profit planning in the hands of management. It is usually desirable to have a low break-even point; the less chances are of operating the business at a profit over the years. For example, in managing a hotel, a comfortable position can be had if the break-even point is at 60 per cent of capacity if it is at 90 per cent of capacity. Further, if an undertaking is operated close to the break-even point, slight changes in business environments are likely to result in losses.
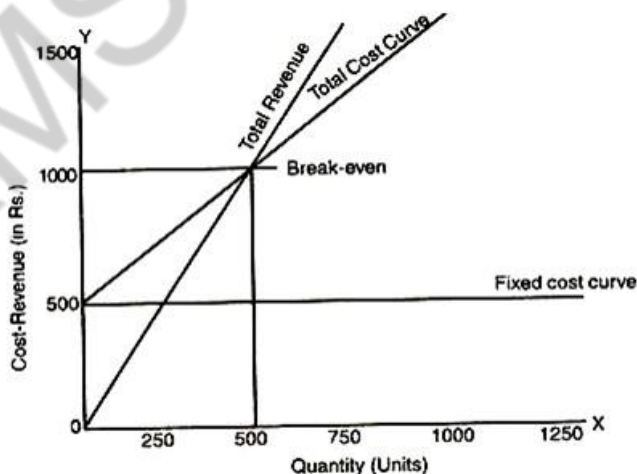
Profit performance of a business can be improved by increasing volume, by increasing selling price, by decreasing variable costs and by decreasing fixed costs. Taking some of the interrelationships of these four possibilities into consideration, one of the feasible things can be selected.

5. Define break point. Draw a break even chart and explain its components? (Nov 2012) (April/May-2019)

Meaning of break point:

The point at which total of fixed and variable costs of a business becomes equal to its total revenue is known as **break-even point (BEP).** At this point, a business neither earns any profit nor suffers any loss. Break-even point is therefore also known as no-profit, no-loss point or zero profit point.

Graphical presentation (Preparation of break-even chart or CVP graph):

The graphical presentation of dollar and unit sales needed to break-even is known as **break-even chart** or **CVP graph**
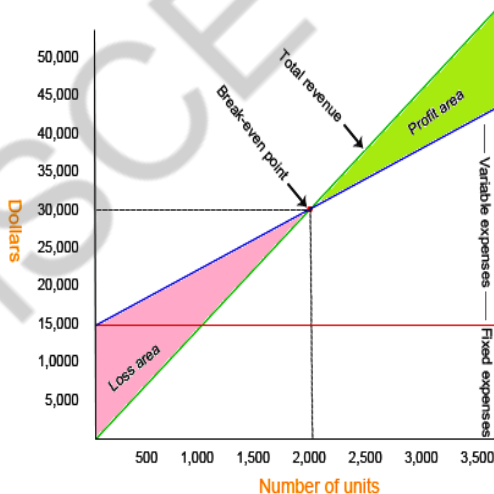
Explanation of the graph:

1. The number of units have been presented on the X-axis (horizontally) where as dollars have been presented on Y-axis (vertically).

2. The straight line in red color represents the total annual fixed expenses of Rs. 15,000.

3. The blue line represents the total expenses. Notice that the line has a positive or upward slop that indicates the effect of increasing variable expenses with the increase in production.

4. The green line with positive or upward slop indicates that every unit sold increases the total sales revenue.

5. The total revenue line and the total expenses line cross each other. The point at which they cross each other is the *break-even point*. Notice that the total expenses line is above the total revenue line before the point of intersection and below after the point of intersection. It tells us that the business suffers a loss before the point of intersection and makes a profit after this point. The break-even point in the above graph is 2,000 units or Rs. 30,000 that agrees with the break-even point computed using equation and contribution margin methods above.

6. The difference between the total expenses line and the total revenue line before the point of intersection (BE point) is the *loss area*. The loss area has been filled with pink color. Notice that this area reduces as the number of units sold increases. It means every additional unit sold before the break-even point reduces the loss.

7. The difference between the total expenses line and the total revenue line after the point of intersection (BE point) is the profit area. The profit area has been filled with green color. Notice that this area increases as the number of units sold increases. It means every additional unit sold after the break-even point increases the profit of the business.

6. Explain the concept of Engineering and Economic Efficiency?
(May 2013)

Concept of Engineering:

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 application systems based on different scientific principles.

Concept of Economic efficiency:

It implies an economic state in which every resource is optimally allocated to serve each individual or entity in the best way while minimizing waste and inefficiency. When an economy is economically efficient, any changes made to assist one entity would harm another. In terms of production, goods are produced at their lowest possible cost, as are the variable inputs of production.

Types of Efficiency

Efficiency of a system is generally defined as the ratio of its output to input. In general business decision making, and policies three different types of efficiency concepts are encountered.

- Engineering efficiency
- Technical Efficiency
- Economic efficiency.

Engineering efficiency

- physical amount of some single key input used in production and is measured by the ratio of that input to output.

Engineering efficiency (%) = (Output/Key Input) x 100

- Engineering efficiency does not take financial considerations.it is purely about physical relationships.

Ex. engineering efficiency of an engine: Let a steam engine is 40 percent efficient means that 40 percent of the energy in the fuel is converted into work done, while the other 60 percent is lost in friction, heat loss, and other unavoidable sources of waste

Technical Efficiency

- Is related to physical amount of all resources used in producing a product.

Technical efficiency (%) = (Output produced / All Input resources) x 100

- Thus technical efficiency is about getting the most output from any given set of inputs; or, equivalently, about producing a given level of output using the least amount of physical inputs.

Ex. Technical efficiency of a diesel engine Technical efficiency (%) = (Heat equivalent of mechanical energy produced/ Heat equivalent of fuel used) x 100

EX., Let a firm is using 100 units of labour and 50 units of capital to produce a level of output. If the firm could maintain its output level by using only 90 units of labour without using more capital, then it is being technically inefficient in current methods as it is "wasting" 10 labour units

Economic efficiency

- Is related to the value or cost (rather than the physical amounts) of all inputs used in producing a given output.

Economic efficiency (%) = (Output/ Input) x 100 = (Worth/ Cost) $\times$ 100

- The production of a given output is economically efficient if there are no other ways of producing the output that use a smaller total value of inputs.

- Ex. a firm have three alternative production methods. First require a lot of labour but only a little capital, Second requires a lot of capital and only a little labour, while third production method may require a lot of land but relatively little of both labour and capital. In order to be economically efficient (maximize its profits) the firm should choose the production method that costs the least.

Economic efficiency is also called 'productivity'

Relationship among various efficiencies

- Engineering efficiency aims to maximizes the output with respect to key input (Engineering efficiency may increase the cost i.e reduce the economic efficiency)

- Technical Efficiency aims to maximize the output with least quantities of resources (A high end technological process may be technically efficient but may significantly increase fixed cost and cost of skilled labor and may not be economic efficient)

- Economic efficiency is maximizing the profit in shortest time (bottom-line is the only yardstick)

(In the context a product or service need only be complete enough to satisfy the customer, especially if it makes it possible to sell the same product repeatedly, or sell a newer, more complete version of the product later. A business that sells a product which completely satisfies its customers indefinitely will put itself out of business; Thus, a business may have a strong disincentive to produce design which are efficient in the engineering sense.)

- Technical efficiency is desirable as long as long as inputs have a positive cost to the firm for being economically efficient. Thus achieving technical efficiency is clearly a necessary condition for producing any output at the least cost. But achieving technical efficiency, however, is not a sufficient condition for producing at the lowest possible cost.

Ex., the engineering efficiency of a gas turbine engine can be increased by using more and stronger steel in its construction. Raising the engineering efficiency of an engine saves on fuel, but at the cost of using more of other inputs. To know whether this is worth doing, the firm must compare the value of the fuel saved with the value of the other inputs used.

A Automobile which is strongly technically efficient (a longer life) may affect the repeat sale/sale of newer versions and may not be economically efficient to the company.

Ways to increase Economics Efficiency (Productivity)

- Increased output for the same input
- Decreased input 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.

7.   Briefly explain about process planning and its various types?

(April 2015)

While planning for a new component, a feasible sequence of operations with the least cost of processing is to be considered.

The process sequence of a component which has been planned in the past is not static.

It is always subject to modification with a view to minimize the cost of manufacturing the component.

So, the objective of process planning/process modification is to identify the most economical sequence of operations to produce a component.

The steps in process planning are as follows:

1. Analyze the part drawing to get an overall picture of what is required.

2. Make recommendations to or consult with product engineers on product design changes.

3. List the basic operations required to produce the part to the drawing or specifications.

4. Determine the most practical and economical manufacturing method and the form or tooling required for each operation.

5. Devise the best way to combine the operations and put them in sequence.

6. Specify the gauging required for the process.

Steps 3–5 aim to determine the most practical and economical sequence of operations to produce a component. This concept is demonstrated with a numerical problem.

Example

The process planning engineer of a firm listed the sequences of operations as shown in Table to produce a component.

Table Data for Example

Sequence	
	Process sequence
1	Turning – Milling – Shaping – Drilling
2	Turning – Milling – Drilling
3	All operations are performed with CNC machine

The details of processing times of the component for various operations and their machine hour rates are summarized in table below.

8. Bring out the scope of engineering economics with appropriate examples? (April 2015)

Scope of Economics:

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 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, inflation adjusted

investment decisions, make or buy decisions, inventory control, project management, value engineering, and linear programming.

9.   Write in detail about elementary economic analysis? (Nov 2014)

Elementary Economic Analysis

Whether it is a business situation or a day-to-day event in somebody as personal life, there are a large number of economic decision making involved. One can manage many of these decision problems by using simple economic analysis.

For example, an industry can source its raw materials from a nearby place or from a far-off place. In this problem, the following factors will affect the decision:

- Price of the raw material
- Transportation cost of the raw material
- Availability of the raw material
- Quality of the raw material

Consider the alternative of sourcing raw materials from a nearby place with the following characteristics:

- The raw material is more costly in the nearby area.
- The availability of the raw material is not sufficient enough to support the operation of the industry throughout the year.
- The raw material requires pre-processing before it is used in the production process. This would certainly add cost to the product.
- The cost of transportation is minimal under this alternative.

On the other hand, consider another alternative of sourcing the raw materials from a far-off place with the following characteristics:

- The raw material is less costly at the far off place.
- The cost of transportation is very high.
- The availability of the raw material at this site is abundant and it can support the plant throughout the year.
- The raw material from this site does not require any pre-processing before using it for production.

Under such a situation, the procurement of the raw material should be decided in such a way that the overall cost is minimized.

The above example clearly highlights the various components of cost that are involved in each of the alternatives of the decision-making process as well as a method of taking a suitable decision.

EXAMPLES FOR SIMPLE ECONOMIC ANALYSIS

In this section, the concept of simple economic analysis is illustrated using suitable examples in the following areas:

- _ Material selection for a product
- _ Design selection for a product
- _ Design selection for a process industry
- _ Building material selection for construction activities
- _ Process planning/Process modification

10. **Analyse the various types of elasticity of demand and their usefulness? (Nov 2015)**

Elasticity of demand:

Elasticity of Demand refers to the degree of responsiveness of quantity demanded to the changes in the determinants of demand .

Types of Elasticity Of Demand

- Price Elasticity of Demand
- Income Elasticity of Demand
- Cross Elasticity of Demand

Price Elasticity of Demand :

Price Elasticity of demand is the degree of responsiveness of demand to a change in its price. In technical terms it is the ratio of the percentage change in demand to the percentage change in price.

Thus,

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

Income Elasticity of Demand:

Income elasticity of demand refers to the sensitivity of the quantity demanded for a certain good to a change in real income of consumers who buy this good, keeping all other things constant.

Thus

$$E_i = \frac{\text{The percentage change in quantity demanded}}{\text{The percentage change in income}}$$

Cross Elasticity of Demand

The **cross** elasticity of demand or cross-price elasticity of demand measures the responsiveness of the quantity demanded for a good to a change in the price of another good.

Thus

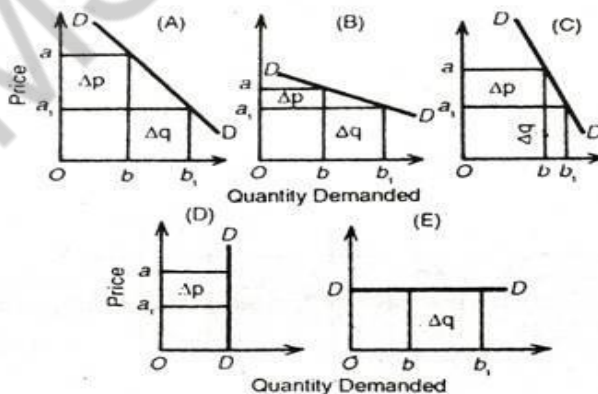$$E_c = \frac{\text{Percentage change in quantity}}{\text{Percentage change in price of the second good}}$$

Figure 11.1

Price elasticity of demand may be unity, greater than unity, less than unity, zero or infinite. These five cases are explained with the aid of the following figures.

Price elasticity of demand is unity when the change in demand is exactly proportionate to the change in price. For example, a 20% change in price causes 20% change in demand, $E_p = 20\%/20\% = 1$. In the diagrams of Figure 11.1, Δ_p represents change in price, Δ_q change in demand, and DD the demand curve. Price elasticity on the first demand curve in Panel (A) is unity, for $\Delta q/\Delta p = 1$.

When the change in demand is more than proportionate to the change in price, price elasticity of demand is greater than unity. If the change in demand is 40% when price changes by 20% then $E_p = 40\%/20\% = 2$, in Panel (B), i.e. $\Delta q/\Delta p > 1$. It is also known as relatively elastic demand.

If, however, the change in demand is less than proportionate to the change in price, price elasticity of demand is less than unity. When a 20% change in price causes 10% change in demand, then $E_p - 10\%/20\% = 1/2 = < 1$, in Panel (C), i.e. $\Delta q/\Delta p < 1$. It is also known as relatively inelastic demand.

Zero elasticity of demand is one when whatever the change in price, there is absolutely no change in demand. Price elasticity of demand is perfectly inelastic in this case. A 20% rise or fall in price leads to no change in the amount demanded, $E_p = 0/20\% = 0$, in Panel (D), i.e. $0/\Delta p = 0$. It is perfectly inelastic demand.

Lastly, price elasticity of demand is infinity when an infinitesimal small change in price leads to an infinitely large change in the amount demanded. Visibly, no change in price causes an infinite change in demand, $E = \infty/0 = \infty$, in Panel (E), at OD price, the quantity demanded continues to increase from O_b to $_{b1}$ … n. It is perfectly elastic demand

11. **What is a Material? What factors could you consider while selecting a material? (Nov 2015)**

Material selection is the process of designing any physical object. In the context of product design, the main goal of material selection is to minimize cost while meeting product performance goals. Systematic selection of the best material for a given application begins with properties and costs of candidate materials.

- Cheaper raw material price
- Reduced machining / process time
- Enhanced durability of the product.

Therefore, the process of raw material selection/substitution will result in finding an alternate raw material which will provide the necessary functions that are provided by the raw material that is presently used. In this process, if the new raw material provides any additional benefit, then it should be treated as its welcoming feature. This concept is demonstrated with two numerical problems.

12. State and explain the factors influencing process design? (Nov 2014) (Nov 2013)

Major Factors affecting Process Design Decisions

Operations managers generally make process-design decisions after taking into consideration several factors. Some of these factors are:

Nature of demand:

The main objective of any production system is to produce products or services, according to customer requirements. Therefore, it is essential for an organization to schedule its production in such a way that it can always meet estimated future demand levels.

Degree of vertical integration:

Vertical integration refers to the extent to which the production and the distribution chain (extending from the suppliers of raw materials and components to the delivery of finished products) is brought under the ownership of the organization.

Flexibility:

An organization is said to be flexible only when it responds quickly to changing customer needs or market conditions. Flexibility is essential for organizations to increase or maintain their market share. Flexibility can be broadly classified into two types: Product/service flexibility and volume flexibility.

Degree of automation:

In the past, automating production processes was very costly. It was also difficult to integrate automated processes with other production processes.

For these reasons, managers in the past tended to avoid automation. But, today, operations managers have realized that if automation is not made a strategic weapon, it will be a strategic limitation for their operations. Automation has become essential for organizations to become or remain competitive.

Quality level and degree of customer contact:

The level of quality of a product or service decides whether it can compete in a market. Decisions taken on the desired quality level of products/ services affect the design of the production process at all stages.

13. Explain why demand curve slope downwards? (Nov 2014)

A demand curve is the graphical representation of the demand schedule for a commodity. It is the graphic statement of an individual buyer's reaction on amount demanded at a given price in the given point of time. A demand curve has got a negative slope. It slopes downwards from left to right. A demand curve shows the maximum quantities per unit of time that consumers will buy at various prices.

(1) Law of diminishing marginal utility:

A consumer always equalises marginal utility with price. The law states that a consumer derives less and less satisfaction (utility) from the every additional increase in the stock of a commodity. When price of a commodity falls the consumer's price utility equilibrium is disturbed i.e. price becomes smaller than utility.

(2) Income effect:

The operation of law of demand is income effect. As the price of a commodity falls, the consumer has to buy the same amount of the commodity at less amount of money. After buying his required quantity he is left with some amount of money.

(3) Substitution effect:

When the price of a commodity falls, it becomes relatively cheaper than other commodities. The consumer substitutes the commodity whose price has fallen for other commodities which becomes relatively dearer.

(4) New consumers:

When the price of a commodity falls many other consumers who were deprived of that commodity at the previous price become able to buy it

now as the price comes within their reach.

(5) Multiple use of commodity:

There are some commodities which have multiple uses. Their uses depend upon their respective, prices. When their prices rise they are used only for certain selected purposes. That is why their demand goes down.

14. Mention the factors influencing Demand and Supply?
(Nov 2013) (Nov 2012)(April/May-2019)

1. Tastes and Preferences of the Consumers:

An important factor which determines the demand for a good is the tastes and preferences of the consumers for it. A good for which consumers' tastes and preferences are greater, its demand would be large and its demand curve will therefore lie at a higher level.

2. Income of the People:

The demand for goods also depends upon the incomes of the people. The greater the incomes of the people, the greater will be their demand for goods. In drawing the demand schedule or the demand curve for a good we take income of the people as given and constant.

3.Changes in Prices of the Related Goods:

The demand for a good is also affected by the prices of other goods, especially those which are related to it as substitutes or complements. When we draw the demand schedule or the demand curve for a good we take the prices of the related goods as remaining constant.

4.Advertisement Expenditure:

Advertisement expenditure made by a firm to promote the sales of its product is an important factor determining demand for a product, especially of the product of the firm which gives advertisements.

5. The Number of Consumers in the Market:

The market demand for a good is obtained by adding up the individual demands of the present as well as prospective consumers of a good at various possible prices. The greater the number of consumers of a good, the greater the market demand for it.

Some of the factors that influence the supply of a product are described as follows:

i. Price:

Refers to the main factor that influences the supply of a product to a greater extent. Unlike demand, there is a direct relationship between the price of a product and its supply. If the price of a product increases, then the supply of the product also increases and vice versa. Change in supply with respect to the change in price is termed as the variation in supply of a product.

Speculation about future price can also affect the supply of a product. If the price of a product is about to rise in future, the supply of the product would decrease in the present market because of the profit expected by a seller in future. However, the fall in the price of a product in future would increase the supply of product in the present market.

ii. Cost of Production:

Implies that the supply of a product would decrease with increase in the cost of production and vice versa. The supply of a product and cost of production are inversely related to each other. For example, a seller would supply less quantity of a product in the market, when the cost of production exceeds the market price of the product.

In such a case the seller would wait for the rise in price in future. The cost of production rises due to several factors, such as loss of fertility of land, high wage rates of labor, and increase in the prices of raw material, transport cost, and tax rate.

iii. Natural Conditions:

Implies that climatic conditions directly affect the supply of certain products. For example, the supply of agricultural products increases when monsoon comes on time. However, the supply of these products decreases at the time of drought. Some of the crops are climate specific and their growth purely depends on climatic conditions. For example Kharif crops are well grown at the time of summer, while Rabi crops are produce well in winter season.

iv. Technology:

Refers to one of the important determinant of supply. A better and advanced technology increases the production of a product, which results in the increase in the supply of the product. For example, the production of

fertilizers and good quality seeds increases the production of crops. This further increase the supply of food grains in the market.

v. Transport Conditions:

Refer to the fact that better transport facilities increase the supply of products. Transport is always a constraint to the supply of products, as the products are not available on time due to poor transport facilities. Therefore even if the price of a product increases, the supply would not increase.

In India sellers usually use road transport and the poorly maintained road makes it difficult to reach the destination on time the products that are manufactured in one part of the city need to be spread in the whole country through road transport This may result in the damage of most of the products during the journey, which can cause heavy loss for a seller. In addition the seller can also lose his/her customers because of the delay in. the delivery of products.

vi. Factor Prices and their Availability:

Act as one of the major determinant of supply. The inputs, such as raw material man, equipment, and machines, required at the time of production are termed as factors. If the factors are available in sufficient quantity and at lower price, then there would be increase in production.

This would increase the supply of a product in the market. For example, availability of cheap labor and raw material nearby the manufacturing plant of an organization would help in reducing the labor and transportation costs. Consequently, the production and supply of the product would increase.

vii. Government's Policies:

Implies that the different policies of government, such as fiscal policy and industrial policy, has a greater impact on the supply of a product. For example, increase in tax on excise duties would decrease the supply of a product. On the other hand, if the tax rate is low, then the supply of a product would increase.

viii. Prices of Related Goods:

Refer to fact that the prices of substitutes and complementary goods also affect the supply of a product. For example, if the price of wheat increases, then farmers would tend to grow more wheat than nee. This would decrease the supply of rice in the market.

15. **Explain the method of deriving the selling price of a product**

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

(a) Direct material costs + Direct labour costs + Direct expenses = Prime cost

(b) Prime cost + Factory overhead = Factory cost

(c) Factory cost + Office and administrative overhead = Costs of production

(d) Cost of production + Opening finished stock – Closing finished stock = Cost of goods sold

(e) Cost of goods sold + Selling and distribution overhead = Cost of sales

(f) Cost of sales + Profit = Sales

(g) Sales/Quantity sold = Selling price per unit

PROBLEMS

16. **Krishna Company Ltd have the Following Details:** (Nov / Dec 2012)

Fixed Cost   = Rs 40,00,000

Variable Cost   = RS 300

Selling price per unit   = 500

Find:

The Break - Even Sales Quantity

The Break –Even sales

If the actual production Quantity is 1,20,000, find the following

1) Contribution

2) Margin of safety by all the methods.

Solution:

Fixed Cost   = Rs 40,00,000

Variable Cost   = RS 300

Selling price per unit   = 500

1) The Break - Even Sales Quantity $= \dfrac{\text{Fixed cost}}{\text{sales} - \text{variable costs}}$

$$= \dfrac{40,00,000}{500 - 300}$$

$$= 20,000 \text{ units}$$

2. The Break –Even sales

$$= \dfrac{\text{Fixed cost}}{\text{sales} - \text{variable cost}} \times \text{selling price per unit}$$

$$= \dfrac{40,00,000}{500 - 300} \times 500$$

$$= \dfrac{40,00,000}{200} \times 500$$

$$= 10,000,000$$

3) If the actual production Quantity is 1,20,000, find the following

a) Contribution = Sales – variable cost

$\qquad\qquad = 1,20,000 \text{x} 500 - 1,20,000 \text{ x } 300$

$\qquad\qquad = 60,000,000 - 36,000,000$

$\qquad\qquad = \textbf{24,000,000}$

b) Margin of Safety:

1). MOS = Sales - Break Even Sales

$\qquad = 1,20,000 \text{ x } 500 - 10,000,000$

$\qquad = 6,00,00,000 - 10,000,000$

$\qquad = \textbf{50,000,000}$

i) $\text{MOS} = \dfrac{\text{Profit}}{\text{contribution}} \times \text{Sales}$

profit = Contribution – Fixed cost

$\qquad = 24,000,000 - 40,00,000$

$\qquad = \textbf{20,000,000}$

Sales = $1,20,000 \text{ x} 500 = \textbf{6,00,00,000}$

$$MOS = \frac{20000000}{24000000} \times 60000000$$

$$= \mathbf{50{,}000{,}000}$$

17. i) From the following Information relating to Geetha Ltd, are required to find out (M ay/June 2013)

1) P/V ratio

2) BEP;

3) Profit

4) Margin of Safety,

Total Fixed Cost   = RS. 4500

Total variable Cost   = RS. 7,500

Total Sales   = RS. 15,000

ii) Also calculate the volume of sales to earn profit of RS. 6000.

