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Chapter 1

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1.1.1 DEFINITION OF ECONOMICS

Economics is the science that deals with the production, distribution and consumption of goods and services or the material welfare of human kind. Economics can be broken down into two main disciplines: macro economics and microeconomics. Macroeconomics deals with the behaviour of economics on a large scale, usually the economics on a large scale, usually the economics of countries or regions. Micro economics, on the other hand, usually addresses individual agent.

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Lion Robbins in 1932 defined "Economics is the science which studies human behaviour as a relationship between ends and scare means which have alternative uses."

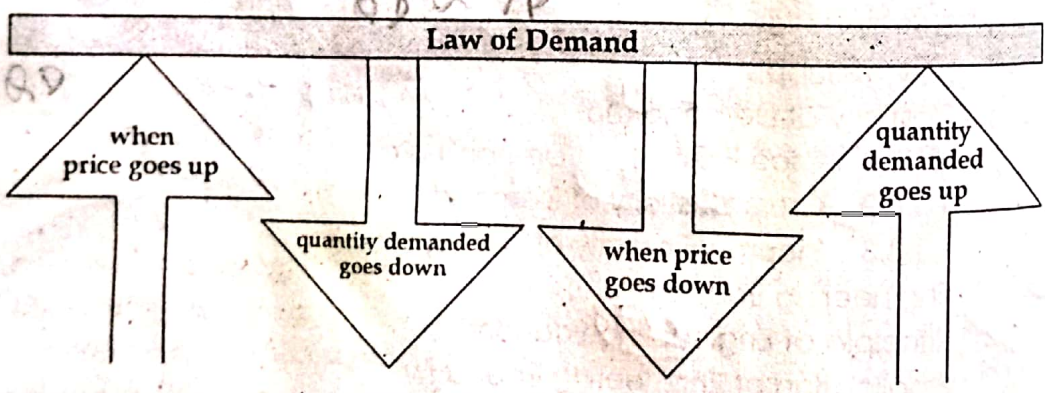
Marshall in 1980 defined "Economics is on the one side, a study of wealth and on the other more important side is a part of the study of man." So, according to him, economics is concerned with human welfare that means man is primary importance and wealth is only secondary importance, *i.e.*, wealth for man.

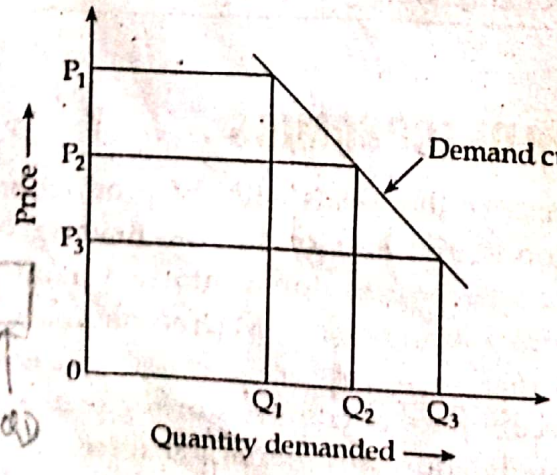
1.1.2 DEMAND

Demand in economics is the consumer's desire and ability to purchase a goods or service. Demand in economics is how many goods and services are bought at various prices during a certain period of time. "Every demand or want supported by the willingness and ability to buy" constitutes demand for a particular product or services.

1.1.3 LAW OF DEMAND

Law of demand states the relationship between quantity demanded and price of the commodity. It explains the relationship between price and quantity demanded. It states: "All other things being equal, demand varies inversely with price".





The higher the price of good, lower will be demand and vice-versa. The chart shows that the curve is a downward slope.

1.1.4 LAW OF DIMINISHING UTILITY

The law of diminishing marginal utility states that all else equal as consumption increases the marginal utility derived from each additional unit declines. The law is based on certain assumptions:

- Utility is measurable. The measurement unit is util.
- Continuous consumption.
- Price of the substitute do not change.
- Commodity is measurable.
- Consumer taste and preferences unchanged.
- Various units of commodity are homogenous in characteristics.
- Suitable and similar units of commodity.

Limitations:

- This law does not hold well in the rare collections. *For example;* collection of ancient coins, stamps etc.
- This law is not fully applicable to money. The marginal utility of money declines with richness but never fails to zero.
- It does not apply to the art, innovation and knowledge.
- The utility increases due to demonstration. It is a natural element.
- The law is not applicable for precious goods.
- Historical things are also included in exceptions to his law.
- Law does not operate if consumer behaves in irrational manner.

Explanation with schedule and diagram

Suppose a person eats bread and 1st unit of bread gives him maximum satisfaction. When he will eat 2nd bread, his total satisfaction would increase. But the utility added by 2nd unit of bread will be less than the 1st bread and this marginal utility will continue to decrease as he will keep on eating additional piece of bread and once his stomach is full, marginal utility will become negative, decreasing the total utility.

Slices of bread	Total utility	Marginal utility
0	0	–
1	70	70
2	110	40
3	130	20
4	140	10
5	145	3
6	140	– 10

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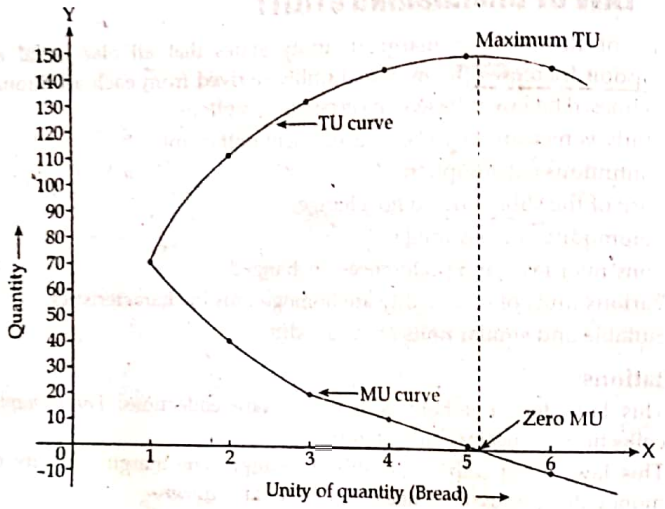
In the graph below, the total utility (TU) curve is increasing at decreasing rate and it becomes maximum when marginal utility is zero. When MU is negative, TU declines plotting the above data on a graph gives,



The MU curve has negative slope and cross the OX-axis on 6th unit. He does not want to consume another *i.e.*, 6th unit gives him negative utility (-10) instead of positive satisfaction which leads to decrease his total utility by 140.