Solution:

1) $P / V \ \text{ratio} = \dfrac{\text{Contribution}}{\text{sales}} \times 100$

Contribution = sales – variable cost

$$= 15000 - 7500$$

Contribution   =   **7500**

$$P / V \ \text{ratio} = \frac{7500}{15000} \times 100$$

$$= \ \mathbf{50\%}$$

2) $BEP = \dfrac{\text{Fixed cos t}}{\text{pv ratio}}$

$$= \frac{4500}{50\%}$$

$$= \mathbf{9000}$$

3) Profit   =   Contribution   -   Fixed cost

            =   7500 – 4500

            =   **3000**

4) Margin of Safety $= \dfrac{\text{profit}}{\text{pv ratio}}$

$$= \dfrac{3000}{50} \times 100$$

$$= \text{RS } 6000$$

ii) volume of sales to earn profit of RS. 6000.

$$= \dfrac{\text{Fixed cos t } 6 + \text{profit}}{\text{pv ratio}}$$

$$= \dfrac{4500 + 6000}{50\%} \times 100$$

$$= \dfrac{10500}{50} \times 100$$

$$= \textbf{RS 21000}$$

18. Max & Co has the following cost data for two successive periods. (May/June 2012)

Year 1 (RS)	Year 2 (RS)	
Sales	50,000	1, 20,000
Fixed cost	10,000	20,000
Variable cost	30,000	60,000

Determine the break Even point.

Solution:

Year 1

$\text{BEP} = \dfrac{\text{Fixed cos t}}{\text{pv ratio}}$

$\text{PV ratio} = \dfrac{\text{contribution}}{\text{sales}} \times 100$

Contribution = sales – variable cost

$$= 50,000 - 30,000$$

$$= \textbf{20000}$$

$$\text{Pv ratio} = \frac{20,000}{50,000} \times 100$$

$$= 40\%$$

$$\text{BEP} = \frac{\text{Fixed cost}}{\text{pv ratio}}$$

$$= \frac{10,000}{40\%}$$

$$= \mathbf{25000}$$

Year 2

$$\text{BEP} = \frac{\text{Fixed cost}}{\text{pv ratio}}$$

$$\text{Pv ratio} = \frac{\text{contribution}}{\text{sales}} \times 100$$

$$\text{Contribution} = \text{sales} - \text{variable cost}$$

$$= 1,20,000 - 60,000$$

$$= 60,000$$

$$\text{Pv ratio} = \frac{60,000}{1,20,000} \times 100$$

$$= 50\%$$

$$\text{BEP} = \frac{\text{Fixed cost}}{\text{pv ratio}}$$

$$= \frac{20,000}{50\%}$$

$$= 40,000$$

Problem 4

19. **In the design of a jet engine part, the designer has a choice of specifying either an aluminium alloy casting or a steel casting. Either material will provide equal service, but the aluminium casting will weigh 1.2 kg as compared with 1.35 kg for the steel casting.**

The aluminium can be cast for Rs. 80.00 per kg. and the steel one for Rs. 35.00 per kg. The cost of machining per unit is Rs. 150.00 for aluminium and Rs. 170.00 for steel. Every kilogram of excess weight is associated

with a penalty of Rs. 1,300 due to increased fuel consumption. Which material should be specified and what is the economic advantage of the selection per unit? **(Nov/ Dec 2013)**

Solution

(a) Cost of using aluminium metal for the jet engine part:

Weight of aluminium casting/unit = 1.2 kg

Cost of making aluminium casting = Rs. 80.00 per kg

Cost of machining aluminium casting per unit = Rs. 150.00

Total cost of jet engine part made of aluminium/unit

= Cost of making aluminium casting/unit + Cost of machining aluminium casting/unit

= 80 x 1.2 + 150

= 96 + 150

= Rs. 246

b) Cost of jet engine part made of steel/unit:

Weight of steel casting/unit = 1.35 kg

Cost of making steel casting = Rs. 35.00 per kg

Cost of machining steel casting per unit = Rs. 170.00

Penalty of excess weight of steel casting = Rs. 1,300 per kg

Total cost of jet engine part made of steel/unit

= Cost of making steel casting/unit + Cost of machining steel casting/unit

+ Penalty for excess weight of steel casting

= 35 x 1.35 + 170 + 1,300 (1.35 – 1.2)

= Rs. 412.25

DECISION: The total cost/unit of a jet engine part made of aluminium is less than that for an engine made of steel. Hence, aluminium is suggested for making the jet engine part. The economic advantage of using aluminium over steel/unit is Rs. 412.25 – Rs. 246 = Rs. 166.25

Problem 5

20. Suguna Associates has the following details: **(April/May 2015)**

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 (Rupees)

c. If the actual production quantity is 60,000, find

     i.   contribution and

     ii.   margin of safety by all methods.

Solution

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

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

(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

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

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

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

$$Rs = 60,00,000$$

(ii) Margin of safety

Method I

M.S = Sales – Break – even sales

$$= 60,000 \times 200 - 40,00,000$$

$$= 1,20,00,000 - 40,00,000$$

Rs = 80,00,000

Method II

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

Profit = sales – (FC + v × Q)

$$= 60,000 \times 200 - (20,00,000 + 100 \times 60,000)$$

$$= 1,20,00,000 - 80,00,000$$

Rs = 40,00,000

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

Rs = 80,00,000

M.S as percent of sales $= \dfrac{80,00,000}{1,20,00,000} \times 100 = 67\%$

21. What is law of demand and supply? Draw a demand supply curve and explain its determinants. (April/May 2018)

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 respect to the price of that product. The interrelationships between them are shown in Fig. 1.2.

From Fig. 1.2 it is clear that when there is a decrease in the price of a product, the demand for the product increases and its supply decreases. Also, the product is more in demand and hence the demand of 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 the *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 of Fig. 1.2. 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,
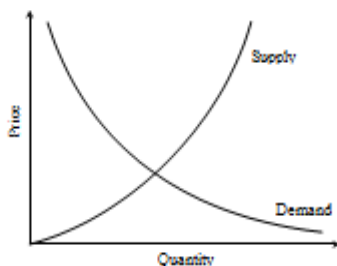
Fig. 1.1 Demand and supply curve.

namely VCDs would also increase. Hence, the prices of related goods influences the demand of a product.

Over a period of time, the preference of the people for a particular product may increase, which in turn, will affect its 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:

- Cost of the inputs
- Technology
- Weather
- 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 labour 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 an advancement in technology used in the 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 woollen products will increase during winter. This means the prices of woollen goods will be increased in winter. So, naturally, manufacturers will supply more volume of woollen goods during winter.

22. Bring out significance of choosing the material for product design selection.   (Nov/Dec 2018)

Ans-Design engineers carry out a series of tests and material analysis both, physical and virtual using 3D solid modeling and simulation in CAD, to identify best material alternative. A virtual test by simulation of 3D prototype of the actual design will evaluate the material suitability and design features for the intended operational conditions on the component.

Factors that should be considered before selecting a material for engineering include:

- Cost of the material
- Its ability to manufacture
- Environmental considerations
- Chemical properties
- Physical properties
- Mechanical attributes

Some Mechanical Material Attributes that Matter Include:

- Tensile strength
- Yield strength
- Fatigue limit
- Impact strength
- Flexural strength and modulus
- Ductility
- Compressive strength
- Roughness and friction coefficient
- Plasticity
- Fracture toughness
- Shear Strength
- Resilience

Design engineers employ different approaches for material selection like, carrying out a class based selection for design requirements and then narrowing down the search to one variation that best suits the design. Another approach to material selection is finalizing the manufacturing process first and then choosing a material that can comply with the selected process and also justify the design requirements.

Besides, if a design under performs, then in this case, design engineers might look for material alternatives to improve the performance of the product.

Selection of a material for an engineering design depends on:

- The Functional Requirements of the Design: e.g : the design should have a certain load carrying capacity, ability to transfer heat etc.

- The Main Objective of the Design: e.g : Improve durability, reduce overall weight of the product/component

- The Constrains of a Design: e.g : Fixed dimensions, material should not buckle under pressure, should be able to retain shape and strength at high temperatures etc.

Why is material selection important?

- If a systematic material selection procedure is not in place, it impacts the design of the product/component making it highly susceptible to failure. Considering the Mechanical Material attributes based on the function, objective and constrains your design, ensures that the design is technically fit to deliver the desired performance.

- Analysis of a design and subjecting it to real working conditions using FEA Analysis and CFD Analysis techniques helps identify the shortcomings and hence identify material properties that need to be altered and improved. This process thus helps choose the best material that augments your designs durability, performance and output.

- Ideal material selection is crucial to ensure that the product does not succumb to extreme conditions and performs well in unpredictable conditions.

  Ideal material choice for your design gives you a competitive edge by affecting and invariably improving the factors such as function, mechanical properties, quality, manufacturability, endurance and performance, environmental impact and the cost of your mechanical product/component design.

(23). With example explain various element of costs. (Nov/Dec 2018)

Ans- The elements that constitute the cost of manufacture are known as the elements of cost. Such element of cost is divided into three categories. In a manufacturing concern, raw materials are converted into a finished product with the help of labour and other service units. They are Material, Labour and Expenses.

Again, these elements of cost are divided into two categories such as Direct Material and Indirect Material, Direct Labour and Indirect Labour, Direct Expenses and Indirect Expenses. All direct material, direct labour and

direct expenses are added to get prime cost. Likewise all indirect material, indirect labour and indirect expenses are added to get overhead. Again, overhead is divided into four categories. They are factory overhead, administration overhead, selling overhead and distribution overhead.

1. Direct Material: It refers to material out of which a product is to be produced or manufactured. The cost of direct material is varying according to the level of output. For example: Milk is the direct material of butter.

2. Indirect Material: It refers to material required to produce a product but not directly and does not form a part of a finished product. For example: Nails are used in furniture. The cost of indirect material is not varying in direct proportion of product.

3. Direct Labour: It refers to the amount paid to the workers who are directly engaged in the production of goods. It varies directly with the output.

4. Indirect Labour: It refers to the amount paid to the workers who are indirectly engaged in the production of goods. It does not vary directly with the output.

5. Direct Expenses: It refers to the expenses that are specifically incurred by the company to produce a product. A product cannot be produced without incurring such expenses. It varies directly with the level of output.

6. Indirect Expenses: It refers to the expenses that are incurred by the organization to produce a product. But, these expenses cannot be easily found out accurately. For example: Power used for production.

7. Overhead: It is the combination of all indirect materials, indirect labour and indirect expenses.

8. Factory Overhead: It is otherwise called Production Overhead or Works Overhead. It refers to the expenses that are incurred in the production place or within factory premises. For example: Indirect material, rent, rates and taxes of factory, canteen expenses etc.

9. Administration Overhead: It is otherwise called Office Overhead. It refers to the expenses that are incurred in connection with the general administration of the company. For example: Salary of administrative staff, postage, telegram and telephone, stationery etc.

10. Selling Overhead: It refers to all expenses incurred in connection with sales. For example: Salary of sales department staff, travelers' commission, advertisement etc.

11. Distribution Overhead: It refers to all expenses incurred in

connection with the delivery or distribution of goods and services from the producer to the consumer. For example: Delivery van expenses. loading and unloading, customs duty, salary of deliverymen etc.

UNIT - 2

VALUE ENGINEERING

PART-A

1. **Classify working capital.** (Nov 2014)
   a. Permanent working capital
   b. Variable working capital

2. **List the internal sources of finance.**

   Retained profit

   Depreciation provisions

   Deferred taxation

   Personal funds

3. **List the external sources of finance.**
   a. Venture capital funds
   b. Loans from financial institutions
   c. Loans from banks
   d. Trade credit

4. **What are the responsibilities of good financial management? (Nov 2014)**

   Profit planning Worth

   maximization

   Procurement of finance

   Capital financing

5. **Enumerate executive function of financial management.**

   Assessment of financial needs in terms of fixed and working capital

   Choosing the sources of funds.

6. **Choosing the sources of funds**

   The specific role of a financial manager includes anticipation of financial needs, acquiring financial resources and allocating funds in business.

7. **What is debenture?** (Nov 2014)

   A debenture is an instrument issued by a company which denotes an obligation resulting from the borrowing of money through the instrument.

8. **Mention any two criteria for buy decision? (April 2015)**

   Fixed Cost

   Better Quality Control

9. **List few factors that need to be considered in making make or buy decision (May / June 2012)**
   Criteria for make (Nov/ Dec 2013)

   The following are the criteria for make:

   1. The finished product can be made cheaper by the firm than by outside suppliers

   2. The finished product is being manufactured only by a limited number of outside firms which are unable to meet the demand.

   3. The part has an importance for the firm and requires extremely close quality control.

   4. The part can be manufactured with the firm's existing facilities and similar to other items in which the company has manufacturing experience.

Criteria for buy (April 2015)

   The following are the criteria for buy:

   1. Requires high investments on facilities which are already available at suppliers plant.

   2. The company does not have facilities to make it and there are more profitable opportunities for investing company's capital.

3. Existing facilities of the company can be used more economically to make other parts.

4. The skill of personnel employed by the company is not readily adaptable to make the part.

5. Patent or other legal barriers prevent the company for making the part.

6. Demand for the part is either temporary or seasonal.

10. Define by value analysis/value engineering? (Nov/ Dec 2012)

According to the Society of American Value Engineers (SAVE), "Value Analysis is the systematic application of recognized techniques which identify the function of a product or service, establish a monetary value for the function and provide the necessary function reliably at the lowest overall cost."

Value analysis is the application of a set of techniques to an existing product with a view to improve its value. It is thus a remedial process. Value engineering is the application of exactly the same set of techniques to a new product at the design stage, project concept or preliminary design when no hardware exists to ensure that bad features are not added. Value engineering, therefore, is a preventive process.

11. How long will it take any sum to triple at 5 percent simple – interest rate? (Nov/ Dec 2012)

Let principal amount, $P = 100$

Then, Simple Interest, $SI = 300$

Rate, $R = 5\%$

Time, $T = ?$

Now,

$SI = (P \times T \times R) / 100$

$300 = (100 \times T \times 5) / 100$

$T = 60$ Years

12. State any two uses of value engineering (May / June 2013)

- Value engineering/analysis identifies and reduces the product cost.
- It modifies and improve the product design
- It increases the performance/utility of the product by economical means.
- It helps to generate new ideas.

13. What is time value of money? (May / June 2013) (Nov 2014)

It represents the growth of capital per unit period. The period may be a month, a quarter, semiannual or a year.

14. Explain function

Function is the purpose for which the product is made.

15. What is Value of the product?

Value of the product is the ratio of performance (utility to cost)

Value = Performance (utility) / Cost

16. Mention any two applications of various interest formulas (Nov/Dec 2013)

Application of Simple Interest

The biggest benefit of simple interest is that it's relatively easy to calculate, since you only need to compute it on the principal amount of a loan or deposit, rather than on the principal amount and accumulated interest of preceding periods

Simple interest is often used

On certificates of deposit for periods of one year or less

On car loans

Application of Compound Interest Formula

There are Some Situations we use CI formula

- In a production unit rate of Growth of a product
- To determine Population Growth (increase or decrease)

17. **Define effective interest rate (April 2015)**

The **effective interest rate**, **effective annual interest rate**, **annual equivalent rate** (**AER**) or simply **effective rate** is the interest rate on a loan or financial product restated from the nominal interest rate as an interest rate with annual compound interest payable in arrears.

It is used to compare the annual interest between loans with different compounding periods like week, month, year, etc.

The effective rate is calculated in the following way, where r is the effective annual rate, i the nominal rate, and C the number of compounding periods per year (for example, 12 for monthly compounding):

$$r = (1 + i \, n) \, n - 1$$

Effective interest rate, $R = (1 + i / C)^C - 1$

where,

i = the nominal interest rate

C = the number of interest periods in a year.

18. **Explain the concept of discounting (Nov 2015)**

Discounting is the process of determining the present value of a payment or a stream of payments that is to be received in the future. Given the time value of money, a rupee is worth more today than it would be worth tomorrow.

19. **What is value engineering? (Nov/Dec2015) (May / June 2012) (Nov 2014)**

It is a special type of cost reduction technique. It critically investigates and analyses the different aspects of materials, design, cost and production of each and every component of the product and produce it economically without decreasing its utility, function or reliability.

Value engineering is the application of exactly the set of techniques to a new product at the design stage, project concept or preliminary design when no hardware exists to ensure that bad features are not added. Value engineering, therefore, is a preventive process.

20. **Mention the Criteria for making decision? (NOV/DEC 2013)**
    Criteria for make

    The following are the criteria for make:

    1. The finished product can be made cheaper by the firm than by outside suppliers

    2. The finished product is being manufactured only by a limited number of outside firms which are unable to meet the demand.

    3. The part has an importance for the firm and requires extremely close quality control.

    4. The part can be manufactured with the firm's existing facilities and similar to other items in which the company has manufacturing experience.

21. **What is value analysis?**

    Value analysis is one of the major techniques of cost reduction and cost prevention. It is a disciplined approach that ensures necessary functions for minimum cost without sacrificing quality, reliability, performance, and appearance.

    Value analysis is the application of a set of techniques to an existing product with a view to improve its value. It is thus a remedial process.

22. **Write any four objectives of value analysis.**

    1. Reduce the cost of the product
    2. Simplify the product
    3. Use (new) cheaper and better materials
    4. Modify and improve product design so as to make it acceptable to consumer.

23. **Define value engineering.   (April/May-2017) (April/May2019)**

    Ans- Value engineering is the application of exactly the set of techniques to a new product at the design stage, project concept or preliminary de- sign when no hardware exists to ensure that bad features are not added. Value engineering, therefore, is a preventive process.

24. What is effective interest rate? (April/May-2017) (April/May2019)

Ans- The effective interest rate, effective annual interest rate, annual equivalent rate (AER) or simply effective rate is the interest rate on a loan or financial product restated from the nominal interest rate as an interest rate with annual compound interest payable in arrears.

It is used to compare the annual interest between loans with different compounding periods like week, month, year, etc.

The effective rate is calculated in the following way, where r is the effective annual rate, i the nominal rate, and C the number of compound- ing periods per year (for example, 12 for monthly compounding):

$$r = (1 + i n) n - 1$$

Effective interest rate, $R = (1 + i / C)^{C} - 1$

where,

i = the nominal interest rate

C = the number of interest periods in a year.

25. State the meaning for the term time value of money. (April/May 2018)

Ans-The time value of money (TVM) is the concept that money available at the present time is worth more than the identical sum in the future due to its potential earning capacity. This core principle of finance holds that provided money can earn interest, any amount of money is worth more the sooner it is received.

26. Identify any two value engineering procedures. (April/May 2018)

Ans- The basic steps of value engineering are as follows:

(a) Blast (i) Identify the product.

(ii) Collect relevant information.

(iii) Define different functions.

(b) Create

(iv) Different alternatives.

(v) Critically evaluate the alternatives.

(c) Refine

(vi) Develop the best alternative.

(vii) Implement the alternative.

26. What is value analysis? **(Nov/Dec-2018)**

Ans- The phrase **value analysis can** be defined as a technique which examines the facts of a function and cost of a product in order **to** determine whether the cost **can** be reduced or altogether eliminated, while retaining all the features of performance and quality of a product or both.

27. What is effective interest rate? **(Nov/Dec-2018)**

Ans- The *effective* annual *interest rate* is the *interest rate* that is actually earned or paid on an investment, loan or other financial product due to the result of compounding over a given time period. It is also called the *effective interest rate*, the *effective rate* or the annual equivalent *rate*.

PART-B

1. **Explain in details about criteria for make or buy decision and its approaches? (April 2015) (May 2013)**

The make-or-buy decision is the act of making a strategic choice between producing an item internally (in-house) or buying it externally (from an outside supplier). The buy side of the decision also is referred to as outsourcing. Make-or-buy decisions usually arise when a firm that has developed a product or part—or significantly modified a product or part—is having trouble with current suppliers, or has diminishing capacity or changing demand.

. Elements of the "make" analysis include:

- Incremental inventory-carrying costs
- Direct labor costs
- Incremental factory overhead costs
- Delivered purchased material costs
- Incremental managerial costs
- Any follow-on costs stemming from quality and related problems
- Incremental purchasing costs
- Incremental capital costs

Cost considerations for the "buy" analysis include:

- Purchase price of the part
- Transportation costs
- Receiving and inspection costs
- Incremental purchasing costs
- Any follow-on costs related to quality or service.

2. **State and explain the functions and aims of value engineering? (Nov 2015)**

Value engineering is used to increase the value of products. Value is a ratio of function to cost. The value of a product can be increased by reducing its cost or increasing the function. Value engineering is an organized technique to reduce the cost of a product without compromising with its quality, reliability, performance, appearance, safety, utility etc.

- Modification in design of product

- By adopting the most efficient manufacturing process
- By changing the source of supply of material
- Possible elimination or addition in the related system

Aims of value engineering/value analysis:

- **Increased profits –** With the cost reduction of a product, the profits of an organization increased. This results in time reduction. It also ensures greater returns on invested capital. The competitive position of company also improves.

- **Improved product Design** – With the modification in design, the customer will get a new and more acceptable product.

- **Efficiency** – It increases the efficiency of employees as it motivates them to come forward with their creative ideas. It also makes contributions to improve human factors such as creativity, team work and positive attitude among employees. The team approach also improves the decision making.

- **Time consideration** – A product has value for the customer if it is available to him on time. So time element has great importance in value engineering. It may have no value if it arrives later.

- **Improvement in quality** – This results in improvement in quality, reliability, performance and maintainability of a product.

3. **What is time value of money? How it is useful in taking investment related decision? (Nov 2015) (April 2015)**

The time value of money (TVM) is an important concept to investors because a dollar on hand today is worth more than a dollar promised in the future; the dollar on hand today can be used to invest and earn interest or capital gains. A dollar promised in the future is actually worth less than a dollar today because of inflation.

The time value of money can be broken up into two areas: present value and future value.

1.Present Value

Present value = (future cash flow) / (1+ rate of return)^number of periods

Present value determines what a cash flow to be received in the future is worth in today's dollars. It discounts the future cash flow back to the present date, using the average rate of return and the number of periods. No matter what the present value is, if you invest that present value amount at the specified rate of return and number of periods, the investment would grow into the future cash flow amount.

2.Future Value

Future value = present value x {1 + (rate of return x number of periods)}

Future value determines what a cash flow received today is worth in the future, based on interest rates or capital gains. It calculates what a current cash flow would be worth in the future, if it was invested at a specified rate of return and number of periods.

Both present value and future value take into account compounding interest or capital gains, another important aspect for investors looking for good investments.

·Money today is worth more than the same quantity of money in the future. You can invest a dollar today and receive a return on your investment.

· Loans, investments, and any other deal must be compared at a single point in time to determine if it's a good deal or not.

· The process of determining how much a future **cash flow** is worth today is called **discounting**. It is done for most major business transactions during investing decisions in **capital budgeting**.

4. Why is the Time Value of Money Important?

The time value of money is a concept integral to all parts of business. A business does not want to know just what an investment is worth todayit wants to know the total value of the investment. What is the investment worth in total? Let's take a look at a couple of examples.

Suppose you are one of the lucky people to win the lottery. You are given two options on how to receive the money.

1. Option 1: Take Rs. 5,000,000 right now.
2. Option 2: Get paid Rs. 600,000 every year for the next 10 years.

In option 1, you get Rs. 5,000,000 and in option 2 you get Rs. 6,000,000. Option 2 may seem like the better bet because you get an extra Rs. 1,000,000, but the time value of money theory says that since some of the

money is paid to you in the future, it is worth less. By figuring out how much option 2 is worth today (through a process called discounting), you'll be able to make an apples-to-apples comparison between the two options. If option 2 turns out to be worth less than Rs. 5,000,000 today, you should choose option 1, or vice versa.

Let's look at another example. Suppose you go to the bank and deposit Rs.100. Bank 1 says that if you promise not to withdraw the money for 5 years, they'll pay you an interest rate of 5% a year. Before you sign up, consider that there is a cost to you for not having access to your money for 5 years. At the end of 5 years, Bank 1 will give you back Rs.128. But you also know that you can go to Bank 2 and get a guaranteed 6% interest rate, so your money is actually worth 6% a year for every year you don't have it. Converting our present cash worth into future value using the two different interest rates offered by Banks 1 and 2, we see that putting our money in Bank 1 gives us roughly Rs.128 in 5 years, while Bank 2's interest rate gives Rs.134. Between these two options, Bank 2 is the better deal for maximizing future value. $FV = PV.(1+i)^t$

5. Mention the basic principles of brain storming? (April 2015)

Some of the important principles of brain storming which are useful in value analysis are now listed.

(i) *A quality idea comes from quantity of ideas.* If the number of ideas generated is more, the more good solutions do turn up.

(ii) *Creative ideas emerge from unconventional thinking.* This is possible when members of the group "talk off the top of their heads" and voice weird ideas as they flash through their minds, regardless of how stupid or impractical they may appear. Often, non-technical personnel can prove to be the greatest innovators in technical areas since their viewpoints are objective and they do not know that some of their ideas are technically not feasible at all. So it is preferable to include one or two non-technical persons in the study team.

Members are to be told by the team leader in the beginning of the session itself, not to breathe a word of criticism of even the most weirdest idea.

(iii) *Spontaneous evaluation of ideas curbs imaginative thinking and retards the flow of creative ideas.* The group should not evaluate

the alternatives suggested by its member immediately since immediate evaluation may curb imaginative thinking and slow down the flow of creative ideas.

(iv) *Hitch-hiking on the ideas often lead to better ideas.* Participants have to improve upon ideas of other members either directly or by combining more ideas in addition to contributing ideas of their own. A brilliant idea may not be a practical one initially, or it may look to be silly or useless but discussions can convert it into a valuable one.

(v) *Creativity is a regenerative process and the recording of ideas as they emerge helps serve as a catalyst to generate more ideas.* Memory may not retain all ideas or recall them when they are needed. So, a stenographer may be asked to record ideas simultaneously. A tape recorder can also be used for this purpose or even ideas can be written on a blackboard. These recorded ideas can be reviewed at some later date.

(vi) *When ideas cease to flow, short diversions enable the mind to rebound with new ideas after recuperation.* Members of the syndicate may reach a stage where new ideas do not come. At such a stage, short diversions—rest, favourite sport, hobby, lunch or tea break, etc.—may be taken during which members are advised to sleep over the ideas and report fresh after the break.

Such short diversions enable mind to recoup and rebound with new ideas.

6. Write briefly about time value for money? (April 2015)

☐ Money loses its value over time which makes it more desirable to have it now rather than later. There are several reasons why money loses value over time. Most obviously, there is inflation which reduces the buying power of money.

☐ Time Value of Money concept attempts to incorporate the above considerations into financial decisions by facilitating an objective evaluation of cash flows from different time periods by converting them into present value or future value equivalents. This ensures the comparison of 'like with like'.

7. Mention the basic steps of value engineering. / Describe the procedure of value engineering with an example? (Nov 2013) (May 2012) (April/May-2019)

Value engineering (**VE**) is a systematic method to improve the "value" of goods or products and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost.

The basic steps of value engineering are as follows:

    (a) Blast

        (i) Identify the product.

        (ii) Collect relevant information.

        (iii) Define different functions.

    (b) Create

        (iv) Different alternatives.

        (v) Critically evaluate the alternatives.

    (c) Refine

        (vi) Develop the best alternative.

        (vii) Implement the alternative.

Step 1: Identify the product. First, identify the component for study. In future, any design change should add value and it should not make the product as obsolete one. Value engineering can be applied to a product as a whole or to sub-units.

Step 2: Collect relevant information. Information relevant to the following must be collected:

_ Technical specifications with drawings

_ Production processes, machine layout and instruction sheet

_ Time study details and manufacturing capacity

_ Complete cost data and marketing details

_ Latest development in related products

Step 3: Define different functions. Identify and define the primary, secondary and tertiary functions of the product or parts of interest. Also, specify the value content of each function and identify the high cost areas.

Step 4: Different alternatives. Knowing the functions of each component part and its manufacturing details, generate the ideas and create different alternatives so as to increase the value of the product. Value engineering should be done after a **brain storming** session. All feasible or non-feasible suggestions are recorded without any criticism; rather, persons are encouraged to express their views freely.

Step 5: Critically evaluate the alternatives. Different ideas recorded under step 4 are compared, evaluated and critically assessed for their virtues, validity and feasibility as regards their financial and technical requirements. The ideas technically found and involving lower costs are further developed.

Step 6: Develop the best alternative. Detailed development plans are made for those ideas which emerged during step 5 and appear most suitable and promising. Development plans comprise drawing the sketches, building of models, conducting discussions with the purchase section, finance section, marketing division, etc.

Step 7: Implement the alternative. The best alternative is converted into a proto-type manufacturing model which ultimately goes into operation and its results are recorded.

8. Discuss the advantage and application areas of value engineering (Nov 2012)

Advantages

The advantages of value engineering are as follows:

1. It is a much faster cost reduction technique.

2. It is a less expensive technique.

3. It reduces production costs and adds value to sales income of the product.

Applications

The various application areas of value engineering are machine tool industries, industries making accessories for machine tools, auto industries, import substitutes, etc.

Problems

9. **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. (Nov / Dec 2012) (April/May 2015)**
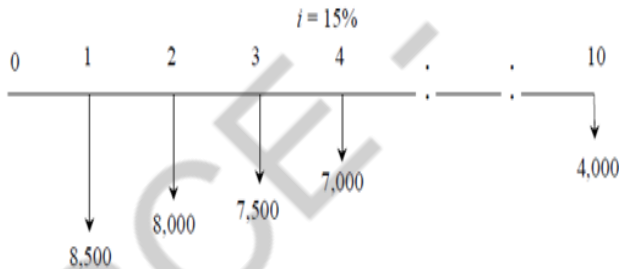
Solution

Here,

$A_1 = $ Rs 8,500, $\quad G = $ Rs 500

$i = 15\%$ $\qquad$ $n = 10$ years

$A = ?$ & $F = ?$

The cash flow diagram is shown in Fig.

Cash flow diagram of uniform gradient series annual equivalent amount.

$$A = A1 - G\frac{(1+i)^n - in - 1}{i(1+i)^n - i}$$

$$A = A1 - G(A/G, i, n)$$

$$= 8,500 - 500(A/G, 15\%, 10)$$

$$= 8,500 - 500 \times 3.3832$$

$$= \text{Rs. } 6,808.40$$

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:

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

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

$$= 6,808.40(20.304)$$

$$= \text{Rs. } 1,38,237.75$$

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

Problem 2

10. **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. (Nov/ Dec 2013)**

Solution

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

$$i = 18\% \text{ compounded annually}$$

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

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

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

$$= 20,000 \times 5.234 = \text{Rs. } 1,04,680$$

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

Problem 3

11. **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. (Nov/ Dec 2013)**

Solution

$$F = \text{Rs. } 5,00,000$$

$$n = 15 \text{ years}$$

$$i = 18\% \ A = ?$$

The corresponding cash flow diagram is shown in Fig..
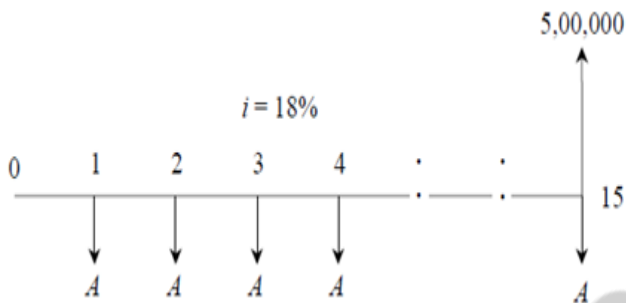
$$A = F\frac{i}{(1+i)^n - 1} = F(A/F, i, n)$$

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

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

$$A = Rs = 8,200$$

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

Problem 4

12. 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. (Nov/ Dec 2012)

Solution

$$F = Rs. \ 5,00,000$$

$$n = 15 \ years$$

$$i = 18\%$$

$$A = ?$$

The corresponding cash flow diagram is shown in Fig.
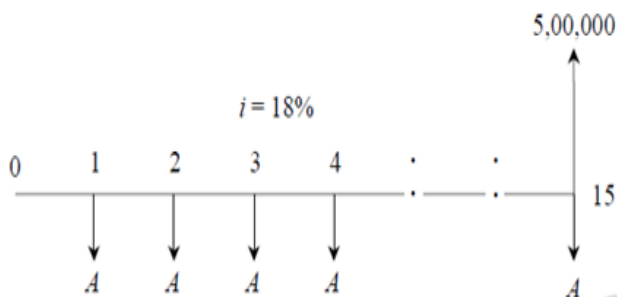
Cash flow diagram of equal-payment series sinking fund.

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

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

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

$$= Rs. \ 8,200$$

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

Problem 5

13. **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. (April/May 2015)**

Solution

$$F = Rs. \ 1,00,000$$

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

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

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

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

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

$$= Rs. \ 24,720$$

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

Problem 6

14. **Sri Nethra Industries Ltd., offers 12% interest on Fixed deposits. What is the effective rate of interest if compounding is done (Nov 2014)**

   (i) Half yearly

   (ii) Quarterly

   (iii) Monthly

Solution

Effective Interest Rate

$$R = \left\{1 + \frac{i}{c}\right\}^{c} - 1$$

(i) Half Yearly

C= 2 times

No. of half in the year = 2

$$R = \left\{1 + \frac{0.12}{2}\right\}^{2} - 1$$

   = 12.36%

(ii) Quarterly

C= 4 times

No. of quarters in the year = 4

$$R = \left\{1 + \frac{0.12}{4}\right\}^{4} - 1$$

   = 12.55%

(iii) Monthly

C= 12 times

$$R = \left\{1 + \frac{0.12}{12}\right\}^{12} - 1$$

   = 12.68%

Problem 7

15. **Mr. Nimish Expects to receive Rs. 10,000 at beginning of each year for 5 years. Calculate the present value of annuity due, assuming an interest rate of 8% (Nov 2014)**

Solution:
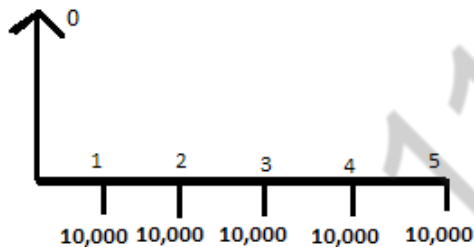
A = Rs. 10,000

$i = 8\%$

$n = 5$ years

$P = ?$

$P = A$

$\quad = A\,(P/A, i, n)$

$\quad = 10,000 \times (P/A, 8\ 5)$

$\quad = 10,000 \times 3.9927$

$\quad = 39,927$

16. Explain various types of value in value engineering with examples
Value Engineering (April/May 2018)

Ans-Value engineering is an approach to productivity improvement that attempts to increase the value obtained by a customer of a product by offering the same level of functionality at a lower cost.

The term *Value Engineering* is sometimes used to refer to the application of this process of cost reduction prior to manufacture, while *Value Analysis* refers to the process when appied to products currently being manufactured.

Both attempt to eliminate costs that do not contribute to the value and performance of the product or service. The approach is more common in manufacturing.

VE originated in General Electric (under Lawrence Miles) during the Second World War. They were seeking ways to make the most efficient use of war-limited funds and raw materials. They found in most cases alternative materials and processes delivered performance and cost at least as good and often better than the original. This led them to formalize the approach and devise a team-oriented technique that determines the value of each part and each product.

Value engineering critically examines the contribution made to product value by each feature of a design. It then looks to deliver the same contribution at lower cost.

Different types of value are recognized by the approach:

- *Use value* relates to the attributes of a product which enable it to perform its function.
- *Cost value* is the total cost of producing the product.
- *Esteem value* is the additional premium price which a product can attract because of its intrinsic attractiveness to purchasers.
- *Exchange value* is the sum of the attributes which enable the product to be exchanged or sold.

Although the relative magnitude of these different types of value will vary between products, and perhaps over the life of a product, VE attempts to identify the contribution of each feature to each type of value through systematic analysis and structured creativity-enhancing techniques.

Value engineering programs are best delivered by multi-skilled teams consisting of designers, purchasing specialists, operations personnel, and financial analysts.

17. Explain the concept of time value of money. Also give examples for application of time value of   money principle. (Nov/Dec-2018)

Ans- Time Value of Money (TVM)

Time value of <u>money</u> is the difference between an amount of <u>money</u> in the present and that same amount of <u>money</u> in the future. Having <u>money</u> now is more valuable than having <u>money</u> later.

The <u>present</u> amount is called the <u>present value</u>, the future amount is called the <u>future value</u>, and the appropriate <u>rate</u> that relates the two amounts is called the <u>discount rate</u>.

<u>Present Value</u> = Future Value / (1 + Discount Rate)

Future Value = <u>Present Value</u> x (1 + Discount Rate)

<u>Time Value of Money Examples</u>

Now, let's look at time value of money examples. If you invest $100 (the <u>present value</u>) for 1 year at a 5% <u>interest rate</u> (the <u>discount rate</u>), then at the end of the year, you would have $105 (the <u>future value</u>). So, according to this example, $100 today is <u>worth</u> $105 a year from today.

$105 = $100 x 1.05

$100 = $105 / 1.05

Likewise, $100 a year from today, <u>discounted</u> back at 5%, is worth only $95.24 today.

$95.24 = $100 / 1.05

To calculate the time value of <u>money</u> for a period longer than one year, you simply raise the <u>discount</u> factor by the appropriate number of time periods. For example, to calculate the future <u>value</u> of $100 at 5% for 5 years:

$127.63 = $100 x $(1.05)^5$

18. **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 = $ 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 = $ 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.

19. **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 = $ Rs. 1,00,000
$i = 15\%$, compounded annually
$n = 10$ years
$P = F/(1 + i)^n = F(P/F, i, n)$

$= 1{,}00{,}000 \ (P/F, 15\%, \ 10)$
$= 1{,}00{,}000 \times 0.2472$
$= $ 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.

20. 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 = 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, $r = 12\%/4$

$\qquad\qquad$ = 3%, compounded quarterly.

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

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

METHOD 2

$$= (1 + 12\%/4)^4 - 1$$

$$= 12.55\%, \text{ compounded annually.}$$

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

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

UNIT - 3

CASH FLOW

PART - A

1. **Explain short run period in economics.** **(Nov 2014)**

   Short run period is defined as a period during which at least one element of factor input is in fixed supply, the fixed factor input is plant and equipment.

2. **What is meant by opportunity cost?** **(May / June 2013)**

   Opportunity cost of a factor refers to its value in its next best alternative use. Opportunity cost is also known as transfer earnings on the foregone alternatives.

3. **Define safety margin.** **(Nov 2014)**

   Safety margin is the difference between the actual sales quantity and the break even sales quantity expressed in monetary terms or as a percentage.

4. **State four pricing methods employed by businessmen.**
   - Full cost pricing
   - Target rate of return pricing
   - Going rate pricing
   - Sealed bid pricing

5. **Define cost.**

   Cost is the amount of expenditure notional or actual, attributes to a thing. Cost refers to sacrifice or receive some benefits.

6. **Define price.**

   Price is defined as the exchange value of a product or a service quantified in monetary terms.

7. **What is the concept of 'Present worth method of comparison'? (NOV/DEC 2013)**

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 comparison the present worth amounts of the alternative.

8. **What is the concept of 'future worth method of comparison'? (April 2015)**

The use of future worth method for comparison of mutually exclusive alternatives will be illustrated in the following examples. Similar to present worth method, first the comparison of equal life span alternatives by future worth method will be illustrated followed by comparison of different life span alternatives.

In this method, 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

9. **What is the concept of 'Annual equivalent method of comparison'?**

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 cost based comparison will be selected as the best alternative.

10. **What is the idea of 'rate of return method of comparison'? (April 2015)**

The gain or loss on an investment over a specified period, expressed as a percentage increase over the initial investment cost. Gains on investments are considered to be any income received from the security plus realized capital gains.

11. **What are cash equivalents? (May / June 2012)**

A cash equivalent is an investment having a maturity of three months or less. it should be at minimal risk of a change in value. it is available for immediate use. It includes coins, currency, Treasury bills, Commercial paper, etc

12. **Is it possible for a cash balance to decrease when the company makes a net profit for any given period? (May / June 2012)**

Yes. Profit and cash-flow are related but they are not directly linked. Profit is a measure of an company's ongoing sustainability while cash-flow is a measure of the company's ability to pay its bills as they become due.

The cash-flow for a particular period is the closing cash balance arrived at after deducting the cash-out (paid) from the cash-in (received). Profit on the other hand, is the amount that remains after deducting from the revenue earned, the expenses incurred in earning that revenue.

13. **Draw a neat sketch of present worth function graph (Nov/ Dec 2012)**
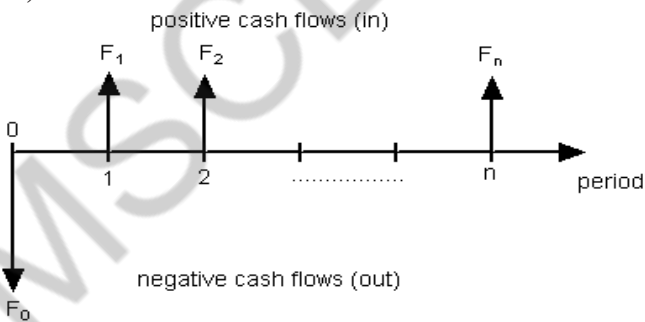
engineeringtoolbox.com

14. **Draw a neat sketch of cost dominated cash flow diagram.**
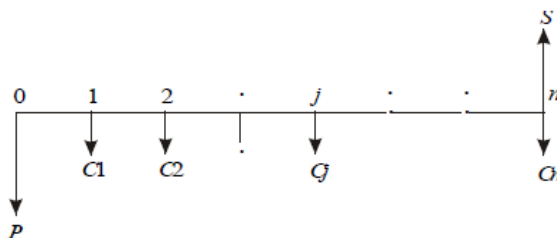
15. Write short notes on rate of return method. (Nov/ Dec 2012)

- The rate of return of a cash flow pattern is the interest rate at which the present worth of that cash flow pattern reduces to zero.

- In this method of comparison, the rate of return for each alternative is computed. Then the alternative which has the highest rate of return is selected as the best alternative.

- A generalized cash flow diagram to demonstrate the rate of return method of comparison is presented in Fig
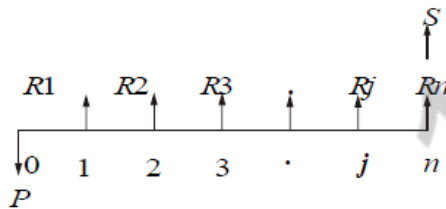
Fig. Generalized cash flow diagram.

16. What is cost dominated cash flow diagram (May / June 2013)

- The cost outflow will be assigned with positive sign and profit, revenue salvage value all inflows etc,.

- Will be assigned with negative sign is called cost dominated cash flow.

17. Define rate of return method (May / June 2013)

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

18. What is the basis of decision made under method of comparison of alternatives?

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

19. What are the methods of cash flow? (Nov 2015)

Cash flow statement shows the changes in the cash position of an organization between 2 periods.

Methods of cash flow

1. Cash flow from Operating Activities

    a. Direct Method

    b. Indirect Method

2. Cash Flow from Investing Activities

3. Cash Flow from Financing Activities

20. 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. Draw the Cash flow diagram if interest rate is 18%.
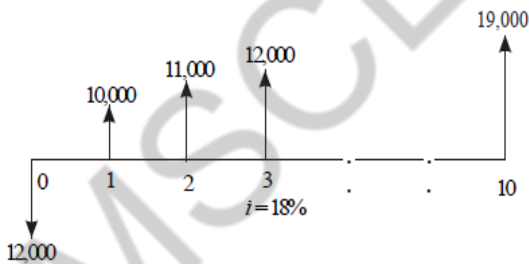
21. What is future worth? **(April/May-2017)**

Ans-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.

22. State the application of rate of return method. (April/May-2017)

Ans- The **rate of return** is used to measure growth between two periods, rather than over several periods. The RoR can be used for many purposes, from evaluating investment growth to year-over-year changes in company revenues. The RoR calculation does not consider the effects of inflation

23. Write the formula to calculate rate of return. (April/May-2018 & April/May-2019)

$$\text{Rate of Return} = \frac{\text{Ending value of investment} - \text{Beginning value of investment}}{\text{Beginning value of investment}} \times 100$$

Ans- The standard formula for calculating ROR is as follows

24. What is the formula used to calculate present value.

(April/May-2018)

Ans-

PV Formula and Calculation

$$\text{Present Value} = \frac{FV}{(1+r)^n}$$

where:

FV = Future Value

r = Rate of return

n = Number of periods

25. What do you mean by present worth method?   (Nov/Dec-2018)

Ans- In this **method** of comparison, the cash flows of each alternative **will** be reduced to time zero by assuming an interest rate **i** also the cash flows of each alternative **will** be reduced to time zero by assuming an interest rate **i**.

26. What is cost dominated cash flow?   **(Nov/Dec-2018)**

Ans- In a **cost dominated cash flow** diagram, the **costs** (outflows) will be assigned with positive sign and the profit, revenue, salvages value (all inflows), etc. will be assigned with negative sign. The **costs** (outflows) will be assigned with negative sign.

27. Write the potential source of cash inflow over the project life. (April/May-2019)

Ans - Cash Flows From Operations

- Cash receipts from sales.
- Cash received from earnings on investments.
- Payments to suppliers and employees.
- Payments for interest and taxes.
- Increases or decreases in accounts receivable, inventory and prepaid expenses.
- Increases or decreases in accounts payable.

1. **Explain the concept of cash flow and different methods of comparison of alternative? List the merits of each? (May 2013)**

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

Comparison of Alternatives

      1. Alternative Comparisons.

      2. Present Worth Analysis

      3. Annual Cost Analysis

      4. Rate of Return Analysis

      5.-Benefit cost Analysis

      6. Break-Even Analysis

    1.Alternative Comparisons: In these problems, two or more mutually exclusive investments compete for limited funds. A variety of methods exists for selecting the superior alternative from a group of proposals. Each method has its own merits and applications.

    2.Present Worth Analysis : The present worth method is restricted to evaluating alternatives that are mutually exclusive and that have the same lives. This method is suitable for ranking the desirability of alternatives.

    3. Annual Cost Analysis : Alternatives that accomplish the same purpose but that have unequal lives must be compared by the annual cost method. The annual cost method assumes that each alternative will be replaced by an identical twin at the end of its useful life (i.e., infinite renewal).

    4**. Rate of Return Analysis:** The rate of return of an investment is the interest rate that would yield identical profits if all money was invested at that rate.

    5. **Benefit cost Analysis:** The benefit-cost ratio method is often used in

municipal project evaluations where benefits and costs accrue to different segments of the community. With this method, the present worth of all benefits (irrespective of the beneficiaries) is divided by the present worth of all costs.