1.1.5 MARGINAL AND MARGINAL UTILITY

1.1.5.1 UTILITY

Utility is the level of satisfaction to a consumer by consuming goods or services *For example;* Bread satisfies hunger, TV satisfies the want for entertainment.

1.1.5.2 MARGINAL UTILITY (MU)

Marginal utility refers to the extra utility a consumer gets from one additional unit of a specific product. It is the utility derived by single unit of consumption.

$$MU = \frac{\text{Change in total utility}}{\text{Change in quantity consumption}}$$

$$= TU_{N+1} - TU_N$$

Here, TU_N = total utility up to n^{th} unit of outcome consume

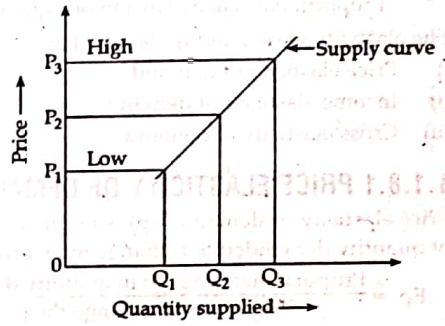
TU_{N+1} = total utility up to $(n + 1)^{th}$ unit of outcome consume

1.1.6 SUPPLY

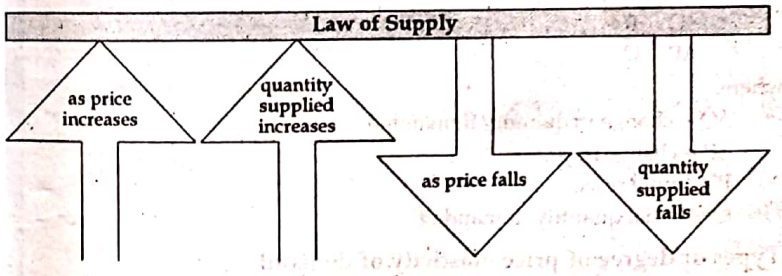
Supply is defined as the desire with ability to sell and willingness to sell. Supply is a fundamental economic concept that describes the total amount of a specific goods or service that is available to consumers

1.1.7 LAW OF SUPPLY

Law of supply states the relationship between quantity supplied and price of the commodity. It states "All other things being equal, the quantity supplied of commodity increases when its price increases and vice-versa". Supply bears a positive relations to the price of the commodity. Higher the price, higher will be quantity supplied and lower the price, smaller will be quantity supplied.



Price and quantity supplied have a direct relationship.



Factors affecting to supply:

- New inventions
- Price of related goods
- Taxes and subsides
- Development of infrastructure state of natural resources
- Change in money income
- Price of commodity
- Production technology
- State of natural resources

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1.1.8 ELASTICITY OF DEMAND (Ed)

The change in quantity demanded due to change in price, income etc is called elasticity of demand. It is a technical term used by the economists to describe the degree of responsiveness of the demand for the commodity to change in price and so on. The elasticity of demand is a measure of change in the quantity demanded in response to the change in the price of the commodity.

Mathematically,

$$Ed = \frac{\text{Prportionate change in quantity demanded}}{\text{Proportionate change in any one quantitative determinant of demand}}$$

The elasticity of demand is classified as:

i) Price elasticity of demand
ii) Income elasticity of demand
iii) Cross elasticity of demand

1.1.8.1 PRICE ELASTICITY OF DEMAND

Price elasticity of demand (Ep) is defined as the degree of responsiveness of quantity demanded to a change in its price.

$$Ep = \frac{\text{Proportionate change in quantity demanded of the commodity}}{\text{Proportionate change the price of the commodity}}$$

$$= \frac{\Delta Q/Q}{\Delta P/P}$$

$$\therefore Ep = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

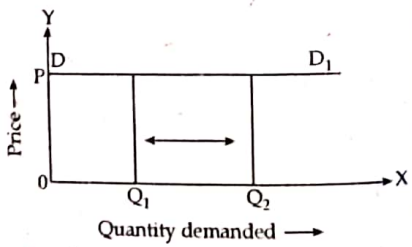
where,

ΔQ = change in quantity demanded
ΔP = change in price
P = Initial price
Q = Initial quantity demanded

Types or degree of price elasticity of demand

1. Perfectly elastic demand (Ep = ∞)

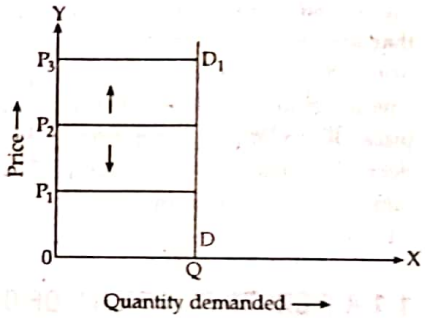
The demand is said to be perfectly elastic if the quantity demanded increases infinitely or by unlimited quantity with a small tall in price or quantity demanded falls to zero with a small rise in price.



In the figure, the curve DD_1 is a horizontal straight line parallel to the X-axis. It shows that negligible change in price causes infinite fall or rise in quantity demanded.

2. Perfectly inelastic demand (Ep = 0)

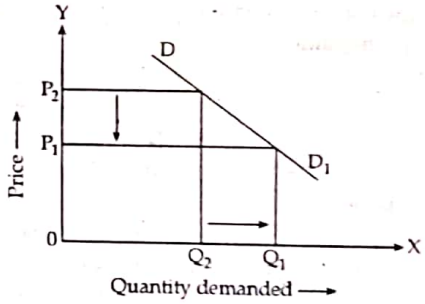
When there is no change in the demand for a product due to the change in the price, then the demand is said to be perfectly inelastic.



In the figure, the curve DD_1 is a straight vertical line which shows that the demand remains unchanged irrespective of change in the price. *i.e.*, quantity OQ remains unchanged at different prices P_1, P_2, P_3, ...

3. Relatively elastic demand (Ep = 1 to ∞)

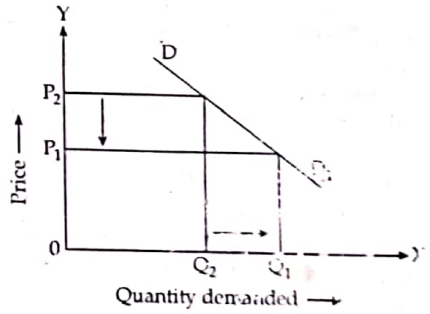
The demand is relatively elastic demand when the proportionate change in the demand for a commodity is greater than the proportionate change in its price.