6. **Break-Even Analysis :** Break-even analysis is a method of determining when the value of one alternative becomes equal to the value of another. IT is commonly used to determine when costs exactly equal revenue. If the manufactured quantity is less than the break-even quantity,

a loss is incurred. If the manufactured quantity is greater than the break-even quantity, a profit is made.

2. Discuss present worth method and future worth method of comparison of alternatives (Nov 2014 / 2015)

Present worth method

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.

Future worth method

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.

In this section, several examples highlighting the applications of the future worth method of comparison are presented.

3. What is the rate of return method? Explain with suitable example (Nov 2015) (May-2018)

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.

The first step is to find the net present worth of the cash flow diagram using the following expression at a given interest rate, i.

$$PW(i) = -P + R1/(1 + i)1 + R2/(1 + i)2 + ... + Rj/(1 + i) j + ... + Rn/(1 + i)n + S/(1 + i)n$$

Example : 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.

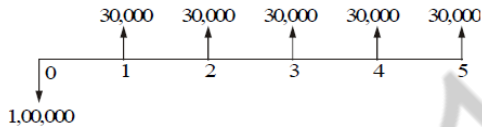| Period	0	1	2	3	4	5
Cash flow (RS)	-1,00,000	30,000	30,000	30,000	30,000	30,000

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.

The present worth function for the business is

$PW(i) = -1,00,000 + 30,000(P/A, i, 5)$

When $i = 10\%$,

$PW(10\%) = -1,00,000 + 30,000(P/A, 10\%, 5)$

$= -1,00,000 + 30,000(3.7908)$

$= $ Rs. 13,724.

When $i = 15\%$,

$PW(15\%) = -1,00,000 + 30,000(P/A, 15\%, 5)$

$= -1,00,000 + 30,000(3.3522)$

$= $ Rs. 566.

When $i = 18\%$,

$PW(18\%) = -1,00,000 + 30,000(P/A, 18\%, 5)$

$= -1,00,000 + 30,000(3.1272)$

$= $ Rs. $- 6,184$

$i = 15\% + $ ⎡ 566- 0 ⎤ x (3%)

566-(-6184)

$= 15\% + 0.252\%$

$= 15.252\%$

Therefore, the rate of return for the new business is 15.252%.

4. **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:**

Bid	Engineer's estimates		
	Initial cost (Rs.)	Service life (years)	Annual operations &maintenance cost (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. (April/May 2015)

Solution

Bid 1: Alpha Elevator Inc.

Initial cost, P = Rs. 4,50,000
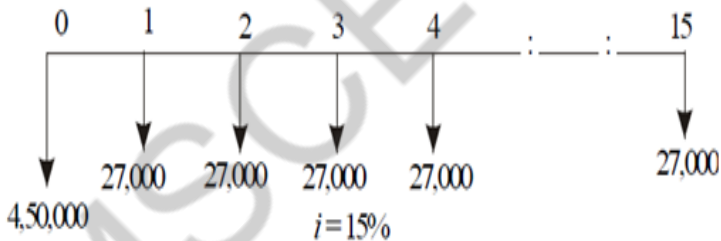
The present worth of the above cash flow diagram is computed as follows:

$$PW(15\%) = 4,50,000 + 27,000(P/A, 15\%, 15)$$
$$= 4,50,000 + 27,000 \times 5.8474$$
$$= 4,50,000 + 1,57,879.80$$
$$= \text{Rs. } 6,07,879.80$$

Bid 2: Beta Elevator Inc.

Initial cost, P = Rs. 5,40,000

Annual operation and maintenance cost, A = Rs. 28,500

Life = 15 years

Interest rate, i = 15%, compounded annually.
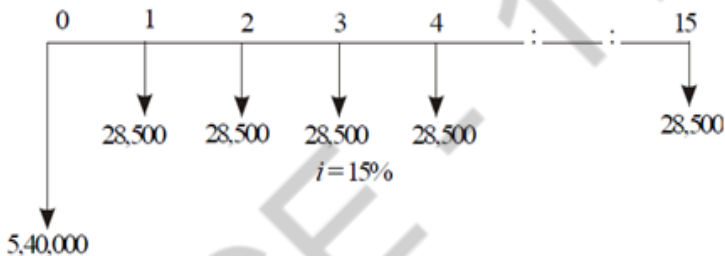
The present worth of the above cash flow diagram is computed as follows:

$$PW(15\%) = 5,40,000 + 28,500(P/A, 15\%, 15)$$
$$= 5,40,000 + 28,500 \times 5.8474$$
$$= 5,40,000 + 1,66,650.90$$
$$= \text{Rs. } 7,06,650.90$$

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.

5. **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. Suggest the best technology which is to be implemented based on the present worth method of comparison assuming 20% interest rate, compounded annually. (Nov/ Dec 2013)**

Table

	Initial outlay	Annual revenue	Life
	(Rs.)	(Rs.)	(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.
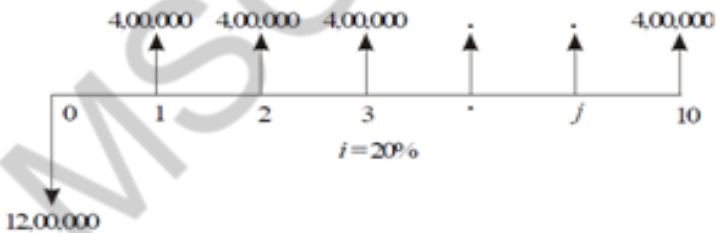
TECHNOLOGY 1

Initial outlay, P = Rs. 12,00,000
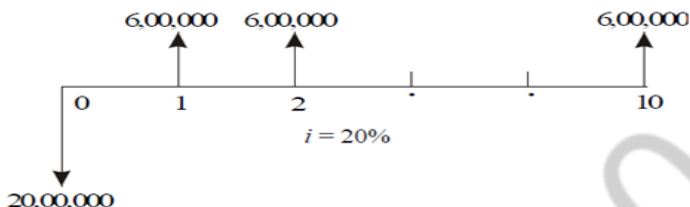
Annual revenue, A = Rs. 4,00,000

Interest rate, i = 20%, compounded annually

Life of this technology, n = 10 years

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

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 = Rs. 20,00,000

Annual revenue, A = Rs. 6,00,000

Interest rate, i = 20%, compounded annually

Life of this technology, n = 10 years

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

The present worth expression for this technology is

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

TECHNOLOGY 3

Initial outlay, P = Rs. 18,00,000

Annual revenue, A = Rs. 5,00,000

Interest rate, i = 20%, compounded annually

Life of this technology, n = 10 years

The cash flow diagram of this technology is shown in Fig.
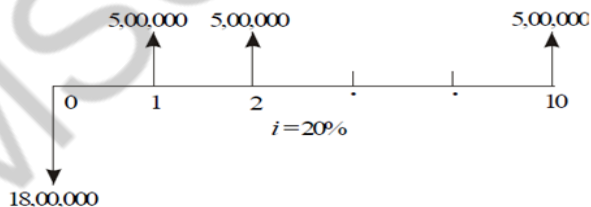
The present worth expression for this technology is

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

6. A company is planning to purchase an advanced machine centre. Three original manufacturers have responded to its tender whose particulars are tabulated as follows: (Nov/ Dec 2013)

Manufacturer	Down payment	Yearly equal installment	No. of installments
	(Rs.)	(Rs.)	
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**
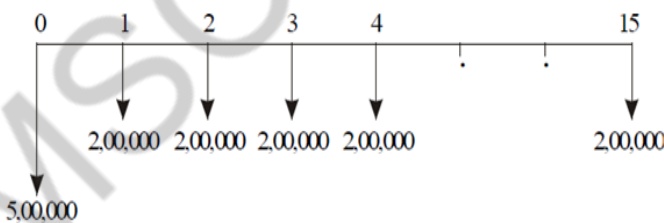
Down payment, $P = $ Rs. 5,00,000

Yearly equal installment, $A = $ Rs. 2,00,000

$n = 15$ years

$i = 20\%$, compounded annually

The cash flow diagram for manufacturer 1 is shown in Fig.

The annual equivalent cost expression of the above cash flow diagram is

$$AE_1(20\%) = 5,00,000(A/P, 20\%, 15) + 2,00,000$$
$$= 5,00,000(0.2139) + 2,00,000$$
$$= 3,06,950$$

Alternative 2
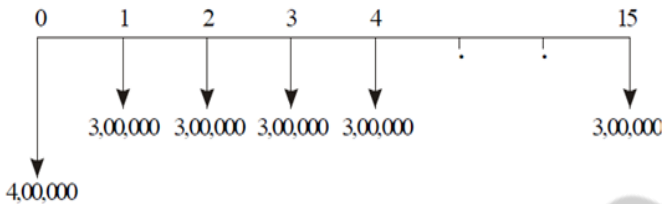
Down payment, $P = $ Rs. 4,00,000

Yearly equal installment, $A = $ Rs. 3,00,000

$n = 15$ years

$i = 20\%$, compounded annually

The cash flow diagram for the manufacturer 2 is shown in Fig.

The annual equivalent cost expression of the above cash flow diagram is

$$AE_2(20\%) = 4,00,000(A/P, 20\%, 15) + 3,00,000$$
$$= 4,00,000(0.2139) + 3,00,000$$
$$= \text{Rs. } 3,85,560.$$

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.
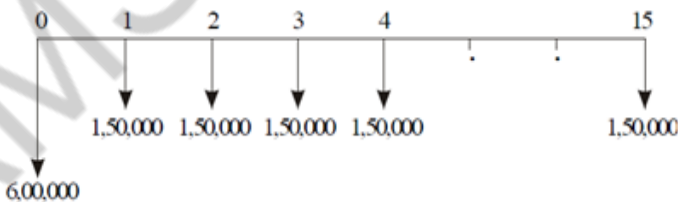
Alternative 3

Down payment, $P = $ Rs. 6,00,000

Yearly equal installment, $A = $ Rs. 1,50,000

$n = 15$ years

$i = 20\%$, compounded annually

The cash flow diagram for manufacturer 3 is shown in Fig.

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.

7. A company must decide whether to buy machine A or machine B: (Nov/ Dec 2012)

	Machine A	Machine B
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
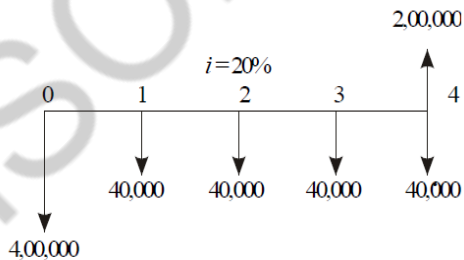
Initial cost of the machine, P = Rs. 4,00,000

Life, n = 4 years

Salvage value at the end of machine life, S = Rs. 2,00,000

Annual maintenance cost, A = Rs. 40,000

Interest rate, i = 12%, compounded annually.

The cash flow diagram of machine A is given in Fig.

The future worth function of Fig is

$$FW_A(12\%) = 4,00,000 \text{ x } (F/P, 12\%, 4) + 40,000 \text{ x } (F/A, 12\%, 4) - 2,00,000$$
$$= 4,00,000 \text{ x } (1.574) + 40,000 \text{ x } (4.779) - 2,00,000$$
$$= \text{Rs. } 6,20,760$$

Machine B
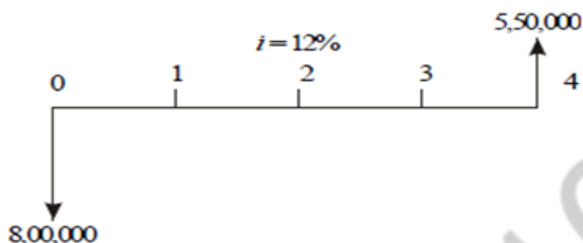
Initial cost of the machine, P = Rs. 8,00,000 Life, n = 4 years

Salvage value at the end of machine life, S = Rs. 5,50,000

Annual maintenance cost, A = zero.

Interest rate, $i = 12\%$, compounded annually.

The cash flow diagram of the machine B is illustrated in Fig.

The future worth function of Fig is

$$FW_B(12\%) = 8,00,000 \times (F/P, 12\%, 4) - 5,50,000$$
$$= 8,00,000 \times (1.574) - 5,50,000$$
$$= \text{Rs. } 7,09,200$$

The future worth cost of machine A is less than that of machine B. Therefore, machine A should be selected.

8. **A transport company has been looking for a new tyre for its truck and has located the following alternatives: (Nov / Dec 2012)**

Brand	Tyre warranty	Price per tyre
	(months)	(Rs.)
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?
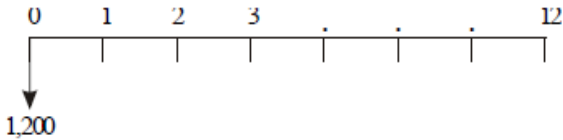
Solution In all the cases, the interest rate is 12%. This is equivalent to 1% per month.

Brand A

Tyre warranty = 12 months

Price/tyre = Rs. 1,200

The cash flow diagram for brand A is shown in Fig.

The annual equivalent cost expression of the above cash flow diagram is

$$AE(1\%) = 1,200(A/P, 1\%, 12)$$
$$= 1,200(0.0888)$$
$$= Rs.\ 106.56$$

Brand B

Tyre   warranty   =   24 months

Price/tyre = Rs. 1,800

The cash flow diagram for brand B is shown in Fig

The annual equivalent cost expression of the above cash flow diagram is

$$AE(1\%) = 1,800(A/P, 1\%, 24)$$
$$= 1,800(0.0471)$$
$$= Rs.\ 84.78$$

Brand C

Tyre   warranty   =   36 months

Price/tyre = Rs. 2,100

The cash flow diagram for brand C is shown in Fig

The annual equivalent expression of the above cash flow diagram is

$$AE(1\%) = 2,100(A/P, 1\%, 36)$$
$$= 2,100(0.0332)$$
$$= \text{Rs. } 69.72$$

Brand D

Tyre warranty = 48 months

Price/tyre = Rs. 2,700

The cash flow diagram for brand D is shown in Fig

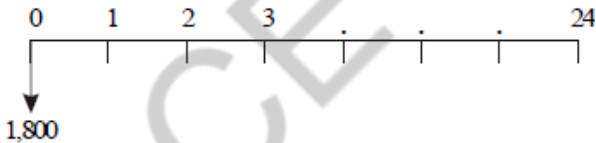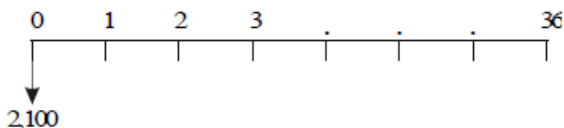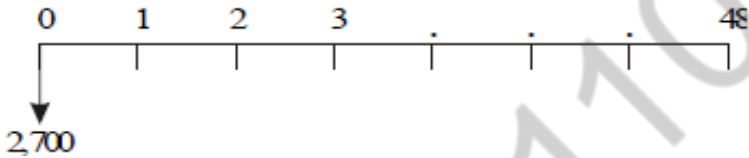The annual equivalent cost expression of the above cash flow diagram is

$$AE(1\%) = 2,700(A/P, 1\%, 48)$$
$$= 2,700(0.0263)$$
$$= \text{Rs. } 71.01$$

Here, minimum common multiple lives of tyres is 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.

9. **Consider the following two mutually exclusive alternatives:**

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

At $i = 18\%$, select the best alternative based on future worth method of comparison.

Solution Alternative A

Initial investment, P = Rs. 50,00,000

Annual equivalent revenue, A = 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

The future worth amount of alternative B is computed as

$$FWA(18\%) = -50,00,000(F/P, 18\%, 4) + 20,00,000(F/A, 18\%, 4)$$
$$= -50,00,000(1.939) + 20,00,000(5.215)$$
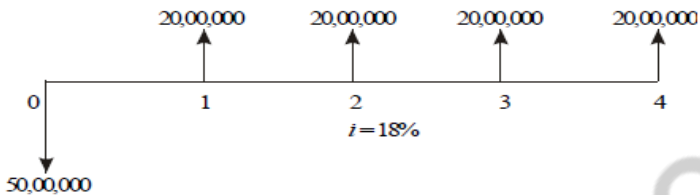$$= \text{Rs. } 7,35,000$$

Alternative B

Initial investment, $P = \text{Rs. } 45,00,000$

Annual equivalent revenue, $A = \text{Rs. } 18,00,000$

Interest rate, $i = 18\%$, compounded annually

Life of alternative B = 4 years

The cash flow diagram of alternative B is illustrated in
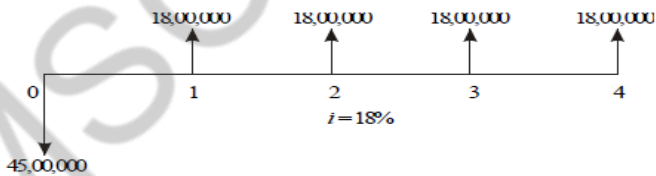
The future worth amount of alternative B is computed as

$$FWB(18\%) = -45,00,000(F/P, 18\%, 4) + 18,00,000(F/A, 18\%, 4)$$
$$= -45,00,000(1.939) + 18,00,000(5.215)$$
$$= \text{Rs. } 6,61,500$$

The future worth of alternative A is greater than that of alternative B. Thus, alternative A should be selected

10. A company is planning to purchase an advanced machine centre. Three original manufacturers have responded to its tender whose particulars are tabulated as follows:

Manufacturer	Down payment (Rs)	Yearly instalment (Rs)	Equal No. of instalments
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 = Rs. 5,00,000

Yearly equal installment, A = Rs. 2,00,000

$n = 15$ years

$i = 20\%$, compounded annually

The cash flow diagram for manufacturer 1 is shown in

The annual equivalent cost expression of the above cash flow diagram is

$AE1(20\%) = 5,00,000(A/P, 20\%, 15) + 2,00,000$

$\qquad = 5,00,000(0.2139) + 2,00,000$

$\qquad = 3,06,950$

Alternative 2

Down payment, P = Rs. 4,00,000

Yearly equal installment, A = Rs. 3,00,000

$n = 15$ years

$i = 20\%$, compounded annually

The cash flow diagram for the manufacturer 2 is shown in
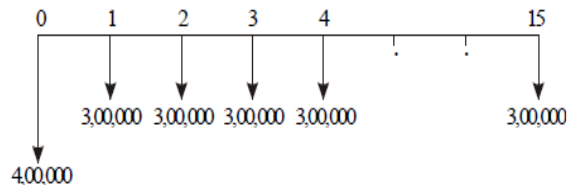
The annual equivalent cost expression of the above cash flow diagram is

$AE2(20\%) = 4,00,000(A/P, 20\%, 15) + 3,00,000$

$= 4,00,000(0.2139) + 3,00,000$
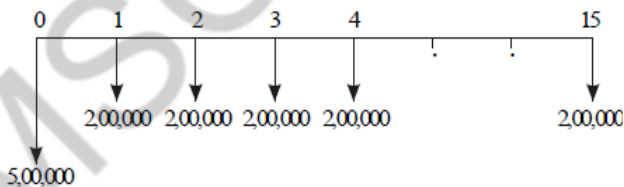
$= \text{Rs. } 3,85,560.$

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
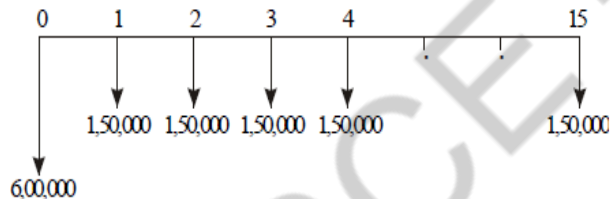
The annual equivalent cost expression of the above cash flow diagram is

$AE3(20\%) \quad = 6,00,000(A/P, 20\%, 15) + 1,50,000$

$= 6,00,000(0.2139) + 1,50,000$

$= \text{Rs. } 2,78,340.$

The annual equivalent cost of manufacturer 3 is less than that of manufacturer 1 and manufacturer 2. Therefore, the company should buy

11. **A certain individual firm desires an economic analysis to deter- mine 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:

	Machine X	Machine Y
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 = Rs. 1,50,000

Life, n = 12 years

Estimated salvage value at the end of machine life, S = Rs. 0. Annual maintenance cost, A = Rs. 0.

Interest rate, i = 15%, compounded annually.

The cash flow diagram of machine X is illustrated in Fig

The annual equivalent cost expression of the above cash flow diagram is

$$AEX(15\%) = 1,50,000(A/P, 15\%, 12)$$
$$= 1,50,000(0.1845)$$
$$= Rs. 27,675$$

Machine Y

First cost, P = Rs. 2,40,000

Life, n = 12 years

Estimated salvage value at the end of machine life, S = Rs. 60,000

Annual maintenance cost, A = Rs. 4,500

Interest rate, i = 15%, compounded annually.

The cash flow diagram of machine Y is depicted in Fig

The annual equivalent cost expression of the above cash flow diagram is

$$AEY(15\%) = 2,40,000(A/P, 15\%, 12) + 4,500 - 6,000(A/F, 15\%, 12)$$
$$= 2,40,000(0.1845) + 4,500 - 6,000(0.0345)$$

= Rs. 48,573

The annual equivalent cost of machine X is less than that of machine Y. So, machine X is the more cost effective machine
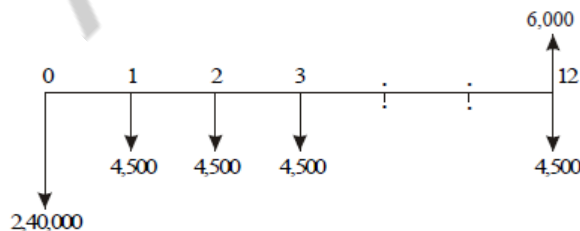
Machine Y

First cost, P = Rs. 2,40,000

Life, n = 12 years

Estimated salvage value at the end of machine life, S = Rs. 60,000

Annual maintenance cost, A = Rs. 4,500

Interest rate, i = 15%, compounded annually.

The cash flow diagram of machine Y is depicted in Fig
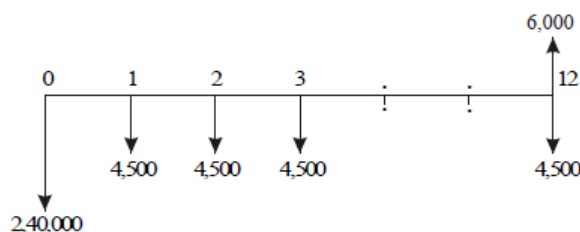
The annual equivalent cost expression of the above cash flow diagram is

$AEY(15\%) = 2,40,000(A/P, 15\%, 12) + 4,500 - 6,000(A/F, 15\%, 12)$

$= 2,40,000(0.1845) + 4,500 - 6,000(0.0345)$

$= \text{Rs. } 48,573$

The annual equivalent cost of machine X is less than that of machine Y. So, machine X is the more cost effective machine

12. With illustration explain the concept of future worth method using revenue dominated cash flow diagram, (Nov/Dec-2018)

Ans- **Future Worth method**

1. Time Value of Money By Suhail Ahmed BSAMT02161001 1

2. The Future Worth Method • Future worth method is used particularly in an investment situation where we need to compute the equivalent worth of the project at the end of its investment period • •For Eg : Building a nuclear power plant, where it is time consuming. In such situation it is more common to measure the worth of the investment at the time of commercialization 2

3. THE ACCEPT AND REJECT RULE • The accept and reject decision rule for a single project evaluation is as follows: • If FW(i) > 0, accept the investment • If FW(i)= 0, Remain indifferent to the investment • If FW(i) < 0, Reject the investment 3

4. REVENUEDOMINATEDCASHFLOW DIAGRAM In revenue/profit dominated cash flow diagram : (a) all inflows to the organization such as profit, revenue, salvage value is (+). (b) The cost (Outflows) will be assigned with (-). 4

5. The formula for computing the future worth of the above diagram FW (i) = •the alternative with

maximum future worth amount should be selected as the best alternative. 5

6. Example • Example -There are two alternatives for purchasing a concrete mixer. Both the alternatives have same useful life. The cash flow details of alternatives are as follows; • Alternative-1: Initial purchase cost = Rs.300000, Annual operating and maintenance cost = Rs.20000, Expected salvage value = Rs.125000, Useful life = 5 years. • Alternative-2: Initial purchase cost = Rs.200000, Annual operating and maintenance cost = Rs.35000, Expected salvage value = Rs.70000, Useful life = 5 years. • Using future worth method, find out which alternative should be selected, if the rate of interest is 10% per year. • The equivalent future worth of Alternative-1 is obtained as follows. 6

7. The future worth of Alternative-1 is obtained as follows. The future worth of Alternative-1 is obtained as follows. 7

8. Bond Value • A bond is a debt instrument that provides a steady income stream to the investor in the form of coupon payment. At maturity date, the full face value of the bond is repaid to the bond holder. • Bond valuation is a technique for determining the theoretical fair value of a particular bond. Bond valuation includes calculating the present value of the bond's future interest payments, also known as its cash flow, and the bond's value upon maturity, also known as its face value or par value. • Because a bond's par value and interest payments are fixed, an investor uses bond valuation to determine what rate of return is required for a bond investment to be worthwhile. • 8

9. • For a bond, let • Z = face, or par, value; • C = redemption or disposal price (usually equal to Z); • r = bond rate (nominal interest) per interest period; • N = number of periods before redemption; • i = bond yield rate per period; • VN = value (price) of the bond N interest periods prior to • redemption—this is a PW measure of merit. • Formula to calculate Bond value • :::- 9

10. Example • Abond with a face value of $5,000 pays interest of 8% per year. This bond will be redeemed at par value at the end of its 20-year life, and the first interest payment is due one year from now. How much should be paid now for bond in order to receive a yield of 10% per year on the investment? 10

11. Capitalized worth method • Capitalized cost represents the present worth of an alternative for a project that is going to serve for a longer period of time i.e. for an infinite period of time. • As the name indicates, it refers to the present worth of mainly cost or expenditures (cash outflows) of the alternative over infinite period of time. • Capitalized worth refers to present worth of expenditures and revenues of an alternative over infinite period of time. The capitalized cost method is used for comparison of mutually exclusive alternatives which have perpetual service life (assumed to serve forever). • The examples of this kind of projects are bridges, dams, irrigation projects, water supply systems for cities, pipeline projects etc. This method an also be used for finding out the capitalized cost of permanent fellowship/scholarship endowment in educational institutes and other organizations. • Formula CW = −A (P/F, i%, n) 11

12. Example • Example -17 A public project has an initial cost of Rs.11000000 and annual operating and

maintenance cost of Rs.700000. Further the project will have one time major repair work of Rs.2000000 at the end of 15 year. Find out the capitalized cost of the alternative if interest rate is 12% per year. •
Solution: The capitalized cost of the alternative is equal to sum of the initial cost, present worth of one time major repair cost and capitalized cost of the annual operating and maintenance cost. The total capitalized cost of the alternative is given by; • CW = −A (P/F, i%, n) 12

13. Explain present worth method in details.

Ans-   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 signing 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.

14. What is revenue-dominated cash flow diagram.

Ans-A generalized revenue-dominated cash flow diagram to demonstrate the present worth method of comparison is presented in Fig. 4.1.
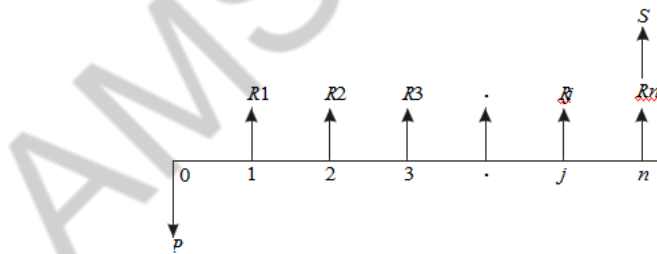
Fig. 4.2 Cost-dominated cash flow diagram.

In Fig. 4.2, P represents an initial investment, Cj the net cost of operation and maintenance at the end of the jth year, and S the salvage value at the end   of the nth year. To compute the present worth amount of the above cash flow diagram for   a given interest rate i, we have the formula

$$PW(i) = P + C1[1/(1 + i)^1] + C2[1/(1 + i)^2] + \dots + Cj[1/(1 + i)^j]$$

$$+ Cn[1/(1 + i)^n] - S[1/(1 + i)^n]$$

In the above formula, the expenditure is assigned a positive sign and the revenue a negative sign. If we have some more alternatives which are to be compared with this alternative, then the corresponding present worth amounts are to be computed and compared. Finally, the alternative with the minimum present worth amount should be selected as the best alternative.

15. What is cost-dominated cash flow diagram.

Ans-

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.
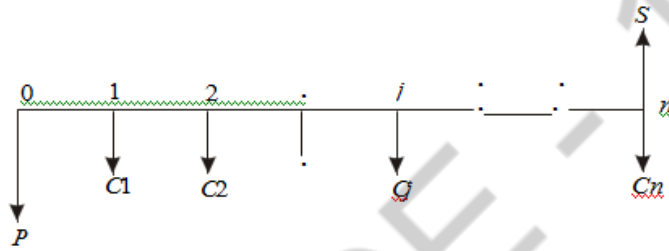
Fig. 5.2 Cost-dominated cash flow diagram.

In Fig. 5.2, P represents an initial investment, Cj the net cost of operation and maintenance at the end of the jth year, and S the salvage value at the end of the nth year.

The formula for the future worth of the above cash flow diagram for
a given interest rate, i is

$$FW(i) = P(1 + i)^n + C1(1 + i)^{n-1} + C2(1 + i)^{n-2} + \dots$$

$$+ Cj(1 + i)^{n-j} + \dots + Cn - S$$

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.

16. What is rate of return method? explain in details.

Ans- 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.

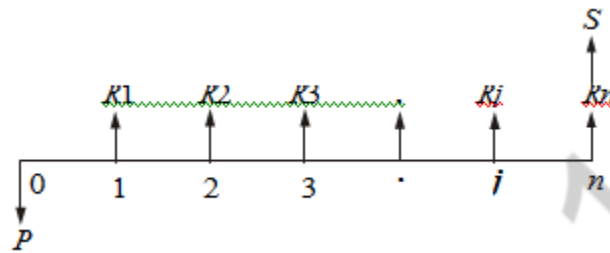A generalized cash flow diagram to demonstrate the rate of return method of comparison is presented in Fig. 7.1.

Fig. 7.1 Generalized cash flow diagram.

In the above cash flow diagram, P represents an initial investment, Rj the net revenue at the end of the jth year, and S the salvage value at the end of the nth year.

The first step is to find the net present worth of the cash flow diagram using the following expression at a given interest rate, i.

$$PW(i) = -P + R1/(1 + i)^1 + R2/(1 + i)^2 + ...$$
$$+ Rj/(1 + i)^j + ... + Rn/(1 + i)^n + S/(1 + i)^n$$

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.

17. 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.

	Initial investment (Rs.)	Yearly revenue (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
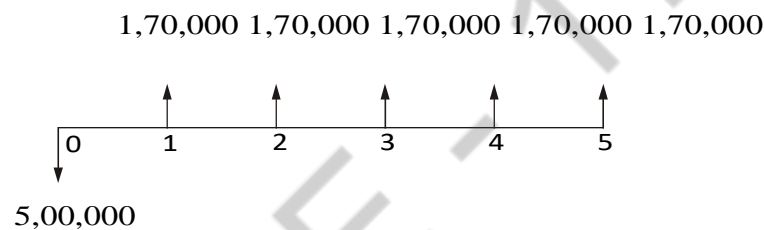
Fig. 7.9 Cash flow diagram for alternative 1.

The formulae for the net present worth of alternative 1 are as follows:

$$PW_1(i) = -5,00,000 + 1,70,000(P/A, i, 5)$$

$$PW_1(15\%) = -5,00,000 + 1,70,000(P/A, 15\%, 5)$$

$$= -5,00,000 + 1,70,000(3.3522)$$

$$= Rs. 69,874$$

$$PW_1(17\%) = -5,00,000 + 1,70,000(P/A, 17\%, 5)$$

$$= -5,00,000 + 1,70,000(3.1993)$$

$$= Rs. 43,881$$

$$PW_1(20\%) = -5,00,000 + 1,70,000(P/A, 20\%, 5)$$

$$= -5,00,000 + 1,70,000(2.9906)$$

$$= Rs. 8,402$$

$$PW_1(22\%) = -5,00,000 + 1,70,000(P/A, 22\%, 5)$$

$$= -5,00,000 + 1,70,000(2.8636)$$

$$= \text{Rs. } -13,188$$

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.

2,70,000 2,70,000 2,70,000 2,70,000 2,70,000
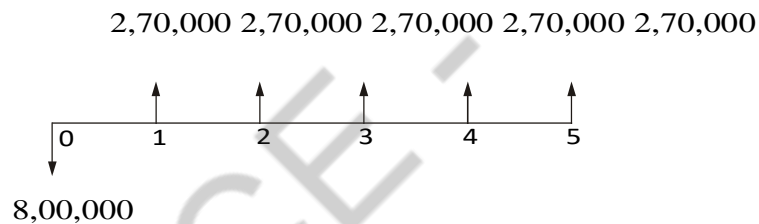
8,00,000

Fig. 7.10 Cash flow diagram for alternative 2.

The formula for the net present worth of alternative 2 is:

$$PW_2(i) = -8,00,000 + 2,70,000(P/A, i, 5)$$

$$PW_2(20\%) = -8,00,000 + 2,70,000(P/A, 20\%, 5)$$

$$= -8,00,000 + 2,70,000(2.9906)$$

$$= \text{Rs. } 7,462$$

$$PW_2(22\%) = -8,00,000 + 2,70,000\,(P/A, 22\%, 5)$$

$$= -8,00,000 + 2,70,000\,(2.8636)$$

$$= \text{Rs. } -26,828$$

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.

18. 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.
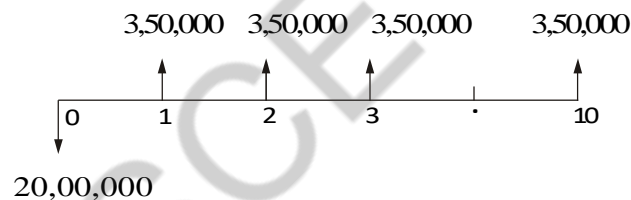
Fig. 7.4 Cash flow diagram.

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%

19. **A person is planning a new business. The initial outlay and cash flow pattern for the new Business is 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	−1,00,000 30,000	30,000 30,000 (Rs.)	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.
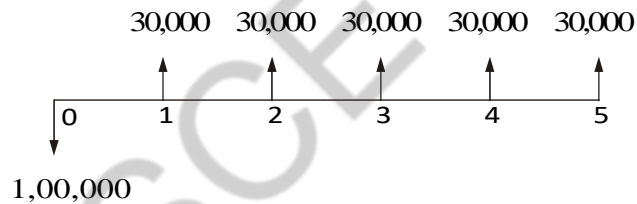
Fig. 7.3 Cash flow diagram.

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 $i = 15\%$,

$$PW(15\%) = -1,00,000 + 30,000(P/A,\ 15\%,\ 5)$$

$$= -1,00,000 + 30,000(3.3522)$$

$$= Rs. 566.$$

When $i = 18\%$,

$$PW(18\%) = -1,00,000 + 30,000(P/A,\ 18\%,\ 5)$$

$$= -1,00,000 + 30,000(3.1272)$$

$$= Rs. - 6,184$$

$$i \approx 15\% + \frac{566 - 0}{566 - (-6184)} \times (3\%)$$

$$= 15\% + 0.252\%$$

$$= 15.252\%$$

Therefore, the rate of return for the new business is 15.252%.

20. **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

$$PW(12\%) = 60{,}000 + 15{,}000(P/F, 12\%, 1)$$

$$= 60{,}000 + 15{,}000(0.8929)$$

$$= 73{,}393.50$$

The above present worth is represented in Fig. 6.20.
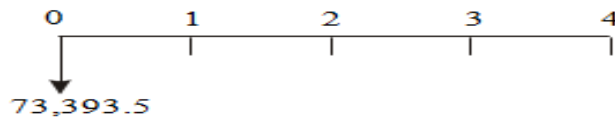
Fig. 6.20 Resultant cash flow diagram.

The annual equivalent expression of the above cash flow diagram is

$$AE(12\%) = 73{,}393.5(A/P, 12\%, 4)$$

$$= 73{,}393.5(0.3292)$$

$$= \text{Rs. } 24{,}161.14$$

Alternative 2

Payment after four years = Rs. 90,000

The cash flow diagram for alternative 2 is shown in Fig. 6.21.
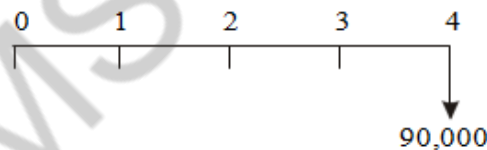
Fig. 6.21 Cash flow diagram of alternative 2.

The annual equivalent cost expression of the above cash flow diagram is

$$AE(12\%) = 90{,}000(A/F, 12\%, 4)$$

$$= 90{,}000(0.2092)$$

$$= \text{Rs. } 18{,}828$$

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.

UNIT - 4

REPLACEMENT AND MAINTAINENCE ANALYSIS

PART - A

1. What are the uncertainties a firm faces?

Dynamic nature of consumer needs

Diverse nature of competition

Uncontrollable nature of most elements of cost

Continuous technological developments

2. What is meant by preventive maintenance? (April 2015) (Nov 2014)

Preventative maintenance is maintenance that is regularly performed on a piece of equipment to lessen the likelihood of it failing. Preventative maintenance is performed while the equipment is still working, so that it does not break down unexpectedly.

3. What are reasons for replacements?   (April 2015)

Upgrading to new technology,

Reducing wear and tear cost,

Avoiding the uncertainties,

Loss of production.

4. What is maintenance cost?

The costs associated with keeping an item or machine in good condition by regularly checking it and repairing it when necessary. When purchasing an item that requires upkeep, consumers should consider not just the initial price tag, but also the item's ongoing maintenance expenses.

5. **What is Benefit Cost Ratio?** (April 2015)

A benefit-cost ratio (BCR) is an indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal.

$$BC\,ratio = \frac{Equivalent\ benefits}{Equivalent\ cos ts}$$

6. **What is preventive maintenance? (May / June 2012) (Nov 2015)**

Preventive maintenance (PM) is the periodical inspection and service activities which are aimed to detect potential failures and perform minor adjustments or repairs which will prevent major operating problems in future.

7. **What are the major factors that determine the economic life of an asset? (May / June 2012)**

1. **Physical factors**: expiration, wear and tear, decay, casualty (fire, flood, theft)
2. **Economic factors**:
   a. *Inadequacy*: a fixed asset becomes not useful when the demands of a company change
   b. *Supersession*: a fixed asset is replaced with a more efficient or economical asset
   c. *Obsolescence*: unforeseen physical or technical obsolescence

8. **Distinguish between breakdown maintenance and preventive maintenance. (Nov/ Dec 2012)**

Preventive maintenance (PM) is the periodical inspection and service activities which are aimed to detect potential failures and perform minor adjustments or repairs which will prevent major operating problems in future.

Breakdown maintenance is the repair which is generally done after the equipment has attained down state. It is often of an emergency nature which will have associated penalty in terms of expediting cost of maintenance and down time cost of equipment.

Preventive maintenance will reduce such cost up to a point. Beyond that point, the cost of preventive maintenance will be more when compared to the breakdown maintenance cost.

9. **Write short notes on reasons for replacement (Nov/ Dec 2013) (Nov/ Dec 2012) (April 2015)**

   There are various reasons that result in replacement of a given equipment. One of the reasons is the reduction in the productivity of currently owned equipment. This occurs due to physical deterioration of its different parts and there is decrease in operating efficiency with age. This necessitates the replacement of the existing one with the new alternative.

   Similarly if the production demands a change in the desired output from the equipment, then there is requirement of augmenting the existing equipment for meeting the required demand or replacing the equipment with the new one.

   Another reason for replacement of the existing equipment is obsolescence. Due to rapid change in the technology, the new model with latest technology is more productive than the currently owned equipment, although the currently owned equipment is still operational and functions acceptably

10. **What is economic life of an asset (May / June 2013)**

    Economic life is the expected period of time during which an **asset** is useful to the average owner. The **economic life of an asset** could be different than its actual physical **life**.

    It is clear that the capital recovery cost (average first cost) goes on decreasing with the life of the machine and the average operating and maintenance cost goes on increasing with the life of the machine. From the beginning, the total cost continues to decrease up to a particular life and then it starts increasing. The point where the total cost is minimum, is called the *economic life* of the machine.

11. **Explain predictive maintenance (May / June 2013)**
    - It is comparatively a newer maintenance technique.
    - Equipment conditions are measured periodically or on a continuous basis and this enable maintenance men to take a timely action such as equipment adjustments repair or overhaul.

12. **List the different types of maintenance (Nov/ Dec 2013)**
    - ˃ Corrective or Breakdown maintenance.
    - ˃ Scheduled maintenance
    - ˃ Preventive maintenance and
    - ˃ Predictive maintenance.

13. **List out the functional elements of maintenance program (Nov 2014)**

    Primary elements in the Maintenance Programme are to be responsive, manageable, measurable and accountable.

14. **List out the preventive maintenance activities (Nov 2014)**
    - ˃ The work carried out on equipment in order to avoid its breakdown or malfunction. It is a regular and routine action taken on equipment in order to prevent its breakdown.
    - ˃ Maintenance, including tests, measurements, adjustments, parts replacement, and cleaning, performed specifically to prevent faults from occurring.
    - ˃ Preventive maintenance activities include partial or complete overhauls at specified periods, oil changes, lubrication, minor adjustments, and so on.
    - ˃ In addition, workers can record equipment deterioration so they know to replace or repair worn parts before they cause system failure

15. **List out Types of Replacement Problem (Nov 2015)**

    Replacement study can be classified into two categories:

    (a) Replacement of assets that deteriorate with time

    (Replacement due to gradual failure, or wear and tear of the components of the machines).

    This can be further classified into the following types:

    (i) Determination of economic life of an asset.

    (ii) Replacement of an existing asset with a new asset.

(b) Simple probabilistic model for assets which fail completely (replacement due to sudden failure).

16. State the main causes of breakdown

   i) Delays in production

   ii) Faster plant deterioration

17. State any two disadvantages of breakdown maintenance.

   i) Failure to replace worn out parts

   ii) Lack of Lubrication

   iii) Indifference towards minor faults

18. What are the components of an asset

Any asset will have the following cost components:

_ Capital recovery cost (average first cost), computed from the first cost

(purchase price) of the machine.

_ Average operating and maintenance cost (O & M cost)

_ Total cost which is the sum of capital recovery cost (average first cost) and average maintenance cost.

19. What is the concept of Challenger and Defender?

If existing equipment is considered for replacement with a new equipment, then the existing equipment is known as the *defender* and the new equipment is known as *challenger*

20. What is the policy to be adopted for items which have the possibility a complete breakdown?

The following are the replacement policies which are applicable for this situation.

(i) Individual replacement policy. Under this policy, an item is replaced immediately after its failure.

(ii) Group replacement policy. Under this policy, the following decision is made:

At what equal intervals are all the items to be replaced simultaneously with a provision to replace the items individually which fail during a fixed group replacement period?

21. Define economic life of an asset. (April/May-2017)

Ans- *Economic life* is the period over which an entity expects to be able to use an *asset*, assuming a normal level of usage and preventive maintenance. *Economic life* can also refer to the number of units produced; for example, the *economic life* of a vehicle may be 100,000 miles, rather than three years.

22. Distinguish between challengers and defenders. (April/May-2017)

Ans- In many cases, we consider replacing an existing asset (*the `defender`*') with another asset (*the `challenger`*'). *The* simplest case, however, occurs when we are considering getting rid of an asset and not replacing it.

23. List any two types of maintenance costs. (April/May-2018)

Ans- (a) Preventive maintenance cost

(b). Breakdown maintenance cost.

24. Compare recovery and return. (April/May-2018)

Ans- Service **recovery** is a company's resolution of a problem from a dissatisfied customer, converting them into a loyal customer. It is the action a service provider takes in response to service failure. By including also customer satisfaction into the definition, A return, also known as a financial return, in its simplest terms, is the money made or lost on an investment over some period of time.

25. List two disadvantages of breakdown maintenance. (Nov/Dec-2018)

Ans- Unplanned breakdown maintenance can be more costly than preventive

maintenance, because it typically causes downtime and interrupts production. It can also be difficult to find the root cause of a breakdown when no maintenance strategy is in place.

26. What is called availability in maintenance engineering?

Ans- Availability is defined as the probability that the system is operating properly when it is requested for use. In other words, **availability** is the probability that a system is not failed or undergoing a **repair** action when it needs to be used.

27. List the types of maintenance (April/ May 2019)
- Corrective or Breakdown maintenance.
- Scheduled maintenance
- Preventive maintenance and
- Predictive maintenance.

28. Identify any two differences between replacement and maintenance.

Ans- Replacement problems involve items that degenerate with use or with the passage of time and those that fail after a certain amount of use or time. Items that deteriorate are likely to be large and costly (*e.g.,* machine tools, trucks, ships, and home appliances).

Non deteriorating items tend to be small and relatively inexpensive (*e.g.,* light bulbs, vacuum tubes, ink cartridges). The longer a deteriorating item is operated the more maintenance it requires to maintain efficiency. Furthermore, the longer such an item is kept the less is its resale value and the more likely it is to be made obsolete by new equipment. If the item is replaced frequently, however, investment costs increase. Thus the problem is to determine when to replace such items and how much maintenance (particularly preventive) to perform so that the sum of the operating, maintenance, and investment costs is minimized.8. List the types of maintenance.

PART B

1. **Explain the causes for replacement of assets in detail with examples** Organizations providing goods/services use several facilities like equipment and machinery which are directly required in their operations. In addition to these facilities, there are several other items which are necessary to facilitate the functioning of organizations.

All such facilities should be continuously monitored for their efficient functioning; otherwise, the quality of service will be poor. Besides the quality of service of the facilities, the cost of their operation and maintenance would increase with the passage of time. Hence, it is an absolute necessity to maintain the equipment in good operating conditions with economical cost. Thus, we need an integrated approach to minimize the cost of maintenance. In certain cases, the equipment will be obsolete over a period of time.

If a firm wants to be in the same business competitively, it has to take decision on whether to replace the old equipment or to retain it by taking the cost of maintenance and operation into account.

There are two basic reasons for considering the replacement of an equipment—physical impairment of the various parts or obsolescence of the equipment.

Physical impairment refers only to changes in the physical condition of the machine itself. This would lead to a decline in the value of the service rendered, increased operating cost, increased maintenance cost or a combination of these.

Obsolescence is due to improvement of the tools of production, mainly improvement in technology.

So, it would be uneconomical to continue production with the same machine under any of the above situations. Hence, the machines are to be periodically replaced.

Sometimes, the capacity of existing facilities may be inadequate to meet the current demand. Under such situation, the following alternatives will be considered.

_ Replacement of the existing equipment with a new one.

_ Augmenting the existing one with an additional equipment.

2. Explain about the challenger and defender concept (May 2013)

If an existing equipment is considered for replacement with a new equipment, then the existing equipment is known as the *defender* and the new equipment is known as *challenger*.

Assume that an equipment has been purchased about three years back for Rs. 5,00,000 and it is considered for replacement with a new equipment. The supplier of the new equipment will take the old one for some money, say, Rs. 3,00,000. This should be treated as the present value of the existing equipment and it should be considered for all further economic analysis. The purchase value of the existing equipment before three years is now known as *sunk cost*, and it should not be considered for further analysiswill have associated penalty in terms of expediting cost of maintenance and down time cost of equipment.