In the figure, the demand curve is gradually sloping which shows that a proportionate change in quantity from OQ_2 to OQ_1 is greater than the proportionate change in the price from OP_1 to OP_2.

4. Unitary elastic demand (Ep = 1)

The demand is unitary elastic demand when the proportionate change in the price of a product results in the same change in quantity demanded.



In the figure, the increase in demand from OQ_2 to OQ_1 is just equal to the increase in price from OQ_2 to OQ_1.

5. Relatively inelastic demand (Ep < 1)

When the proportionate change in the demand for a product is less than the proportionate change in the price, the demand is said to be relatively inelastic demand.

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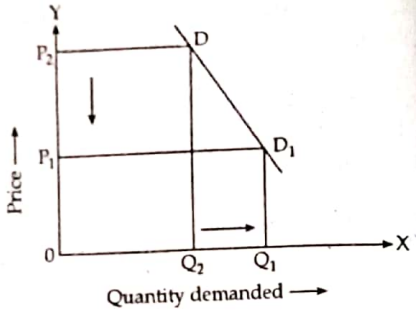
Here, the demand curve DD_1 is rapidly slopping which shows that the change in the quantity from OQ_2 to OQ_1 is relatively smaller than the change in the price OP_1 to OP_2 *i.e.*, when price decreases from OP_2 to OP_1 demand increases from OQ_2 to OQ_1.



1.1.8.2 CROSS ELASTICITY OF DEMAND (Ec)

Cross elasticity of demand measures the responsiveness of demand for good x following a change in the price of good y (a related good). If the change in the price of one commodity brings the change in demand for the other commodity, then it is called cross elasticity of demand mathematically,

$$Ec = \frac{\text{Proportionate change in quantity demanded of x}}{\text{Proportionate change in price of y}}$$

$$= \frac{\Delta Qx/Qx}{\Delta Py/Py} = \frac{\Delta Qx}{\Delta Py} \times \frac{Py}{Qx}$$

where,

ΔQx = Change in quantity demanded for x commodity

Qx = Initial demand for x commodity

ΔPy = Change in price of y commodity

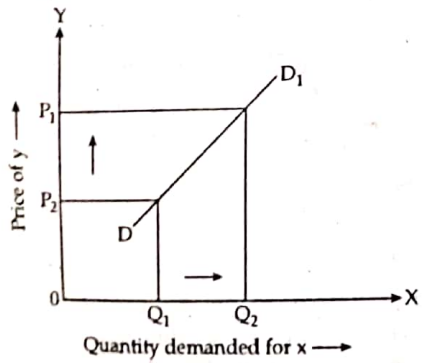
Py = Initial price of y commodity

Types of cross elasticity of demand:

1. **Positive cross elasticity (Ec = +ve)**

If rise in price of one good leads to rise in quantity demanded of other good of a similar nature and vice-versa, it is known as positive cross elasticity of demand.

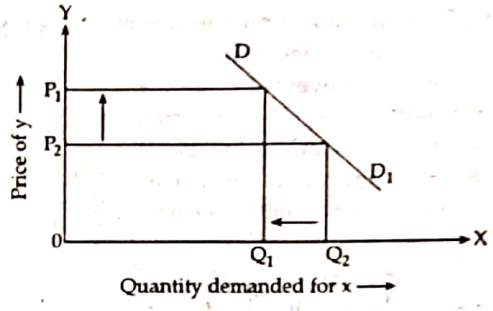
In the above figure, quantity demanded for coke and price of Pepsi are measured along x-axis and y-axis respectively. When the price of Pepsi increases from OP_2 to OP_1, quantity demanded for coke rises from OQ_1 to OQ_2 and vice-versa.



2. **Negative cross elasticity (Ec < O)**

If the rise in price of one good leads to fall in quantity demanded of its complementary good and vice-versa, it is known as negative cross elasticity of demand.

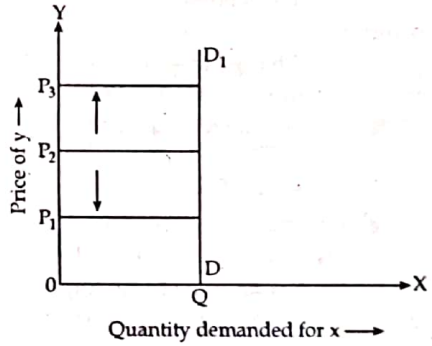
In figure, quantity demanded for tea and price to sugar are measured along x-axis and y-axis respectively. When the price of sugar increases from OP_2 to OP_1, quantity demanded for tea falls from OQ_2 to OQ_1 and vice-versa.



3. **Zero cross elasticity (Ec = O)**

Cross elasticity of demand is zero when two goods are not related to each other. If there is no any response in quantity demanded for one commodity due to the change in price of another commodity, the cross elasticity of demand will be zero. For instance, increase in price of car does not affect the demand of cloth. Hence, cross elasticity of demand is zero. Thus, it depends upon substitutability if goods.

In figure, vertical straight line DD_1 shows zero cross elasticity of demand. Here, increase in price of commodity y (car) does not effect to demand for commodity x (cloth) because these goods are non related with each other.



1.8.3 INCOME ELASTICITY OF DEMAND (Ey)

Income elasticity of demand refers to the change in quantity demanded due to the result of change in income, other things remaining constant.

$$Ey = \frac{\text{Proportionate change in quantity demanded}}{\text{Proportionate change in income}}$$

$$= \frac{\Delta Q/Q}{\Delta Y/Y} = \frac{\Delta Q}{\Delta Y} \times \frac{Y}{Q}$$

where, ΔQ = change in quantity demanded

ΔY = change in income

Y = initial income

Q = initial demand of quantity

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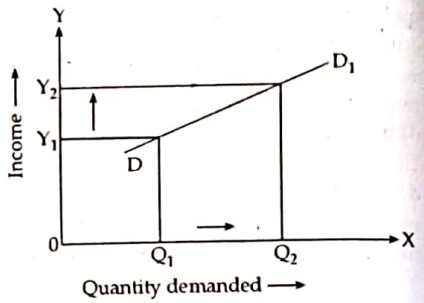
Types/degrees of income elasticity of demand:

1. Greater than unity income elasticity (Ey > 1)

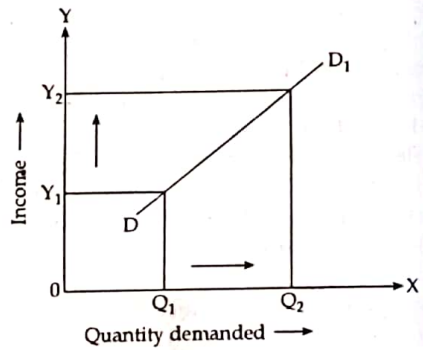
If the percentage change in quantity demanded for a commodity is greater than percentage change in income of the consumer, it is said to be greater than unity income elasticity.