3. What are the factors involved in determination of economic life of an asset? (Nov 2015)

Capital recovery cost (average first cost), computed from the first cost (purchase price) of the machine.

Average operating and maintenance cost (O & M cost)

Total cost which is the sum of capital recovery cost (average first cost) and average maintenance cost.

4. Discuss the types of maintenance (Nov 2014) (May 2012)

Maintenance activity can be classified into two types: preventive maintenance and breakdown maintenance.

Preventive maintenance (PM) is the periodical inspection and service activities which are aimed to detect potential failures and perform minor adjustments or repairs which will prevent major operating problems in future.

Breakdown maintenance is the repair which is generally done after the equipment has attained down state. It is often of an emergency nature which

will have associated penalty in terms of expediting cost of maintenance and down time cost of equipment.

Preventive maintenance will reduce such cost up to a point. Beyond that point, the cost of preventive maintenance will be more when compared to the breakdown maintenance cost. The total cost, which is the sum of the preventive maintenance cost and the breakdown maintenance cost, will go on decreasing with an increase in the level of maintenance up to a point. Beyond that point, the total cost will start increasing. The level of maintenance corresponding to the minimum total cost is the optimal level of maintenance. The concepts are demonstrated in Fig.
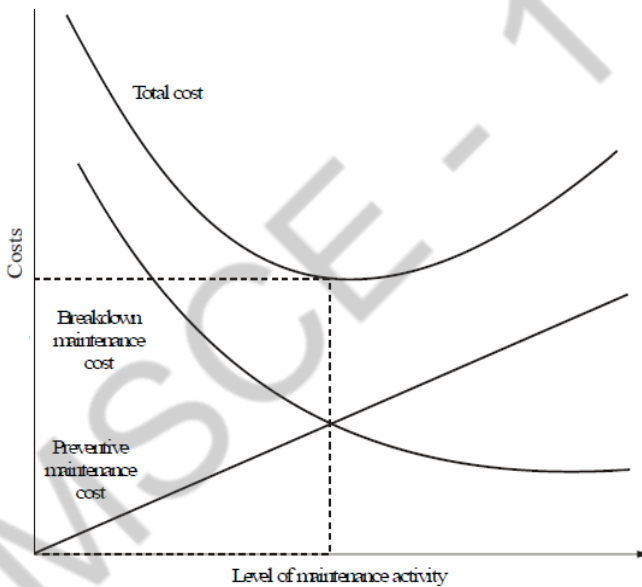
5. Give a detailed account of various types of replacement problems with an example (May 2012) (May 2013)

Replacement study can be classified into two categories:

(a) Replacement of assets that deteriorate with time (Replacement due to gradual failure, or wear and tear of the components of the machines).

This can be further classified into the following types:

(i) Determination of economic life of an asset.

(ii) Replacement of an existing asset with a new asset.

(b) Simple probabilistic model for assets which fail completely (replacement due to sudden failure).

6. Write short notes on economic life of an equipment. (Nov 2013) (April/May-2018)

DETERMINATION OF ECONOMIC LIFE OF AN ASSET

Any asset will have the following cost components:

- Capital recovery cost (average first cost), computed from the first cost (purchase price) of the machine.
- Average operating and maintenance cost (O & M cost)
- Total cost which is the sum of capital recovery cost (average first cost) and average maintenance cost.

A typical shape of each of the above costs with respect to life of the machine is shown in
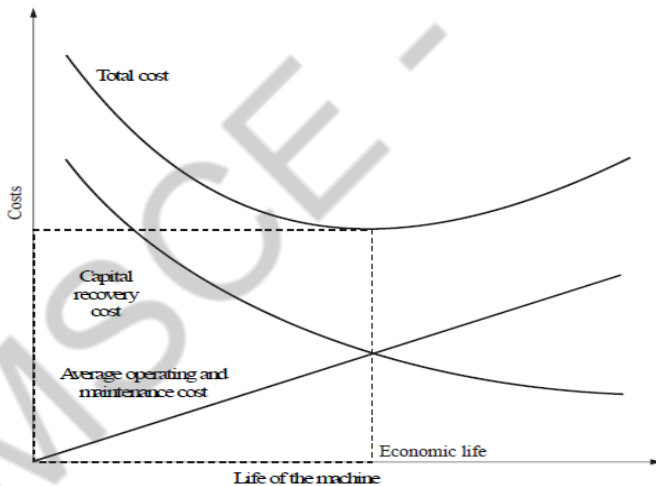
From Fig, it is clear that the capital recovery cost (average first cost) goes on decreasing with the life of the machine and the average operating and maintenance cost goes on increasing with the life of the machine. From the beginning, the total cost continues to decrease up to a particular life and then it starts increasing. The point where the total cost is minimum is called the *economic life* of the machine. If the interest rate is more than zero per cent, then we use interest formulas to determine the economic life.

The replacement alternatives can be evaluated based on the present worth criterion and annual equivalent criterion.

7. **Explain the simple probability model? Simple Probabilistic Model For Items Which Fail Completely.** **(Nov/Dec-2018)**

Electronic items like transistors, resistors, tubelights, bulbs, etc. could fail all of a sudden, instead of gradual deterioration. The failure of the item may result in complete breakdown of the system. The system may contain a collection of such items or just one item, say a tubelight. Therefore, we use some replacement policy for such items which would avoid the possibility of a complete breakdown.

The following are the replacement policies which are applicable for this situation.

(i) Individual replacement policy. Under this policy, an item is replaced immediately after its failure.

(ii) Group replacement policy. Under this policy, the following decision is made:

At what equal intervals are all the items to be replaced simultaneously with a provision to replace the items individually which fail during a fixed group replacement period?

There is a trade-off between the individual replacement policy and the group replacement policy. Hence, for a given problem, each of the replacement policies is evaluated and the most economical policy is selected for implementation. This is explained with two numerical problems.

Problem 1

8. **A firm is considering replacement of an equipment, whose first cost is Rs. 4,000 and the scrap value is negligible at the end of any year. Based on experience, it was found that the maintenance cost is zero during the first year and it increases by Rs. 200 every year thereafter. (Nov/ Dec 2013)**

When should the equipment be replaced if $i = 0\%$?

When should the equipment be replaced if $i = 12\%$?

Solution

When $i = 0\%$. In this problem,

First cost = Rs. 4,000

Maintenance cost is Rs. 0 during the first year and it increases by Rs. 200 every year thereafter.

This is summarized in column B of Table

Calculations to Determine Economic Life (First cost = Rs. 4,000, Interest = 0%)

End of the year (n)	Maintenance cost at end of the year	Summation of maintenance costs	Average cost of maintenance through year given	Average first cost replaced at your end given	Average total cost through year given
		$\sum B$	C/A	4000/A	D+E
A	B(Rs.)	C(Rs.)	D(Rs.)	E(Rs.)	F(Rs.)
1	0	0	0	4000	4000
2	200	200	100	2000	2100
3	400	600	200	1333.33	1533.33
4	600	1200	300	1000	1300
5	800	2000	400	800	1200
6	1000	3000	500	666.67	1166.67
7	1200	4200	600	571.43	1171.43
*Economic life of the machine = 6 years					

Column C summarizes the summation of maintenance costs for each replacement period. The value corresponding to any end of year in this column represents the total maintenance cost of using the equipment till the end of that particular year.

$$\text{Average total cost} = \frac{\text{First cost(FC)} + \text{Summation of maintenance cost}}{\text{Replacement period}}$$

$$= \frac{FC}{n} + \frac{\text{Column C}}{n}$$

= Average first cost for   Average maintenance cost
   the given period   +   for the given period

Column total cost F = Column E + Column D

The value corresponding to any end of year (n) in Column F represents the average total cost of using the equipment till the end of that particular

year. For this problem, the average total cost decreases till the end of year 6 and then it increases. Therefore, the optimal replacement period is six years, i.e. economic life of the equipment is six years.

(b) When interest rate, $i = 12\%$. When the interest rate is more than 0%, the steps to be taken for getting the economic life are summarized with reference to Table

Calculations to Determine Economic Life (First cost = Rs. 4,000, Interest = 12%)

End of the year (n)	Maintenance cost at end of the year	P/F, 12%, n	Present worth as of beginningof year 1 of maintenance costs	summation of present worth of maintenance costs through year given	Present worth of cumulative maintenance cost & first cost	A/P,12%,n	Annual equvalent total cost through year given
			B × C	$\sum D$	E+Rs.4000	E+Rs.4000	F × C
A	B(Rs.)	C	D(Rs.)	E(Rs.)	F(Rs.)	G	H(Rs.)
1	0	0.8929	0	0	4000	1.12	4480
2	200	0.7972	159.44	159.44	4159.44	0.5917	2461.14
3	400	0.7118	284.72	444.16	4444.16	0.4163	1850.1
4	600	0.6355	381.3	825.46	4825.46	0.3292	1588.54
5	800	0.5674	453.92	1279.38	5279.38	0.2774	1464.5
6	1000	0.5066	506.6	1785.98	5785.98	0.2432	1407.15
7	1200	0.4524	542.88	2328.86	6328.86	0.2191	1386.65*
8	1400	0.4039	565.96	2894.32	6894.32	0.2013	1387.83
9	1600	0.3606	576.96	3471.28	7471.28	0.1877	1402.36
10	1800	0.322	579.6	4050.88	8050.88	0.177	1425

*Economic life of the machine = 7 years

The steps are summarized now:

1. Discount the maintenance costs to the beginning of the year 1

$$\text{ColumnD} = \text{Column B} \times \frac{1}{(1+i)^n}$$

$$= \text{Column B} \times (P/F, i, n) = \text{Column B} \times \text{Column C}$$

2. Find the summation of present worth of maintenance costs through the year given (Column E = $\sum$ Column D).

3. Find column F by adding the first cost Rs.4000 to column E.

4. Find the annual equivalent total cost through the year given.

$$\text{Column H} = \text{Column F} \times \frac{i(1+i)^n}{(1+i)-1}$$

$$= \text{Column F} \times (A/P, 12, n) = \text{Column F} \times \text{Column G}$$

5. Identify the end of year for which the annual equivalent total cost is minimum.

For this problem, the annual equivalent total cost is minimum at the end of year 7. Therefore, the economic life of the equipment is seven years.

Problem 2

9. **Two years ago, a machine was purchased at a cost of Rs. 2,00,000 to be useful for eight years. Its salvage value at the end of its life is Rs. 25,000. The annual maintenance cost is Rs. 25,000. The market value of the present machine is Rs. 1,20,000. Now, a new machine to cater to the need of the present machine is available at Rs. 1,50,000 to be useful for six years. Its annual maintenance cost is Rs. 14,000. The salvage value of the new machine is Rs. 20,000. Using an interest rate of 12%, find whether it is worth replacing the present machine with the new machine. (Nov/ Dec 2013) (Apr/ May 2015)**

Solution   Alternative 1—Present machine
- Purchase price = Rs. 2,00,000
- Present value (P) = Rs. 1,20,000
- Salvage value (F) = Rs. 25,000
- Annual maintenance cost (A) = Rs. 25,000
- Remaining life = 6 years
- Interest rate = 12%
- The cash flow diagram of the present machine is illustrated in Fig
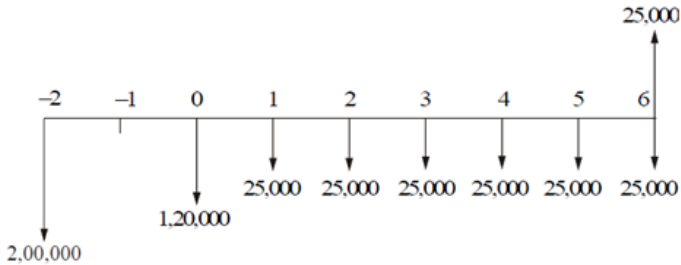
The annual maintenance cost for the preceding periods is not shown in this figure. The annual equivalent cost is computed as

$$AE\,(12\%) = (P - F)(A/P,\,12\%,\,6) + F \times i + A$$
$$= (1,20,000 - 25,000)(0.2432) + 25,000 \times 0.12 + 25,000$$
$$= \text{Rs. } 51,104$$

Alternative 2 — New machine

Purchase price (P) = Rs. 1,50,000

Salvage value (F) = Rs. 20,000

Annual maintenance cost (A) = Rs. 14,000

Life = 6 years

Interest rate = 12%

The cash flow diagram of the new machine is depicted in Fig
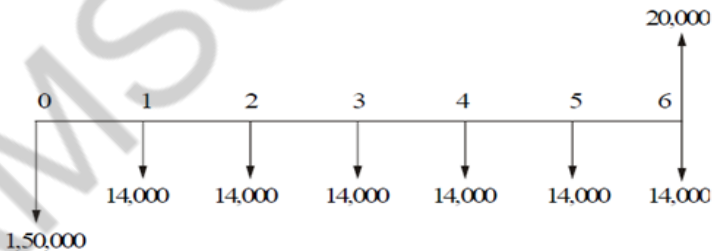
The formula for the annual equivalent cost is

$$AE(12\%) = (P - F)(A/P,\,12\%,\,6) + F \times i + A$$
$$= (1,50,000 - 20,000)(0.2432) + 20,000 \times 0.12 + 14,000$$
$$= \text{Rs. } 48,016$$

Since the annual equivalent cost of the new machine is less than that of the present machine, it is suggested that the present machine be replaced with the new machine.

Problem 3

10. **A diesel engine was installed 10 years ago at a cost of Rs. 50,000. It has a present realizable market value of Rs. 15,000. If kept, it can be expected to last five years more, with operating and maintenance cost of Rs. 14,000 per year and to have a salvage value of Rs. 8,000 at the end of the fifth year. This engine can be replaced with an improved version costing Rs. 65,000 which has an expected life of 20 years. This improved version will have an estimated annual operating and maintenance cost of Rs. 9,000 and ultimate salvage value of Rs. 13,000. Using an interest rate of 15%, make an annual equivalent cost analysis to determine whether to keep or replace the old engine. (Nov/ Dec 2012)**

Solution   **Alternative 1— Old diesel engine**

Purchase price = Rs. 50,000

Present value (P) = Rs. 15,000

Salvage value (F) = Rs. 8,000

Annual operating and maintenance cost (A) = Rs. 14,000

Remaining life (n) = 5 years

Interest rate = 15%

The cash flow diagram of the old diesel engine is shown in Fig.
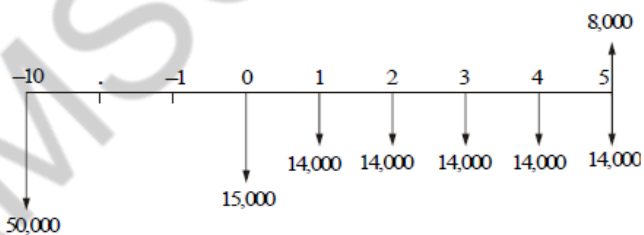
The formula for the annual equivalent cost is

$$AE(15\%) = (P - F)(A/P, 15\%, 5) + F \times i + A$$
$$= (15,000 - 8,000)(0.2983) + 8,000 \times 0.15 + 14,000$$
$$= \text{Rs. } 17,288.10$$

Alternative 2 — New diesel engine

Present value (P) = Rs. 65,000

Salvage value (F) = Rs. 13,000

Annual operating and maintenance cost $(A) = $ Rs. 9,000

Life $(n) = 20$ years

Interest rate $= 15\%$

The cash flow diagram of the new diesel engine is shown in Fig
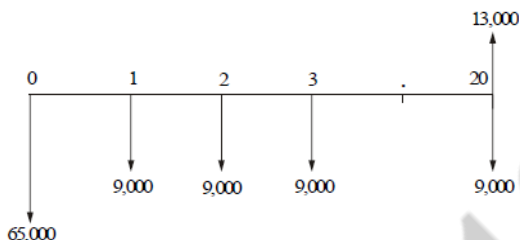
The formula for the annual equivalent cost is

$$AE(15\%) = (P - F)(A/P, 15\%, 20) + F \times i + A$$
$$= (65,000 - 13,000)(0.1598) + 13,000 \times 0.15 + 9,000$$
$$= \text{Rs. } 19,259.60$$

For comparing the engines based on equal lives (20 years), the annual equivalent figures are given in Fig. Equal lives are nothing but the least common multiple of the lives of the alternatives.

Old engine		New engine	
	0		0
17,288.10	1	19,259.60	1
17,288.10	2	19,259.60	2
17,288.10	3	19,259.60	3
17,288.10	4	19,259.60	4
17,288.10	5	19,259.60	5
17,288.10	6	19,259.60	6
17,288.10	7	19,259.60	7
17,288.10	8	19,259.60	8
17,288.10	9	19,259.60	9
17,288.10	10	19,259.60	10
17,288.10	11	19,259.60	11
17,288.10	12	19,259.60	12
17,288.10	13	19,259.60	13
17,288.10	14	19,259.60	14
17,288.10	15	19,259.60	15
17,288.10	16	19,259.60	16
17,288.10	17	19,259.60	17
17,288.10	18	19,259.60	18
17,288.10	19	19,259.60	19
17,288.10	20	19,259.60	20

Cash flow diagram of alternatives based on common lives.

Since the annual equivalent cost of the old diesel engine is less than that of

the new diesel engine, it is suggested to keep the old diesel engine. Here, an important assumption is that the old engine will be replaced four times during the 20 years period of comparison

Problem 4

11. **An electronic equipment contains 1,000 resistors. When any resistor fails, it is replaced. The cost of replacing a resistor individually is Rs. 10. If all the resistors are replaced at the same time, the cost per resistor is Rs. 4. The per cent surviving, $S(i)$ at the end of month i is tabulated as follows: (Nov / Dec 2012)**

i	0	1	2	3	4	5	6
$S(i)$	100	96	89	68	37	13	0

What is the optimum replacement plan?

Solution Let p_i be the probability of failure during the month i. Then,

$$p_1 = (100\text{-}96)/100 = 0.04 \quad p_4 = (68\text{-}37)/100 = 0.31$$

$$p_2 = (96\text{-}89)/100 = 0.07 \quad p_5 = (37\text{-}13)/100 = 0.24$$

$$p_3 = (89\text{-}98)/100 = 0.21 \quad p_6 = (13\text{-}0)/100 = 0.13$$

It is clear that no resistor can survive beyond six months. Hence, a resistor which has survived for five months would certainly fail during the sixth month. We assume that the resistors failing during a month are accounted at the end of the month.

Let

N_i = No. of resistors replaced at the end of the ith month.

$N_0 = 1,000$

$N_1 \quad = N_0 p_1$

$\quad = 1,000 \times 0.04$

$\quad = 40$

$N_2 \quad = N_0 p_2 + N_1 p_1$

$\quad = 1,000 \times 0.07 + 40 \times 0.04$

$\quad = 72$

$N_3 \quad = N_0 p_3 + N_1 p_2 \quad + N_2 p_1$

$$= 1{,}000 \times 0.21 + 40 \times 0.07 + 72 \times 0.04$$

$$= 216$$

$N4 \qquad = N0p4 + N1p3 + N2p2 + N3p1$

$$= 1{,}000 \times 0.31 + 40 \times 0.21 + 72 \times 0.07 + 216 \times 0.04$$

$$= 332$$

$N5 \qquad = N0p5 + N1p4 + N2p3 + N3p2 + N4p1$

$$= 1{,}000 \times 0.24 + 40 \times 0.31 + 72 \times 0.21 + 216 \times 0.07 + 332 \times 0.04$$

$$= 296$$

$N6 \qquad = N0p6 + N1p5 + N2p4 + N3p3 + N4p2 + N5p1$

$$= 1{,}000 \times 0.13 + 40 \times 0.24 + 72 \times 0.31 + 216 \times 0.21 + 332 \times 0.07$$
$$+\ 296 \times 0.04$$

$$= 242$$

Determination of individual replacement cost

Expected life of each resistor $= \sum_{i=1}^{n} i \times p_i$

$$= 1 \times 0.04 + 2 \times 0.07 + 3 \times 0.21 + 4 \times 0.31$$
$$+\ 5 \times 0.24 + 6 \times 0.13$$

$$=\ 4.03 \text{ months.}$$

Average number of failures/month = 1,000 /4.03 = 248 (approx.) Therefore,

Cost of individual replacement

= (No. of failures/month x individual replacement cost/resistor)

= 248 x 10 = Rs. 2,480.

Determination of group replacement cost

Cost/resistor when replaced simultaneously = Rs. 4.00

Cost/resistor when replaced individually = Rs. 10.00

The costs of group replacement policy for several replacement periods are summarized in Table

Table Calculations of Costs for Preventive Maintenance

End of month	Cost of replacing 1000 resistors at a time	Cost of replacing resistor individually during given replacement period	Total cost (B+C)	Average cost / month(D/A)
A	B (Rs.)	C (Rs.)	D (Rs.)	E (Rs.)
1	4000	$40 \times 10 = 400$	4400	4400
2	4000	$(40+72)10 = 1120$	5120	2560
3	4000	$(40+72+216)10 = 3280$	7280	2426.67
4	4000	$(40+72+216+332) = 6600$	10600	2650

Indicates the minimum average cost/ month.

From Table, it is clear that the average cost/month is minimum for the third month. Thus, the group replacement period is three months.

Summary

Individual replacement cost/month = Rs. 2,480.00

Minimum group replacement cost/month = Rs. 2,426.67

Since the minimum group replacement cost/month is less than the individual replacement cost/month, the group replacement policy is the best and hence all the resistors are to be replaced once in three months and the resistors which fail during this three months period are to be replaced individually.

Problem 5

12. **The following table gives the operation cost, maintenance cost and salvage value at the end of every year of a machine whose purchase value is Rs. 20,000. (April/May 2015)**

Find the economic life of the machine assuming interest rate, $i = 15\%$.

End of year (n)	Operation cost at the end of year (Rs.)	Maintenance cost at the end of year (Rs.)	Salvage value at the end of year (Rs.)
1	3,000	300	9,000
2	4,000	400	8,000
3	5,000	500	7,000
4	6,000	600	6,000
5	7,000	700	5,000
6	8,000	800	4,000
7	9,000	900	3,000
8	10,000	1,000	2,000
9	11,000	1,100	1,000
10	12,000	1,200	0

Solution

First cost = Rs. 20,000

Interest rate = 15%

The other details are summarized in Table along with regular calculations for determining the economic life.

Calculations to Determine Economic Life

			(First Cost = Rs. 20,000, Interest Rate = 15%)								
End of year (n)	Operation cost at the end of year	Maintenance cost at the end year	Sum of operation and maintenance costs at the end of year	P/F, 15%, n	Present Worth as of beginning of year 1 of sum of operation and maintenance costs	Cumulative sum of Column F through year designated	Salvage value at the end of year	Present Worth as of beginning of year 1 of Salvage Value	Total Present Worth	A/P, 15%,n	Annual
			B + C		D x E	Σ F		H x E	G + 20,000 - I		J x K
A	B (Rs.)	C (Rs.)	D (Rs.)	E	F (Rs.)	G (Rs.)	H(Rs.)	I (Rs.)	J (Rs.)	K	L (Rs.)
1	3,000	300	3,300	0.8696	2,869.68	2,869.68	9,000	7,826.40	15,043.28	1.1500	17,299.77
2	4,000	400	4,400	0.7562	3,326.84	6,196.52	8,000	6,048.80	20,147.72	0.6151	12,392.86
3	5,000	500	5,500	0.6575	3,616.25	9,812.77	7,000	4,602.50	25,210.27	0.4380	11,042.01
4	6,000	600	6,600	0.5718	3,773.88	13,586.65	6,000	3,430.80	30,155.85	0.3503	10,563.59
5	7,000	700	7,700	0.4972	3,828.44	17,415.09	5,000	2,486.00	34,929.09	0.2983	10,419.35*
6	8,000	800	8,800	0.4323	3,804.24	21,219.33	4,000	1,729.20	39,490.13	0.2642	10,433.29
7	9,000	900	9,900	0.3759	3,721.41	24,940.74	3,000	1,127.70	43,813.04	0.2404	10,532.66

* Economic Life = 5 years

Problem 6

13. **There are 10,000 bulbs in a decorative set. When any bulb fails to be replaced, the cost of replacing a bulb individually is Re. 1 only. If all the bulbs are replaced at the same time, the cost per bulb would be reduced to Re. 0.35. The percentage of bulbs surviving at the end of Month (t).i.e., $S(t)$ and the probability of failures during the month(t) i.e. P(t) are given below (Nov / Dec 2014)**

t	0	1	2	3	4	5	6
S(t)	100	97	90	70	30	15	0
P(t)	-	0.03	0.07	0.20	0.40	0.15	0.15

Determine the optimum replacement policy?