In the figure, flatter demand curve DD_1 shows income elasticity is greater than unity. When income increases from OY_1 to OY_2, demand increases from OQ_1 to OQ_2.

2. Equal to unity income elasticity (Ey = 1)

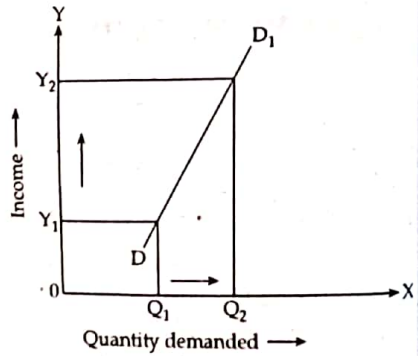
If the percentage change in quantity demanded for a commodity is equal to percentage change in income of the consumer, then such elasticity is called equal to unity.



In the figure, $Y_1 Y_2 = Q_1 Q_2$, the increase in income from OY_1 to OY_2 leads to increase in demand from OQ_1 to OQ_2 *i.e.*, change in demand and change in income are same.

3. Less than unity income elasticity (Ey < 1)

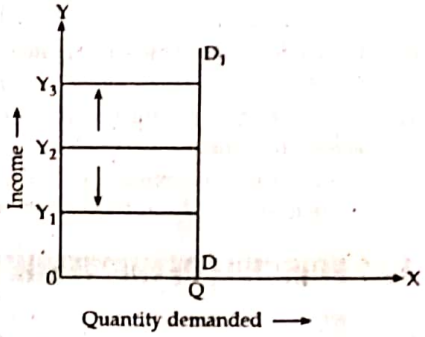
If the percentage change in quantity demanded for a commodity is less than percentage change in income of the consumer, then such elasticity is said to be less than unity income elasticity.



Here, the change in quantity demanded $Q_1 Q_2$ is less than the change in income $Y_1 Y_2$.

4. Zero income elasticity (Ey = O)

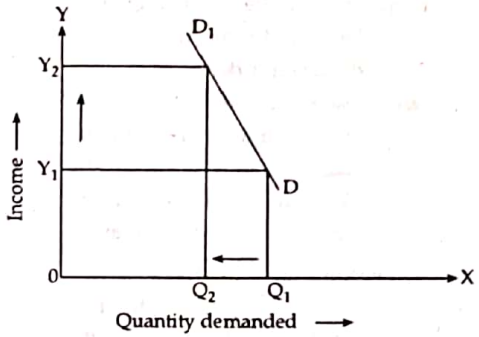
If the quantity demanded for a commodity remains constant with any rise or fall in income of the consumer, then such elasticity is known as zero income elasticity.



Here, demand of quantity remains constant whatever changes in the income of the consumer. DD_1, a vertical straight demand curve indicates zero income elasticity.

5. Negative income elasticity (Ey < O)

If the quantity demanded for a commodity decreases with the rise in income of the consumer and vice-versa, then such type of elasticity is called negative income elasticity of demand.



Here, increase in income from Y_1 to Y_2 leads to the decrease in quantity demanded from Q_1 to Q_2.

1.2.1 ENGINEERING ECONOMIES

Engineering economics is the application of economic technique to the evaluation of design and engineering alternatives. Engineering economics is the study of how engineers choose to optimize their designs and construction methods to produce objects and systems that will optimize their efficiency and hence the satisfaction of their clients.

Engineering economics, previously known as engineering economy, is a subset of economics concerned with the use and application of economic principles in the analysis of engineering decisions.

Special characteristics of engineering economics are:

i) Engineering economics is closely related or aligned with conventional micro economics.

ii) Engineering economics is devoted to the problem solving and decision making at the operation level.

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iii) Engineering economics mainly uses the body of economic concepts and principles.

iv) Engineering economics integrates economic theory with engineering practice.

v) Engineering economics removes complicated abstract issues of economical theory.

vi) Engineering economics is useful to identify alternative uses of limited resources and to select the preferred course of action.

1.2.2 PRINCIPLE OF ENGINEERING ECONOMICS

Engineering economics principle focus on the process used to make an economics based decision, not on the decision itself. These principles are crucial to the decision making and accomplishment of good engineering economy studies. The 7 principle of engineering economics are:

i) Develop the alternatives
ii) Focus on differences
iii) Use a consistent view point
iv) Use of common unit of measure
v) Consider all relevant criteria (social and environmental aspect)
vi) Make uncertainty explicit
vii) Revisit your (self evaluation)

i) Develop the alternatives

The alternatives need to be identified and then defined for subsequent analysis. Since the decision is among alternatives, developing and defining comprehensive list of alternatives for detailed evaluation is important creativity and innovation are essential.

ii) Focus on differences

Only the differences in expected future outcomes among the alternatives are relevant to their comparison and should be considered in the decision. Outcomes that are common to all alternatives can be disregarded in the process of compassion and decision.

iii) Use a consistent viewpoint

The prospective outcomes of the alternatives, selection of the criteria and other, should be consistently developed from a defined viewpoint. *For example;* the perspective of employees is used for the problem of designing the employee benefit package.

iv) Use a common unit of measure

Using a common unit of measurement to enumerate as many of the prospective outcomes as possible will simplify the analysis of the alternatives. For measuring economic consequences, a monetary unit such as dollars is the common measure. Using more than one monetary unit for economic analysis will complicate the overall analysis of a project.

v) Consider all relevant criteria

Selection of a preferred alternative (decision making) requires the use of a criteria (or several criteria). *For example;* long term interest.

vi) Make uncertainty explicit

Risk and uncertainty are inherent in estimating the future outcomes of the alternatives and should be recognized in the analysis and comparison.

vii) Revisit your decisions

Improved decision making results from an adaptive process. The initial projected outcomes of the selected alternative should be subsequently compared with the actual results achieved.