Solution

It is clear that no bulb can survive beyond six months. Hence, a bulb which has survived for five months would certainly fail during the sixth month. We assume that the bulbs failing during a month are accounted at the end of the month.

Let

Ni = No. of resistors replaced at the end of the ith month.

$N0 = 10,000$

$$N1 \quad = N0p1$$

$$= 10,000 \times 0.03$$

$$= 300$$

$$N2 \quad = N0p2 + N1p1$$

$$= 10,000 \times 0.07 + 300 \times 0.03$$

$$= 709$$

$$N3 \quad = N0p3 + N1p2 \quad + N2p1$$

$$= 10,000 \times 0.20 + 300 \times 0.07 + 709 \times 0.03$$

$$= 243$$

$$N4 \quad = N0p4 + N1p3 + N2p2 + N3p1$$

$$= 10,000 \times 0.40 + 300 \times 0.20 + 709 \times 0.07 + 243 \times 0.03$$

$$= 517$$

$$N5 = N0p5 + N1p4 + N2p3 + N3p2 + N4p1$$

$$= 10,000 \times 0.15 + 300 \times 0.40 + 709 \times 0.20 + 243 \times 0.07 + 517$$
$$\times 0.03$$

$$= 1795$$

$$N6 = N0p6 + N1p5 + N2p4 + N3p3 + N4p2 + N5p1$$

$$= 10,000 \times 0.15 + 300 \times 0.15 + 709 \times 0.40 + 243 \times 0.20 + 517 \times$$
$$0.07 + 1795 \times 0.03$$

$$= 1968$$

Determination of individual replacement cost

Expected life of each resistor $= \sum_{i=1}^{6} i \times p_i$

$$= 1 \times 0.03 + 2 \times 0.07 + 3 \times 0.20 + 4 \times 0.40$$
$$+ 5 \times 0.15 + 6 \times 0.15$$

$$= 4.02 \text{ months.}$$

Average number of failures/month = 10,000 /4.02 = 2,488 (approx.) Therefore,

Cost of individual replacement

$$= \text{(No. of failures/month } \times \text{ individual replacement cost/resistor)}$$

$$= 2,488 \times 1 = \text{Rs. } 2,488.$$

Determination of group replacement cost

Cost/resistor when replaced simultaneously = Rs. 0.35

Cost/resistor when replaced individually = Rs. 1.00

The costs of group replacement policy for several replacement periods are summarized in Table

End of month	Cost of replacing 10,000 bulbs at a time	Cost of replaing bulbs individually dueirn giiven period	Total cost	Avg Cost/ Month
A	B	C	D = B+C	D/A
1	3,500	300 X 1 =300	3,800	3,800
2	3,500	(300+709) X 1 = 1009	4,509	2254.5
3	3,500	(300+709+243) x 1 = 1252	4,752	1584*
4	3,500	(300+709+243+1252) x 1 = 1769	5,269	1756.33

⁎ Indicates the min. avd. Cost / month

Individual replacement cost/ month = 2488

Group replacement cost/ month = 1584

Group replacement cost is comparatively low, so group replacement

method should be adopted.

Hence all bulbs are to be replaced once in four months and bulbs which fail during this period should be replaced individually.

End of month	Cost of replacing 10,000 bulbs at a time	Cost of replaing bulbs individually dueirn giiven period	Total cost	Avg Cost/ Month
A	B	C	D = B+C	D/A
1	3,500	300 X 1 =300	3,800	3,800
2	3,500	(300+709) X 1 = 1009	4,509	2254.5
3	3,500	(300+709+243) x 1 = 1252	4,752	1584*
4	3,500	(300+709+243+1252) x 1 = 1769	5,269	1756.33

* Indicates the min. avd. Cost / month

Individual replacement cost/ month = 2488

Group replacement cost/ month   = 1584

Group replacement cost is comparatively low, so group replacement
method should be adopted.

Hence all bulbs are to be replaced once in four months and bulbs which fail during this period should be replaced individually.

14. Explain the concept of life cycle analysis cost ((May/June-2013)

Ans-Meaning of Life Cycle Costing:

Life cycle costing is a system that tracks and accumulates the actual costs and revenues attributable to cost object from its invention to its abandonment. Life cycle costing involves tracing cost and revenues on a product by product base over several calendar periods.

The Life Cycle Cost (LCC) of an asset is defined as:
" The total cost throughout its life including planning, design, acquisition and support costs and any other costs directly attributable to owning or using the asset". Life Cycle Cost (LCC) of an item represents the total cost of its ownership, and includes all the cots that will be incurred during the life of the item to acquire it, operate it, support it and finally dispose it. Life Cycle Costing adds all the costs over their life period and enables an evaluation on a common basis for the specified period (usually discounted costs are used).

This enables decisions on acquisition, maintenance, refurbishment or disposal to be made in the light of full cost implications. In essence, Life Cycle Costing is a means of estimating all the costs involved in procuring, operating, maintaining and ultimately disposing a product throughout its life.

Life cycle costing is different from traditional cost accounting system which reports cost object profitability on a calendar basis (i.e. monthly, quarterly and annually) whereas life cycle costing involves tracing costs and revenues of a cost object (i.e. product, project etc.) over several calendar periods (i.e. projected life of the cost object).

Thus, product life cycle costing is an approach used to provide a long-term picture of product line profitability, feedback on the effectiveness of the life cycle planning and cost data to clarify the economic impact on alternative chosen in the design, engineering phase etc. It is also considered as a way to enhance the control of manufacturing costs. It is important to track and measure costs during each stage of a product's life cycle.

15. What are the objectives of plant maintenance? ((May/June-2013)

Ans- Objectives of maintenance management
The more specific objectives of maintenance management are as follows:

      (i) to optimize the reliability of equipment and infrastructure;

      (ii) to ensure that equipment and infrastructure are always in good condition;

      (iii) to carry out prompt emergency repair of equipment and infrastructure so as to secure the best possible availability for production;

      (iv) to enhance, through modifications, extensions, or new low-cost items, the productivity of existing equipment or production capacity;

      (v) to ensure the operation of equipment for production and for the distribution of energy and fluids;

      (vi) to improve operational safety;

      (vii) to train personnel in specific maintenance skills;

      (viii) to advise on the acquisition, installation and operation of machinery;

      (ix) to contribute to finished product quality;

      (x) to ensure environmental protection.

16. Identify the replacement problem and suggest your idea to eradicate it. ((May/June-2015)

Ans-

1. Analyze the Costs

Always think in the long-term when analyzing the costs of repairing or replacing. For a new piece of equipment, consider the cost of purchasing the equipment, its service life, potential salvage value, operating costs, and any revenue increase it may bring.

For an old piece of equipment, consider its remaining service life, operating costs, its market value and future salvage rate. From these figures, you can determine an annual average cost for each option, which will then be easy to compare.

2. Consider the Age of Equipment

Equipment does not age with grace. The older your machinery, the more extensive repairs it will need. This often translates to higher maintenance costs. As you continue to repair, the machine will give you less and less for your investment of repair. You may want to consider replacing an old malfunctioning piece of equipment for a newer, technologically advanced model that will give you better efficiency and longevity. When your equipment is new, it makes more sense, in many cases, to repair it once it malfunctions.

3. Consider the Cost of Repairs

What are the cost of repairs, and more importantly, how often will you be paying those costs for repairs? Documenting asset repair events provides information on number and frequency of breakdown events and costs for the repairs. Can you tell if you're going to continue repairing this equipment several times a year, or will it likely just be a one-time fix?

4. Consider Downtime

What's the impact of downtime while the asset is being repaired? If it takes several days to repair, and if this happens frequently, you're looking at too many hours of lost productivity. Consider this when deciding if repair or replacement is better in your situation. Keep in mind, however, that repairing often takes less time than replacing a machine. Replacing involves waiting for the replacement to arrive, installation, new training, and more. If you're on an extremely tight schedule and if the equipment is crucial to your process, you may lose too much in production if you take the time to replace.

5. Consider Safety

Remember that older equipment can cause injury to workers if it malfunctions. Even if you stay up to date on maintenance, equipment wears down as it ages. Thoroughly inspect your machinery before making your decision so you can determine if your current equipment will continue to provide a safe environment for your workers. If it won't, replacement is the obvious choice. If it is still meeting safety standards, it's worth comparing costs of a replacement versus repair.

6. Consider Efficiency

Always think of the long run. How efficient is your machine operating now, and will a simple repair keep efficiency at the level you want, or would a new piece of equipment that uses less fuel, offers newer features, and breaks down less frequently be better for your efficiency and your bottom line?

MicroMain Maintenance Management Software

MicroMain offers CMMS / EAM software that enables businesses to make more informed decisions when it comes to repairing or replacing equipment. Decisions will be based on actual data provided by the CMMS / EAM solution, not merely guesses. MicroMain's CMMS / EAM solutions help businesses streamline their maintenance operations and take the guesswork out of their maintenance related decisions.

17. Difference between individual and group replacements. (April/May-2017)

Ans-There are certain items which do not deteriorate but fail completely after certain amount of use. These kinds of failures are analysed by the method called as group replacement theory. Here, large numbers of items are failing at their average life expectancy. This kind of items may not have maintenance costs as such but they fail suddenly without any prior warning. Also, in case of sudden breakdowns immediate replacement may not be available. Few examples are fluorescent tubes, light bulbs, electronic chips, fuse etc.

Let's consider the example of street lights. We often see street-lights being repaired by the corporation staff using extendable ladders. If a particular light is beyond repairs, then it is replaced. This kind of policy of replacement is called as 'replacement of items as-and-when they fail' or *'Individual Replacement'*. On the other hand, if all the street lights in a particular cluster are replaced as and when they fail and also simultaneously in groups, then the policy is called as *'Group Replacement'*. It should be noted that, **group replacement does involve periodic simultaneous replacements along with individual replacements in between**.

It is found that replacing these random failing items simultaneously at specific intervals is economical as compared to replacing them only when an item fails. A long period between group replacements results in increase in cost of individual replacements, while frequent group replacements are definitely costly. There lies the need to balance this and find an optimum replacement time for optimum cost of replacement.

18. Discuss economic service life of an asset and main causes of breakdown. (April/May-2018)

Ans- The useful life of an asset is an accounting estimate of the number of years it is likely to remain in service for the purpose of cost-effective revenue generation. The Internal Revenue Service (IRS) employs useful life estimates to determine the amount of time during which an asset can be depreciated. There are a variety of factors that can affect useful life estimates, including usage patterns, the age of the asset at the time of purchase and technological advances.

Understanding Useful Life

Useful life refers to estimated durations of utility placed on a variety of business assets, including buildings, machinery, equipment, vehicles, electronics and furniture. Useful life estimations terminate at the point when assets are expected to become obsolete, require major repairs, or cease to deliver economical results. The estimation of the useful life of each asset, which is measured in years, can serve as a reference for depreciation schedules used to write off expenses related to the purchase of capital goods.

Useful Life and Straight Line Depreciation

The depreciation of assets using the straight line model divides the cost of an asset by the number of years in its estimated life calculation to determine a yearly depreciation value. The value is depreciated in equal amounts over the course of the estimated useful life. For example, the depreciation of an asset purchased for $1 million with an estimated useful life of 10 years is $100,000 per year.

Useful Life and Accelerated Depreciation

Businesses may also elect to take higher depreciation levels at the beginning of the useful life period, with declining depreciation values over the duration of the time span using an accelerated model. The yearly write-offs in the reducing balance depreciation model decline by a set percentage rate to zero. Using the sum of the years method, depreciation declines by a set dollar amount each year throughout the useful life period.

Useful Life Adjustments

The duration of utility in a useful life estimate can be changed under a variety of conditions, including early obsolescence of an asset due to technological advances in similar applications. To

change a useful life estimate in this circumstance, the company must provide a clear explanation to the IRS, backed by documentation comparing the old and new technologies. For example, if a company's original useful life estimate is 10 years, but new technology is likely to render it obsolete after eight years, the company may be able to accelerate depreciation based on a shorter schedule. In this situation, a company that is depreciating assets based on a 10-year schedule may be able to increase yearly depreciation values based on a newly abbreviated eight-year useful life estimate.

19. Summarize the concept of challenger and defender with suitable example. (April/May-2019)

Ans-

Concept of Challenger and Defender

If an existing equipment is considered for replacement with a new equipment, then the existing equipment is known as the *defender* and the new equipment is known as *challenger*. Assume that an equipment has been purchased about three years back for Rs. 5,00,000 and it is considered for replacement with a new equipment. The supplier of the new equipment will take the old one for some money, say, Rs. 3,00,000. This should be treated as the present value of the existing equipment and it should be considered for all further economic analysis. The purchase value of the existing equipment before three years is now known as *sunk cost*, and it should not be considered for further analysis.

EXAMPLE- Two years ago, a machine was purchased at a cost of Rs. 2,00,000 to be useful for eight years. Its salvage value at the end of its life is Rs. 25,000. The annual maintenance cost is Rs. 25,000. The market value of the present machine is Rs. 1,20,000. Now, a new machine to cater to the need of the present machine is available at Rs. 1,50,000 to be useful for six years. Its annual maintenance cost is Rs. 14,000. The salvage value of the new machine is Rs. 20,000. Using an interest rate of 12%, find whether it is worth replacing the present machine with the new machine.

Solution   Alternative 1—Present machine

Purchase price = Rs. 2,00,000

Present value (P) = Rs. 1,20,000

Salvage value (F) = Rs. 25,000

Annual maintenance cost (A) = Rs. 25,000

Interest rate = 12%

The cash flow diagram of the present machine is illustrated in Fig. 8.4. The
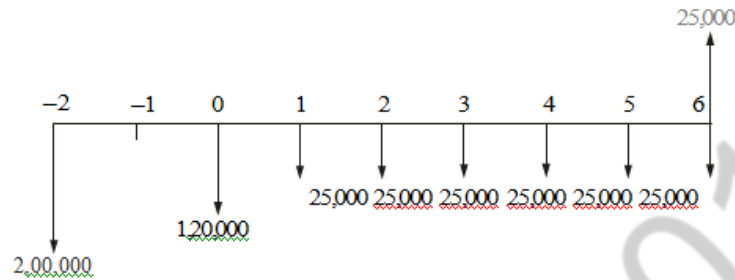
Fig. 8.4 Cash flow diagram for alternative 1.

annual maintenance cost for the preceding periods are not shown in this figure. The annual equivalent cost is computed as

$$AE(12\%) = (P - F)(A/P, 12\%, 6) + F \times i + A$$

$$= (1,20,000 - 25,000)(0.2432) + 25,000 \times 0.12 + 25,000$$

$$= \text{Rs. } 51,104$$

Alternative 2 — New machine

Purchase price (P) = Rs. 1,50,000

Salvage value (F) = Rs. 20,000

Annual maintenance cost (A) = Rs. 14,000

Life = 6 years

Interest rate = 12%

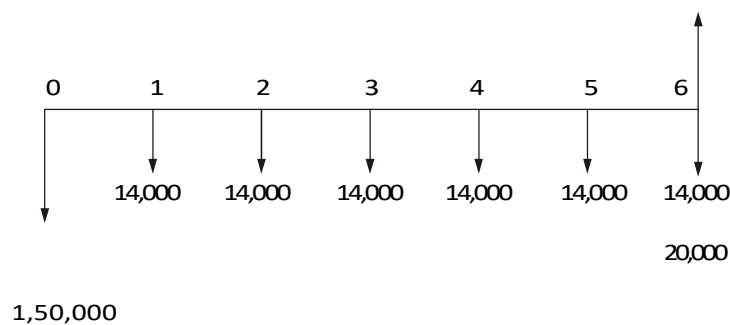The cash flow diagram of the new machine is depicted in Fig. 8.5.

Fig. 8.5 Cash flow diagram for alternative 2.

The formula for the annual equivalent cost is

$$AE(12\%) = (P - F)(A/P, 12\%, 6) + F \times i + A$$

$$= (1,50,000 - 20,000)(0.2432) + 20,000 \times 0.12 + 14,000$$

$$= \text{Rs. } 48,016$$

Since the annual equivalent cost of the new machine is less than that of the present machine, it is suggested that the present machine be replaced with the new machine.

20. What is meant by maintenance and replacement? Elucidate the various types of replacement models. **(April/May-2019)**

Ans-

TYPES OF REPLACEMENT PROBLEM

Replacement study can be classified into two categories:

(a) Replacement of assets that deteriorate with time (Replacement due to gradual failure, or wear and tear of the components of the machines).

This can be further classified into the following types:

(i) Determination of economic life of an asset.

(ii) Replacement of an existing asset with a new asset.

(b) Simple probabilistic model for assets which fail completely (replacement due to sudden failure).

DETERMINATION OF ECONOMIC LIFE OF AN ASSET

Any asset will have the following cost components:

- Capital recovery cost (average first cost), computed from the first cost (purchase price) of the machine.

- Average operating and maintenance cost (O & M cost)

- Total cost which is the sum of capital recovery cost (average first cost) and average maintenance cost.

A typical shape of each of the above costs with respect to life of the machine is shown in Fig. 8.2.
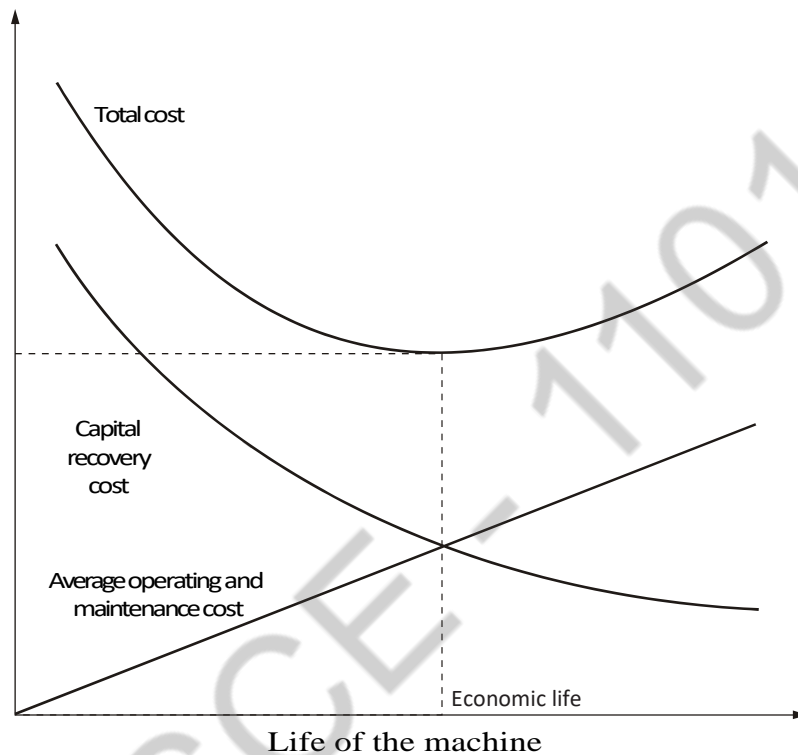
Fig. 8.2 Chart showing economic life.

From Fig. 8.2, it is clear that the capital recovery cost (average first cost) goes on decreasing with the life of the machine and the average operating and maintenance cost goes on increasing with the life of the machine. From the beginning, the total cost continues to decrease up to a particular life and then it starts increasing. The point where the total cost is minimum is called the *economic life* of the machine.

If the interest rate is more than zero per cent, then we use interest formulas to determine the economic life. The replacement alternatives can be evaluated based on the present worth criterion and annual equivalent criterion.

UNIT - 5

DEPRECIATION

PART - A

1. **Define Depreciation?   (Nov/Dec 2013) (Nov 2014) (April 2015) (Nov 2015)**

   The monetary value of an asset decreases over time due to use, wear and tear or obsolescence. This decrease is measured as depreciation.

2. **Write the methods to find the depreciation of an asset. / What are the types of Depreciation?   (Nov 2014)**

         a.   Straight Line Method,

         b.   Declining / Reducing Balance Method

         c.   Sum of the year digit Method

         d.   Sinking Fund Method

         e.   Service Output Method

3. **Define Straight line method of depreciation?**

   Straight line depreciation is the default method used to gradually reduce the carrying amount of a fixed asset over its useful life.

4. **Define Declining balance method of depreciation?**

   Declining balance method is an accelerated form of depreciation under which the vast majority of the depreciation associated with a fixed asset is recognized during the first few years of its useful life.

5. **Define Sum of the year-digits method of depreciation?**

   An accelerated method for calculating an asset's depreciation, this method takes the asset's expected life and adds together the digits for each year. So if the asset was expected to last for five years, the sum of the years› digits would be obtained by adding: 5 + 4 + 3 + 2 + 1 to get a total of 15. Each digit is then divided by this sum to determine the

percentage by which the asset should be depreciated each year, starting with the highest number in year.

6. **Give the expression for the calculation of depreciation under sum of years-digits method of depreciation.**

   If the asset has a life of eight years, first the sum of the years is computed as

   Sum of the years $= 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8$

   $$= 36 = n(n + 1)/2$$

   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 = $ Rate x $(P - F)$

   $B_t = B_t - 1 - D_t$

7. **Define sinking fund method of depreciation?**   **(Nov 2014)**

   Under the sinking fund method, the business sets aside an amount of money to invest annually so that the principal plus the interest earned in the fund will be enough to replace the asset.

8. **Define Service output method of depreciation?**

   The term units-of-output depreciation refers to one of several methods of allocating the cost of an asset over its expected lifetime. The units-of-output depreciation method is based on the assumption the asset will output a fixed number of units over its lifetime; therefore, the depreciation expense in a given accounting period is directly related to the asset's output in that same accounting period.

9. **State the objective behind provision of depreciation.**
   ˃ To know the correct profits
   ˃ To show correct financial position

- To compute tax liability
- To decide how much to buy or sell the assets in the second hand market
- To make provision for replacement of assets

10. Define inflation?

Inflation is the rate at which the general level of prices for goods and services is rising and, consequently, the purchasing power of currency is falling. Central banks attempt to limit inflation, and avoid deflation, in order to keep the economy running smoothly.

11. List the reasons for inflation?

- Excess aggregate demand,
- Demand pull inflation,
- Cost push inflation,
- Monetary expansion.

12. List the effect of inflation?

- Misallocation of Resources,
- Reduction in Production,
- Fall in quality,
- Black Marketing,
- Reduction in Savings.

13. List few causes of depreciation. (May / June 2012)

- *Wear and tear*. Any asset will gradually break down over a certain usage period, as parts wear out and need to be replaced. Eventually, the asset can no longer be repaired, and must be disposed of. This cause is most common for production equipment, which typically has a manufacturer's recommended life span that is based on a certain number of units produced. Other assets, such as buildings, can be repaired and upgraded for long periods of time.

- *Usage rights*. A fixed asset may actually be a right to use something (such as software or a database) for a certain period of time. If so, its life span terminates when the usage rights expire, so depreciation must be completed by the end of the usage period.

- *Inefficiency/obsolescence*. Some equipment will be rendered obsolete by more efficient equipment, which reduces the usability of the original equipment.