The first two principles setup the thought process. The next three principles focus on evaluation criteria and last two principle focus on analysis.

1.2.3 APPLICATION OF ENGINEERING ECONOMY

The application of engineering economy are diverse and found in most areas of an organization. Engineering economy enables Engineers to consider all aspects of investment from both the technical and financial view points. Engineering economy furnishes several pattern of analysis to determine rate of return, annual costs and payout periods which all serve as bases for decision.

They are typically classified as:

i) Equipment replacement
ii) Equipment and process selection
iii) Cost reduction
iv) Capital budgets allocation
v) Service improvement
vi) New product and production expansion, etc.

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BOARD EXAM SOLVED PROBLEMS

1. **Define engineering economics 11/S, 12/F, 13/F, 14/S, 15/F, 16/S, 17/F, 15/S, 18/S**

Ans: Refer to topic 1.2.1

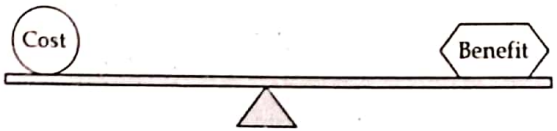
2. **Why is it important to study engineering economics for engineers? 12/F, 13/F, 14/F, 17/F, 18/S, 10/F**

Ans: Engineers seek solutions to problem and the economic viability of each potential solution is normally considered along with the technical aspects. Fundamentally, engineering economics involves formulating, estimating and evaluating the economic out comes when alternatives to accomplish a defined purpose are available. Engineer tends to work on projects. Projects use capital (money) to improve a process, develop a new product, improve a product, improve the safety of a process, etc. Engineers are typically responsible for writing the project which determines the cost of the project and return on investment. When doing a project study, Engineers compare and contrast alternative options for accomplishing goals of a project.

Engineers are called upon to analyze and select the most economical alternative among several design alternatives. Engineers often play a major role in investment decisions based on the analysis and design of new products or the processes. Decisions made by the engineer during the engineering phase of a product's development determine the majority of the cost of manufacturing the product.

Some engineering economic decisions are equipment or process selection, equipment replacement, new product or product expansion, cost reduction and improve in-service or quality. Increasingly, in the new world economy, successful businesses will rely on Engineers with such expertise.

Engineering economics involves the evaluation of costs of benefits of proposed projects.



So, studying engineering economics provides foundation for Engineers to make good decisions in business environment.

3. **Explain how the engineering economics and decision making are inter-related? 13/S**

Ans: Engineering economics is considered as a set of techniques that allow the monetary qualification and economic evaluation of investment alternatives, enabling the manager to have the necessary information knowledge to support decision making. Engineering economics helps to deal with the identification of economic choices and is concerned with the decision making of engineering problems of economics nature. Most decisions involve money called capital or capital fund which is usually limited. Therefore, in order to make decision where and how to invest capital with a goal of adding value in the future, several alternatives are analyzed to anticipate the outcome of projects.

Decision are based on two factors-economic and non-economic. Engineering economics helps to deal with identification of the economic choices and is concerned with decision making of engineering problems of economic nature. Economic analysis and decision making are important engineering considerations because Engineers are capable of evaluating decisions both technically and from a business prospective. Decision made during engineering design phase of a products development determine the majority of the costs manufacturing that product. Engineering economy is chiefly concerned with assisting decision making about the future financial decision in an engineering project.

4. **What are the principle of engineering economics? Describe about the principle of engineering economics.** [12/F, 13/S, 14/F, 16/F, 11/F, 11/S, 14/S, 15/F, 15/S, 16/S]

Ans: Refer topic 1.2.2.

5. **Define demand.** [11/F, 13/F, 14/F, 14/F, 16/F, 18/F, 10/F]

Ans: Refer topic 1.1.2.

6. **Explain law of demand.** [12/S, 13/S]

Ans: Refer topic 1.1.3.

7. **"Hydropower is known as demandable project in Nepal." What are the factors influencing the demand?** [17/S]

Ans: The factors influencing the demand are:-

i) Consumer Innovativeness
ii) State of business
iii) Substitutes
iv) Time
v) Distribution of income

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vi) Number of consumers
vii) Income of consumers
viii) Price of commodity
ix) Demonstration effect
x) Quality of goods/ services
xi) Expectations about price in the future
xii) Weather
xiii) Custom and fashion, etc.

8. What are the factors affecting demand of a commodity? [12/S, 18/F]

Ans: The factors affecting demand of a commodity are:

i) Price of commodity
ii) Size of population
iii) Future expectation
iv) Weather
v) Custom and fashion
vi) Income of consumer
vii) Price of related goods
viii) Quality of goods, etc.

9. Define supply. [14/F, 16/ F]

Ans: Refer topic 1.1.6.

10. Explain law of supply. [12/S 13/S]

Ans: Refer topic 1.1.7.

11. Define utility/ marginal utility. [12/S, 10/F, 14/F, 16/F]

Ans: Refer topic 1.1.5.1.

12. Explain law of diminishing utility with suitable example and figure. [10/F, 11/S, 12/F, 12/S, 18/F]

Ans: Refer topic 1.1.4.

13. Define elasticity of demand. [11/F, 11/S, 13/F, 10/F, 14/S]

Ans: Refer topic 1.1.8.

14. Describe three kinds of elasticity of demand. [11/F, 13/S, 10/F, 16/F]

Ans: Refer topic 1.1.8.1, 1.1.8.2 and 1.1.8.3.

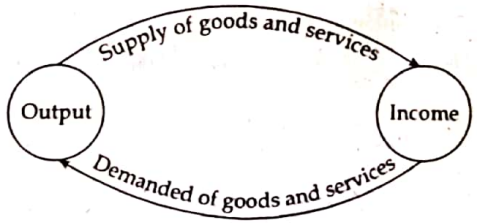
15. Describe all types of price elasticity of demand with suitable figures. [14/S]

Ans: Refer topic 1.1.8.1.

ADDITIONAL QUESTIONS

1. "Supply creates its own demand". Justify this statement

Ans: Whenever any product is produced, the demand of that product is also simultaneously generated on account of or through the process of payment of remuneration to the factors of production. In other words, every output produced, results in an equivalent demand being generated which leads to its sale so that there is no surplus output or over production.



Say's law is explained with the help of simplified circular flow figure. Say's law means that supply creates its own demand for goods and services.

2. "Engineering economics is all about decision making." Explain.

Ans: Economic analysis and decision making are important engineering considerations because Engineers are capable of evaluating decisions both technically and from a business perspective. The term engineering economic decision refers to all investment decisions relating to engineering projects. The five main types of engineering economic decisions are:

- Equipment and process selection
- Equipment replacement
- New product and product expansion
- Cost reduction
- Service improvement

Engineering economics helps to deal with the identification of economic choices, and is concerned with the decision making of engineering problems of economic nature. The factors of time and uncertainty are the defining aspects of any engineering economic decisions. A decision is simply the selection of best one from two or more options in course of action whether it takes place in construction or production, service or manufacturing industries, private or public agencies.

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The techniques and methodology of engineering economy can assist in decision making process from the following grounds,

- Understand the problem
- Define objective
- Collect relevant information
- Develop possible alternatives
- Identify the criteria for decision making
- Select the best alternative
- Evaluate each alternative
- Effective implementation

The principles of engineering economics are mandatory to the decision making. Hence, "Engineering economics is all about decision making."

Chapter 2

COST CONCEPT AND FUNDAMENTALS OF COST ACCOUNTING

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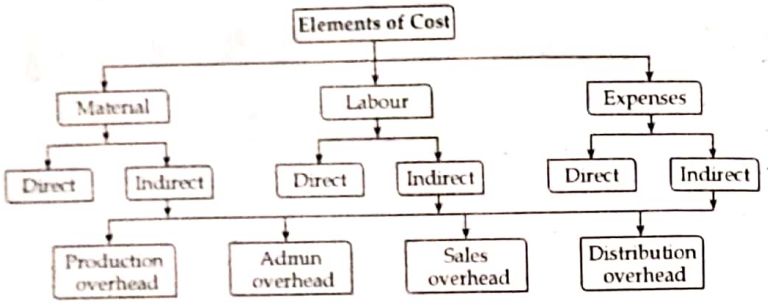
2.1 COST

Cost refers to the amount of expenditure incurred in acquiring something. In general terms, cost refers to an amount to be paid or given up for acquiring any resources or services. The organization decision of maximizing profit depends on the behavior of its cost and revenues.

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

The following chart shows the various elements of cost and their classification:



1. **Material cost**

Material implies a substance from which a product is made. This include the cost of commodities and materials used by the organization.

i) **Direct material cost:** Refers to a material that is directly related to specific product, job or process. *For example;* golds for making jewellery, etc.

ii) **Indirect material cost:** Materials which cannot be identified with the individual cost centre, assist the manufacturing process and doesn't become an integral part of finished goods. *For example;* oils and lubricants, etc.

2. **Labour cost**

Labour cost is the main element of cost. An organization requires labour to convert raw materials into finished goods.

i) **Direct labour cost:** Refers to labour that takes an active part in manufacturing a product. The costs related to direct labour are called labour costs. These costs very directly with change in the level of output thus it is referred as a variable express.

ii) **Indirect labour cost:** The indirect labour costs may or may not vary with the change in the volume of output.

3. **Expenses**

Refers to the costs that are incurred in production of finished goods other than material costs and labour cost.

i) **Direct expenses:** Imply the expenses that are directly or easily allocated to a particular cost centre or cost units. These expenses are called chargeable expenses. *For example;* cost of patents, royalties, etc.

ii) **Indirect expenses:** Refers to expenses that cannot be allocated to specific cost center or cost units. *For example;* rent, depreciation, insurance, etc.

4. **Overheads**

Overhead is defined as the aggregate of the cost of indirect materials, indirect labour and such other expenses including services as cannot conveniently be charged direct to specific cost of units. Thus overhead are all expenses other than direct expenses.

i) **Manufacturing overheads:** It is the indirect expenses of operating manufacturing divisions of a concern and covers all indirect expenditure incurred. *For example;* repairs and maintenance of taxed assets, wages of indirect labour, etc.

ii) **Administrative overhead:** It is the indirect expenditure incurred in formulating the policy, directing the organization, controlling and managing the operations of an undertaking which is not related directly to a research, development or production. *For example;* office rent, light, heat, credits approval, etc.

iii) **Sales over head:** It refers to those indirect costs which are associated with marketing and selling (excluding distribution) activities. *For example;* advertisement charges, samples and free gifts, etc.

iv) **Distribution overhead:** It comprises all expenditure incurred from the time the product is completed in the works until it reaches its destination. *For example;* expenses on delivery van trucks, ware house staff salaries, etc.

2.1.1 MANUFACTURING COST

Manufacturing cost is the sum of costs of all resources consumed in the process of making a product. The manufacturing cost is defined as the costs that are incurred during the production of a product. These costs include direct material costs, direct labour costs and manufacturing overhead costs. Manufacturing cost = cost of (labor + overhead + materials).

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Direct material	Milk for curd, cloth in pant, plastic for toys, wood for table, etc.
Direct labour	Salary for labor, salary for security guards, salary for supervisors, etc.
Direct expenses	Tax, depreciation, insurance, cost of patents, design cost, etc.

2.1.2 NON-MANUFACTURING COST

Non-manufacturing costs are the cost for the compa operations that are not directly related to manufacturing. It includes marketing costs and administrative costs. Marketing costs include all costs necessary to secure customer orders and get the finished product or service into hands of and get the finished product or service into hands of the customer.

For example; marketing costs-secure customer order, shipping, commissions, advertisement, etc.

For example; Administrative cost-public relations cost, management salaries, office supplies, etc.

2.2 COST FOR BUSINESS DECISION

2.2.1 DIFFERENTIAL COST

Differential cost is the difference between cost of two alternative decisions or of a change in output levels. A differential cost can be a variable cost, a fixed cost or a mix of the two-there is no differentiation between these types of costs.

For example; Decision regarding purchase of the machinery out of two. The differential cost is the difference in the prices paid plus the cost of operating the machines.

2.2.2 DIFFERENTIAL REVENUE

Differential revenue is the difference in sales that will be generated by two different courses of action. The concept is commonly used when evaluating which of two (or more) investments to make in a businesses.

For example; You have a job paying Rs. 30,000 per month in your hometown. You have a job offer in neighbouring city that pays Rs. 35,000 per month. The commuting cost to the city is Rs. 2,000.