- **Effusion Of Time**

The value of asset may decrease due to the passage of time even if it is not in use. There are some intangible fixed assets like copyright, patent right, and lease hold premises which decrease its value as time elapse.

- **Exhaustion**

An asset may loss its value because of exhaustion too. This is the case with wasting assets such as mines, quarries, oil-wells and forest-stand. On account of continuous extraction, a stage will come where mines and oil-wells get completely exhausted.

14. **What are the assumptions for straight line method of calculating depreciation? (May / June 2012)**

The straight line depreciation method is based on the assumption the asset will lose the same value each accounting period.

Increased use of the asset has no effect on the amount of depreciation each year since it is the same every period

15. **Define the following depreciation and book value. (Nov/ Dec 2012)**

In accountancy, **depreciation** refers to two aspects of the same concept

- The decrease in value of assets (fair value depreciation)
- The allocation of the cost of assets to periods in which the assets are used

- **Depreciation** is an accounting method of allocating the cost of a tangible asset over its useful life. Businesses **depreciate** long-term assets for both tax and accounting purposes

Book value of an asset is the **value** at which the asset is carried on a balance sheet and calculated by taking the cost of an asset minus the

accumulated **depreciation**. **Book value** is also the net asset **value** of a company, calculated as total assets minus intangible assets (patents, goodwill) and liabilities.

16. **Distinguish between declining balance method of depreciation and double declining balance method of depreciation (Nov/ Dec 2012)**

    Declining balance refers to the asset's *book value or carrying value* at the beginning of the accounting period.

    The double declining balance method of depreciation, also known as the 200% declining balance method of depreciation, is a common form of *accelerated* depreciation. Accelerated depreciation means that an asset will be depreciated *faster* than would be the case under the straight line method.

17. **What is sinking fund (May / June 2013)**

    Under the sinking fund method, the business sets aside an amount of money to invest annually so that the principal plus the interest earned in the fund will be enough to replace the asset.

18. **What is amortization? (May / June 2013)**

    Amortization is the paying off of debt with a fixed repayment schedule in regular installments over a period of time for example with a mortgage or a car loan. It also refers to the spreading out of capital expenses for intangible assets over a specific period of time (usually over the asset's useful life) for accounting and tax purposes.

19. **Write any two differences in evaluating alternatives of private and public sector organization (Nov/ Dec 2013)**

    1. In evaluating alternatives of private organizations, the criterion is to select the alternative with the maximum profit. The profit maximization is the main goal of private organizations while providing goods/ services as per specifications to their customers.

    2. The main objective of any public alternative is to provide goods/services to the public at the minimum cost. In this process, one should see whether the benefits of the public activity are at least equal to its costs.

    Examples of some public alternatives are

- Constructing bridges,
- Roads, dams,
- Establishing public utilities, etc.

20. **Differentiate straight line method of depreciation and declining balance method of depreciation (Nov 2015)**

   In straight line 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.

   In declining balance 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.

21. **What is benefit – cost ratio?**

   The ratio between the equivalent benefit and equivalent cost is called the benefit - cost ratio

   $$\text{BC ratio} = \frac{\text{Equivalent benefits}}{\text{Equivalent cos ts}}$$

22. **Define depreciation.**   **(April/May-2017)**

   Ans- Depreciation is an accounting method of allocating the cost of a tangible or physical asset over its useful life or life expectancy. Depreciation represents how much of an asset's value has been used up.

23. **State the nature of annuity method of depreciation. (April/May-2017)**

   Ans- The annuity method of depreciation is also referred to as the compound interest method of depreciation. The annuity method assumes that the sum spent on buying an asset is an investment that should be expected to yield interest. As such, the interest is charged on the diminishing balance of the asset

24. Mention note on straight line method of depreciation. (April/May-2018)

Ans- Straight line depreciation can be calculated using any of the following formulas

● Depreciation per annum $= \dfrac{(\text{Cost} - \text{Residual Value})}{\text{Useful Life}}$

● Depreciation per Annum $= (\text{Cost} - \text{Residual Value}) \times \text{Rate of depreciation}$

25. Sketch the procedure to adjust inflation. (April/May-2018)

Ans- A procedure to deal with this situation is summarized below.

1. Estimate all the costs/returns associated with an investment proposal interims of today's Rupees.
2. Modify the costs/returns estimated in step 1 using an assumed inflation rate so that at each future date they represent the costs/returns at that date in terms of the rupees that must be expended/received at that time, respectively.
3. As per our requirement, calculate either the annual equivalent amount or future amount or present amount of the cash flow resulting from step 2 by considering the time value of money.

26. What is depreciation?   (Nov/Dec-2018)

Ans- *Depreciation* is an accounting method of allocating the cost of a tangible or physical asset over its useful life or life expectancy. *Depreciation* represents how much of an asset's value has been used up. The Businesses can *depreciate* long-term assets for both tax and accounting purposes.

27. What is inflation?   (Nov/Dec-2018)

Ans- *Inflation* is a quantitative measure of the rate at which the average price level of a basket of selected goods and services in an economy increases over a period of time. Inflation often expressed as a percentage, *inflation* indicates a decrease in the purchasing power of a nation's currency.

28. State the objectives of providing depreciation. (April/May-2019)

Ans- Objectives for Providing Depreciation is to ascertain the true results of operations: For proper matching of costs with revenues of that

period, depreciation should be charged; otherwise it would result in an overstatement of profit. As a result of this, the income statement will not show a true and fair view.

29. An asset has purchased for Rs 10000/ and it will have scrap value of Rs 1000/ at the end of its useful   life of 10 years. Calculate depreciation.

(April/May-2019)

Ans- $D_t = (P-F)/n = (10000-1000)/10 = Rs\ 900/$

D_t = Depreciation amount for period 't'

P = First Cost of the asset

F = Salvage value

n = Life of the asset

PART - B

1. **Explain the various methods of depreciation with example? (Nov 2015) (April 2015) (May 2013) (May 2012).(April/May-2018)**

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.

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.

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

Sum of the years = $1 + 2 + 3 + 4 + 5 + 6 + 7 + 8$

$$= 36 = n(n + 1)/2$$

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.

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

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.

2. **Explain the procedure to adjust the inflation and discuss the determination of economic life of assets? (April 2015) (Nov 2014)(May 2018)**

A procedure to deal with this situation is summarized now.

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

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

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

INFLATION ADJUSTED ECONOMIC LIFE OF MACHINE

In any industrial/service organization, equipment/machinery forms an important element. The productivity of any organization is a function of many factors. It is largely affected by efficient and effective use of machinery and equipment. So, operations and maintenance of these equipment are very important to the organization.

A machine which is purchased today cannot be used forever. It has a definite economic lifetime. After the economic life, the machine should be replaced with a substitute machine with similar operational capabilities. This kind of analysis is called replacement analysis.

The elements of costs involved in the replacement analysis are as follows:

1. Purchase cost (initial cost)
2. Annual operation and maintenance cost
3. Salvage value at the end of every year, if it is significant

The determination of economic life of a machine without considering the effect of inflation is demonstrated using the following example.

EXAMPLE A machine costs Rs. 5,00,000. Its annual operation cost during the first year is Rs. 40,000 and it increases by Rs. 5,000 every year thereafter. The maintenance cost during the first year is Rs. 60,000 and it increases by Rs. 6,000 every year thereafter. The resale value of the machine is Rs. 4,00,000 at the end of the first year and it decreases by Rs. 50,000 every year thereafter. Assume an interest rate (discounting factor) of 20%. The method of finding the economic life of the machine with a discounting

factor of 20% at zero inflation rate . From the table it is clear that the total annual equivalent cost is minimum if the machine is used for 14 years. Hence, the economic life of the machine is 14 years.

Economic Life Determination with Inflationary Effect

The illustration in Section is reconsidered for analyzing the effect of inflation on the economic life of the machine. An average annual inflation rate of 6% is assumed for discussion. The corresponding steps are explained. From the Table it is clear that the total annual equivalent cost is minimum if the machine is used for three years. Thus, the economic life of the machine is three years.

3. What is functional depreciation? (May 2013)

Functional depreciation: represents the loss of value caused by outdated or poor design. There are two types of functional depreciation, curable and incurable. Curable depreciation is the cost of remodeling or adding additional rooms, doorways, or enhancements, etc. Incurable depreciation is really a matter of judgment as when a certain style of housing goes out of style.

4. Write on accelerated depreciation? (May 2013)

Accelerated depreciation allows companies to write off their assets faster in earlier years than the straight-line depreciation method and to write off a smaller amount in the later years. The major benefit of using

this method is the tax shield it provides. Companies with a large tax burden might like to use the accelerated-depreciation method, even if it reduces the income shown on the financial statement.

This depreciation method is popular for writing off equipment that might be replaced before the end of its useful life since the equipment might be obsolete (e.g. computers).

Problem 1

5. **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. (Nov/ Dec 2013). (Nov / Dec 2012)**

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 summarized in Table

Table D_t and B_t Values under Straight line Method of Depreciation

End of year	Depreciation	Book value
(t)	(D_t)	$(B_t = B_{t-1} - D_t)$
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.

Problem 2

6. **Consider above problem 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 Dt and Bt for different values of t are summarized in Table 9.2 using the following formulae:

$$Dt = K \_ Bt\text{–}1$$

$$Bt = Bt\text{–}1 - Dt$$

Table Dt and Bt according to Declining Balance Method of Depreciation

End of year (t)	Depreciation (D_t)	Book value (B_t)
0		1,00,000
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

Problem 3

7. **A state government is planning a hydroelectric project for a river basin. In addition to the production of electric power, this project will provide flood control, irrigation and recreation benefits. The estimated benefits and costs that are expected to be derived from this project are as follows: (Nov/ Dec 2013)**

  Initial cost = Rs. 8,00,00,000

  Annual power sales = Rs. 60,00,000

  Annual flood control savings = Rs. 30,00,000

  Annual irrigation benefits = Rs. 50,00,000

  Annual recreation benefits = Rs. 20,00,000

  Annual operating and maintenance costs = Rs. 30,00,000

  Life of the project = 50 years

Check whether the state government should implement the project (Assume $i = 12\%$)

Solution

  Initial cost = Rs. 8,00,00,000

  Annual power sales = Rs. 60,00,000

  Annual flood control savings = Rs. 30,00,000

  Annual irrigation benefits = Rs. 50,00,000

  Annual recreation benefits = Rs. 20,00,000

  Annual operating and maintenance costs = Rs. 30,00,000

  Life of the project = 50 years, $i = 12\%$

Total annual benefits   = Flood control savings + Irrigation benefits+
Recreation benefits = Rs. 30,00,000 + Rs. 50,00,000 + Rs. 20,00,000

  = Rs. 1,00,00,000

Present worth of the benefits = Total annual benefits x $(P/A, 12\%, 50)$

  = 1,00,00,000 x (8.3045)

  = Rs. 8,30,45,000

Problem 3 Present worth of costs = Initial cost + Present worth of annual operating and maintenance cost

– Present worth of power sales

= Rs. 8,00,00,000 + 30,00,000 x (*P/A*, 12%, 50) – 60,00,000 (*P/A*, 12%, 50)

= Rs. 8,00,00,000 + 30,00,000 x 8.3045 – 60,00,000 x 8.3045

= Rs. 5,50,86,500

$$BC \text{ ratio} = \frac{Present \ worth \ of \ benefits}{Present \ worth \ of \ costs}$$

$$= \frac{83045000}{55086500}$$

$$= 1.508$$

Since, the BC ratio is more than 1, the state government can implement the hydroelectric project.

Problem 4

8. **The first coat 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. (Nov/Dec 2012)**

Solution

P = Rs. 80,00,000

F = Rs. 50,000

X = 75,000 km

x = 2,000 km

Depreciation for x unit of service in a period $= \dfrac{P - F}{X} x$

Depreciation for year 3 $= \dfrac{(8000000 - 50000)}{75000} \cdot 2000$

$$= \text{Rs. } 2,12,000$$

9. A machine is purchased for Rs. 45,000 and has a life of 20 years. Its salvage value is estimated to be Rs. 3,000. Using the sum of digital method, calculate Annual Depreciation charges for first, sixth and eleventh, sixteenth and twentieth years. (Nov 2014) (April/May-2018)

Solution

Sum of the years digital method

$P = 45,000$

$N = 20$ years

$F = 3,000$

Sum of years $= 1 + 2 + \ldots + 20$

$$= \frac{n(n+1)}{2}$$

$$= \frac{20(21)}{2}$$

$$= 210$$

Depreciation, $D_t = \dfrac{n - t + 1}{\dfrac{n(n+1)}{2}} \cdot (P - F)$ or Rate $\cdot$ (P-F)

Book value, $B_t = (P - F) \left\{ \dfrac{n - t}{n} \right\} \dfrac{n - t + 1}{n(n+1)} + F$ or $B_{t-1} = D_t$

$D_1 = \dfrac{20 - 1 + 1}{210}(45,000 - 3,000)$ $D_{16} = \dfrac{20 - 16 + 1}{210}(45,000 - 3,000)$

$= 4,000$ $= 1,000$

$D_6 = \dfrac{20 - 6 + 1}{210}(45,000 - 3,000)$ $D_{20} = s\dfrac{20 - 20 + 1}{210}(45,000 - 3,000)$

$= 3,000$ $= 200$

$D_{11} = \dfrac{20 - 11 + 1}{210}(45,000 - 3,000)$

$= 2,000$

Problem 6

10. **Calculate the Depreciation, accumulated Depreciation and book value for the following Data using Declined Balance Method (Nov 2014)**

   Initial Investment   = Rs. 24,000

   Salvage Value   = Rs. 3,000

   Time   = 5 years

Declined Balance method

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

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

   $= (1-K) \times B_{t-1}$

P =24,000   F= 3,000   N= 5 years

Assume K = 0.2

End of year	D	Book Value, B_t
0	0	24,000
1	3,840	19,200
2	3,072	15,360
3	2,458	12,288
4	1,966	9,830
5	----	7,864

Problem 7

11. **The first coat 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 = Rs. 80,00,000

F = Rs. 50,000

X = 75,000 km

x = 2,000 km

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

Depreciation for year 3 $= \dfrac{(80,00,000 - 50,000)}{75,000} \cdot 2,000$

$=$ Rs. 2,12,000

12. **With an example explain the straight line method of depreciation.**
   Also list the advantages of using straight line method of depreciation.
           (Nov/Dec-2018)

Ans- Every business hands over money to the government in the form of taxes. Everybody recognizes that paying taxes is necessary for the maintenance of services and infrastructure locally as well as on the state and federal levels. Individuals and businesses attempt to pay their fair share of taxes while at the same time taking allowable deductions. Depreciation is a permissible business tax deduction.

Depreciation

Depreciation is a fixed business expense. The Internal Revenue Service (IRS) allows businesses to offset the cost of newly acquired tangible assets. Businesses allocate the expenditure over a period of years. A specific dollar amount is allotted each year over the life of the depreciable asset. The cost reduction is depreciation. There are a number of systems the IRS allows for depreciating business assets. Three examples of depreciation methods are straight-line depreciation, declining-balance method and the sum-of-years' digits method.

Straight-Line Depreciation

A common method of reducing the cost, or purchase price, of assets is straight-line depreciation. This process reduces the cost of an asset by an equal amount each year over the estimated useful life of the asset, typically a number of years. Straight-line depreciation is calculated by dividing the depreciable cost of the asset by the number of years the asset will be used.

Advantages of Straight-Line Depreciation

Straight-line depreciation, also known as the fixed or equal-installment depreciation method, is the simplest and most widespread form of depreciation used by businesses. It is suitable for assets that operate uniformly and consistently over the life of the item. The fixed method is straightforward, uncomplicated, easy to understand and simple to apply. Each year the same amount of money is taken as a depreciable business expense on the company's tax return. Straight-line depreciation is suitable for less expensive items, such as furniture, that can be written off within the asset's defined legal, estimated or commercial life. The IRS sets guidelines for estimating an asset's useful life.

Disadvantages of Straight-Line Depreciation

Most pieces of office equipment, machinery and other items purchased do not perform exactly the same each year. As assets age they become less efficient. Repair costs usually increase over time. Straight-line depreciation does not account for the loss of efficiency or the increase in repair expenses over the years and is, therefore, not as suitable for costly assets such as plant and equipment. The functional life span of some assets cannot clearly be estimated. The straight-line depreciation method should not be used when the useful life of an asset is unpredictable.

13. What is functional depreciation? (April/May 2017)

Ans-Functional depreciation is the depreciation provided as a result of lack of adaptation of an asset to

function. It results from change of conditions and surroundings which render the asset ill adapted to its work, from the growth of business which renders the asset inadequate, or to the decline of business.

14. Elucidate different methods of calculating depreciation.

Ans- Various methods of depreciation are generally classified as follows:

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

1. Straight Line Method:

This method assumes that depreciation is a function of time rather than use. This method is based on the assumption that each accounting period receives same benefits from using the assets. It allocates an equal amount of depreciation in each accounting periods of the service life of the assets. Therefore, it is called Straight Line Method.

The formula for calculating depreciation charge for each accounting period is:

$$\text{Annual Depreciation} = \frac{\text{Acquisition cost} - \text{Estimated scrap value}}{\text{Estimated Life in Years}}$$

Advantages:

(i) It is simple in use.

(ii) It realistically matches cost and revenue and determine income of each period easily.

(iii) There is no change either in the rate or the amount of depreciation over the useful life of the assets. Such a procedure provides for improved comparability.

Disadvantages:

(i) It ignores the cost of capital.

Illustration 1:

ABC Ltd. acquires a machine on 1st July, 2007 at a cost of Rs. 2, 80,000 and spent Rs. 20,000 on its installation. The firm writes off depreciation at 10% of the original cost every year. The books are closed on 31st December every year. Prepare machinery A/c for 3 years.

Solution: **Machinery A/c**

Date	Particulars	(₹)	Date	Particulars	(₹)
2006	To Bank	2,80,000	2006	By Depreciation A/c	15,000
July 1	To Bank (installation Exps.)	20,000	Dec. 31	By Balance c/d	2,85,000
		3,00,000			3,00,000
2007			2007		
Jan. 1	To balance b/d	2,85,000	Dec. 31	By Depreciation A/c	30,000
			Dec. 31	By balance c/d	2,55,000
		2,85,000			2,85,000
2008			2008		
Jan. 1	To balance b/d	2,55,000	Dec. 31	By Depreciation A/c	30,000
			Dec. 31	By balance c/d	2,25,000
		2,55,000			2,55,000

Sale of Asset:

If the asset is disposed of in the middle of the year, the amount realized should be credited to the asset a/c for the time it has been in use. Any balance left in the account of asset will be profit or loss and should be transferred to P&L A/c.

15. Explain the procedure to adjust inflation in calculation depreciation.   (Nov/Dec- 2018)

Ans- These adjustments are done for the twenty groups of companies separately, exactly as in the case of inventory adjustment. These groups are listed at the beginning of the preceding chapter. For all the twenty groups, the adjusted depreciation figures are arrived at using four sets of price indices, alternatively—the consumer price index, the wholesale price index for all commodities, the implicit GNP deflator and the specific price indices. In the last case, the price indices used for the five groups of fixed assets were: cost of construction index (in Delhi, assuming that elsewhere the trend would be more or less the same) for roads, buildings and other construction; wholesale price index for manufactured products to adjust depreciation on other plant and machinery; simple average of the wholesale price indices for electrical and non-electrical machinery to adjust depreciation on basic plant and machinery; the wholesale price index for transport equipment to adjust depreciation on motor vehicles, and the wholesale price index for manufactured pro-ducts to adjust depreciation on furniture and fixtures.

Since our sample consists of only manufacturing companies, plant and machinery constitute the bulk of the fixed assets. Naturally, the depreciation adjusted or unadjusted on this category of assets dominates total depreciation. The calculation of adjusted depreciation for the first category of assets is based on the assumption made earlier that they were on an average, 25 years old in 1979. That was reasonable for the sample as whole (group 1), and for the non-government companies selected. For all the industry groups and size groups also this may be reasonable approximation. However, for groups 7, and 9, this was not so by definition and hence we assume them to be on an average 30, 15 and years old, respectively.

For the government companies also, this assumption was modified as they turned out to be 20 years old on an average. As in the case of inventory adjustments, the blowing-up of our estimates is undertaken with respect to the government companies and the three age-groups of non-government companies. The blown-up figures for these four groups together yield the estimate for the population of manufacturing companies.

2. Results

Tables 6.1 through 6.20 report the result of our calculations. Each table refers to one group of companies, classified as earlier. The figures refer to the year 1979, the last year under observation. This is so because the method of adjustment employed requires data for previous nine years to adjust the depreciation in the tenth year. Tt should be noted that due to the approximations made in the estimation method1 the bias of these estimated values would be downwards, i.e., these estimates are conservative. Also, the backlog problem a controversial issue in the inflation accounting methods is ignored here, and no provision for backlog

16. With an example explain the straight line methods of depreciation. Also list the advantages of using straight line methods of depreciation. (Nov/Dec- 2018)

Ans-

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

End of year (t)	Depreciation (D_t)	Book value ($B_t = B_{t-1} - D_t$)
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.

17. Define inflation and elaborate the procedure to adjust inflation.   (April/May 2019)

Ans-

What Is Inflation?

To put it simply, inflation is the long term rise in the prices of goods and services caused by the devaluation of currency. While there are advantages to inflation which I will discuss later in this article, I want to first focus on some of the negative aspects of inflation.

Inflationary problems arise when we experience *unexpected* inflation which is not adequately matched by a rise in people's incomes. If incomes do not increase along with the prices of goods, everyone's purchasing power has been effectively reduced, which can in turn lead to a slowing or stagnant economy. Moreover, excessive inflation can also wreak havoc on <u>retirement savings</u> as it reduces the purchasing power of the money that savers and investors have squirreled away.

Methods to Control Inflation

Inflation is generally controlled by the Central Bank and/or the government. The main policy used is monetary policy (changing interest rates). However, in theory, there are a variety of tools to control inflation including:

1. **Monetary policy** – Higher interest rates reduce demand in the economy, leading to lower economic growth and lower inflation.

2. **Control of money supply** – Monetarists argue there is a close link between the money supply and inflation, therefore controlling money supply can control inflation.

3. **Supply-side policies** – policies to increase the competitiveness and efficiency of the economy, putting downward pressure on long-term costs.

4. **Fiscal policy** – a higher rate of income tax could reduce spending, demand and inflationary pressures.

5. **Wage controls** – trying to control wages could, in theory, help to reduce inflationary pressures. However, apart from the 1970s, it has been rarely used.

18. State the meaning for depreciation fund and explain various methods of depreciation
(April/May 2019)

Ans-

The sinking fund method is a technique for depreciating an asset while generating enough money to replace it at the end of its useful life. As depreciation charges are incurred to reflect the asset's falling value, a matching amount of cash is invested. These funds sit in a sinking fund account and generate interest.

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

1. Straight Line Method:

This method assumes that depreciation is a function of time rather than use. This method is based on the assumption that each accounting period receives same benefits from using the assets. It allocates an equal amount of depreciation in each accounting periods of the service life of the assets. Therefore, it is called Straight Line Method.

The formula for calculating depreciation charge for each accounting period is:

$$\text{Annual Depreciation} = \frac{\text{Acquisition cost} - \text{Estimated scrap value}}{\text{Estimated Life in Years}}$$

19. **What is Declining Balance Method of Depreciation?**
     Ans-

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:

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

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

$$= (1 - K) \times B_{t-1}$$

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.*

20. **Explain the Sum-of-the-Years-Digits Method of Depreciation.**
Ans-

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

Sum of the years $= 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8$

$\quad = 36 = n(n + 1)/2$

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:

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

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

Solution

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

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

$\quad n = 8$ years

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

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:

$D_t = \text{Rate} \times (P - F)$, $t = B_{t-1} - D_t$

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

End of year (n)	Depreciation (D_t)	Book value (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.