Hence, differential cost = Rs. 2,000

Differential revenue = Rs. 35,000 – Rs. 30,000

= Rs. 5,000

2.2.3 OPPORTUNITY COST

Opportunity cost is defined as the potential benefit that is given up as you seek an alternative course of action. In fact, virtually every alternative has some opportunity cost associated with it.

For example; The opportunity cost of starting your own business in the wages you give up by working for another company.

For example; The opportunity cost of watching TV on a weeknight is the benefit you could have gotten from studying.

2.2.4 SUNK COST

Sunk cost is a cost that has already been incurred and cannot be recovered. Sunk costs are not relevant to decisions, because they cannot be changed regardless of what decision is made now or in the future.

For Example;

- You bought a bike that cost Rs. 2 lakh two years ago. The 2 lakh cost is sunk because whether you drive it, park it, trade it, you cannot change that 2 lakh cost.
- Cost of marketing
- Feasibility study

2.2.5 MARGINAL COST

Marginal cost is defined as the added cost that would result from increasing the rate of output by a single unit. The marginal cost of production is the change in total costs that come from making one additional item. The marginal cost formula can be used in financial modeling to optimize the generation of cash flow.

$$\text{Marginal cost} = \frac{\text{Change in costs}}{\text{Change in quantity}}$$

$$\therefore \quad MC = \frac{\Delta TC}{\Delta Q}$$

For example; if a firm produces 'X' unit at a cost of Rs. 300, 'X + 1' units at a cost of Rs. 320, then the cost of an additional unit will be Rs. (320-300) = Rs. 20 which is marginal cost.

2.2.6 FIXED COST

Fixed costs are the cost that the firm has to pay independently of whether it is operating or not. *For example;* rent of a building

Fixed costs are expenses that have to be paid by a company, independent of any business activity.

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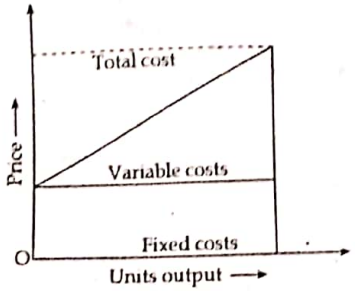
2.2.7 VARIABLE COST

Variable cost are the cost that varies with the level of output.

For example; Wages paid to labor, cost of raw materials, etc.

2.2.8 TOTAL COST

Total cost is the summation of fixed cost and the variable cost



2.2.9 PRIME COSTS

The sum total of direct material, direct labor and direct expenses. *For example;* cost of raw materials

2.2.10 OVERHEAD COST

Overhead cost refer to an ongoing expense of operating a business. There are essentially two types of business overheads-administrative overheads and manufacturing overheads.

For example; telephone bills, legal fees, supplies, repairs, etc.

BOARD EXAM SOLVED PROBLEMS

1. **Following are the data for the production of 100 badminton rackets:** **[15/F]**

Labour rate	Rs. 40/hr
Leather	50m at Rs. 200/ meter
Gut	300m at Rs. 50/ meter
Graphite	100kg at Rs. 200/kg

Total annual factory over head = Rs. 5,00,000

Total annual direct labour hour = 25,000 hours

Labour hours needed = 200 hours

Show the cost breakdown and calculate the total cost per racket.

Solution:

Cost	Amount (Rs)
Manufacturing cost:	
Direct material cost:	
Leather (50m × Rs. 200)	10,000
Gut (300m × Rs. 50)	15,000
Graphite (100 kg × Rs. 200)	10,000
Direct labour cost (200 hrs × Rs. 40)	8,000
Direct overhead cost	5,00,000
Non-manufacturing cost:	
Sales and marketing	-
Administrative	-
Indirect over head cost	-
Total cost for 100 rackets	5,43,000
∴ Total cost per racket	5,430

2. **Type of cost:** **[16/F]**

Ans: Types of cost are:

i) Fixed and variable costs
ii) Direct and indirect costs
iii) Actual and opportunity costs
iv) Real and prime costs
v) Implicit and explicit costs
vi) Total costs, marginal cost and average costs
vii) Sunk costs and incremental costs
viii) Recurring costs and non-recurring costs
ix) Historical costs and replacement costs
x) Short run costs and long-run costs

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3. Explain different types of cost involved in manufacturing products with suitable example. [15/S]

Ans: Refer topic 2.1.1

4. Define

i) Manufacturing cost: [14/S, 16/S, 18/S]

Ans: Refer topic 2.1.1

ii) Non-manufacturing cost: [14/S, 16/S, 18/S]

Ans: Refer topic 2.1.2

iii) Opportunity cost: [13/F, 16/S, 17/F, 18/F, 18/S]

Ans: Refer topic 2.2.3

iv) Sunk cost: [13/F, 17/F, 18/F, 18/S]

Ans: Refer topic 2.2.4

v) Marginal cost: [17/F, 18/F]

Ans: Refer topic 2.2.5

vi) Fixed cost: [13/F, 18/F]

Ans: Refer topic 2.2.6

vii) Variable cost: [13/F, 18/F]

Ans: Refer topic 2.2.7

viii) Differential cost: [18/F]

Ans: Refer topic 2.2.1

ix) Prime costs: [18/F]

Ans: Refer topic 2.2.9

x) Overhead costs: [18/F]

Ans: Refer topic 2.2.10

5. What do you mean by cost? Explain the elements of cost. [12/S, 12/F, 14/F]

Ans: Refer topic 2.1.

Chapter 3

TIME VALUE OF MONEY

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3.1 INTEREST

Interest is the money paid regularly at a particular rate for the use of money lent, or for delaying the repayment of a debt.

3.1.1 SIMPLE INTEREST

Simple interest is the interest earned on only the principal amount during each interest period. In other word, the interest earned during each interest period does not earn additional interest in the remaining period

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even though you do not with draw it. The total amount available at the end of 'N' periods is

$$F = P + I = P + p \times T \times R$$

where, P = Present sum of money

F = future sum of money

T = Time period

I = Interest rate

3.1.2 COMPOUND INTEREST

Compound interest is the addition of interest to the principal sum of a loan or deposits, or in other words, interest on interests. This interest earning process repeats and after N periods, the total accumulated value, F will grow to $F = P(1 + i)^N$

where, i = effective interest rate per interest period

3.1.3 EFFECTIVE OR REAL INTEREST RATE

The actual rate of interest earned during one year is called effective interest rate. It is represented by i.

$$i = \left(\frac{T}{P}\right)^{\frac{1}{y}} - 1$$

where, y = no. of years

T = Final value

P = initial investment

3.1.4 NOMINAL INTEREST RATE

An interest is called nominal if the frequency of compounding period is not identical to the time unit (usually a year). It is denoted by r.

$$r = N\left(\frac{T}{P}\right)^{\frac{1}{Ny}} - N$$

Relationship between i and r

Let 'r' be the nominal annual interest rate, 'i' be the effective annual interest rate, 'm' be the number of compounding period per year, 'n' be the invested years and 'p' be the principal amount.

The equivalence between the two rates suggests that if a principal 'p' is invested for 'n' years, the two compound amounts, would be same, *i.e.*,

or, $P(1 + i)^N = P\left(1 + \frac{r}{m}\right)^{Nm}$

Dividing both sides by P,

or, $(1 + i)^N = \left(1 + \frac{r}{m}\right)^{Nm}$

Taking the nth root of both sides result in,

or, $(1 + i) = \left(1 + \frac{r}{m}\right)^m$

$\therefore$ $i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$

When m = 1, i_{eff} = r and

or, $\left(1 + \frac{r}{m}\right)^m = 1 + i_{eff}$

or, $\left(1 + \frac{r}{m}\right) = (1 + i_{eff})^{1/m}$

or, $\frac{r}{m} = (1 + i_{eff})^{1/m} - 1$

$\therefore$ $i_{monthly} = (1 + i_{eff})^{1/m} - 1$

Effective interest rate formulas for different time periods:

$i_{time, effective}$	Formula	Value of m
$i_{annually}$	$(1 + r)^1 - 1$	1 year
$i_{semiannually}$	$\left(1 + \frac{r}{2}\right)^2 - 1$	2 semiannual
$i_{quarterly}$	$\left(1 + \frac{r}{4}\right)^4 - 1$	4 quarter
$i_{monthly}$	$\left(1 + \frac{r}{12}\right)^{12} - 1$	12 months
i_{weekly}	$\left(1 + \frac{r}{52}\right)^{52} - 1$	52 weeks
i_{daily}	$\left(1 + \frac{r}{365}\right)^{365} - 1$	365 days
i_{hourly}	$\left(1 + \frac{r}{8760}\right)^{8760} - 1$	8760 hours
$i_{infinite}$ or $i_{continuous}$	$e^r - 1$	-

3.2 ECONOMIC EQUIVALENCE

Calculations for determining the economic effects of one or more cash flows are based on the concept of the economic equivalence. Economic equivalence exists between cash flows that have the same economic effect and therefore could be traded for one another in the financial market place, which we assure to exist.

Economic equivalence refers to the fact that a cash flow whether a single payment or a series of payments can be converted to an equivalent cash flow at any point in time.

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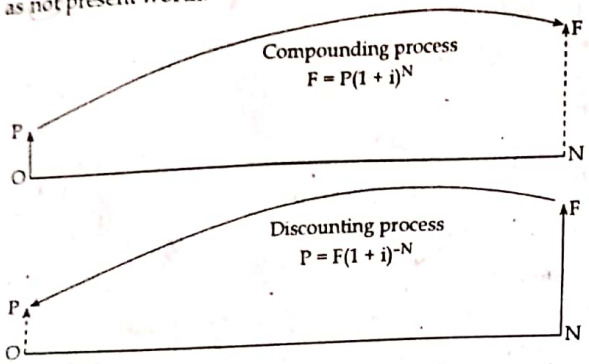
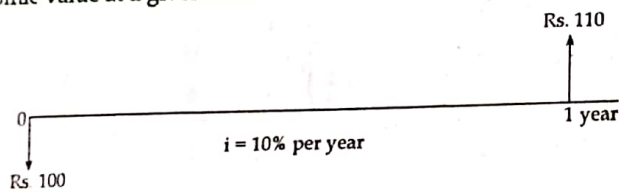
3.2.1 PRESENT WORTH (PW)

In this method all the cash inflows and outflows are discounted to the beginning points at an interest rate for the economic study. It is also known as not present worth.



For example; Different sum of money at different times may be equal in economic value at a given rate.

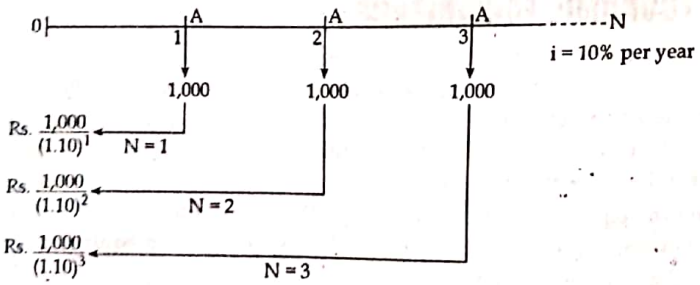


Here, Rs. 100 now is economically equivalent to Rs. 110 one year from now, if the Rs. 100 is invested at a rate of 10% per year.

Economic equivalence refers to the fact that a cash flow-whether a single payment-can be converted to an equivalent cash flow at any point in time.

3.2.2 ANNUAL WORTH (AW)

It provide basis for measuring investment worth in a series of equal payments at the each period. *For example;*



Hence, present value of ordinary annuity

$$= 909.09 + 826.4 + 751.32$$

$$= \text{Rs. } 2{,}486.80$$

or, Use formula; $P = A\,(P/A, i\,\%, N)$

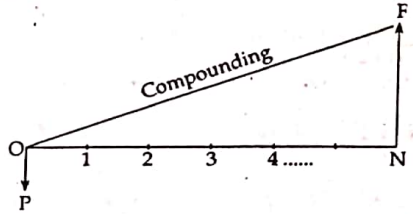
$$= 1{,}000\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right] \quad [\because N = 3 \text{ and } i = 10\%]$$

$$= \text{Rs. } 2486.80$$

3.2.3 FUTURE WORTH (FW)

The future worth of money relates how much a current investment will be worth in the future.

$$F = P\,(1 + i)^N$$



3.3 CASH FLOW DIAGRAM

The graphical representation of the cash flows *i.e.*, both cash out flows and cash inflows with respect to a time scale is generally referred as cash flow diagram. The cash outflows (*i.e.*, expenses) are generally represented by vertical downward arrows whereas the cash inflows (*i.e.*, revenue or income) are represented by vertically upward arrows. The number of interest period is shown on the time scale.

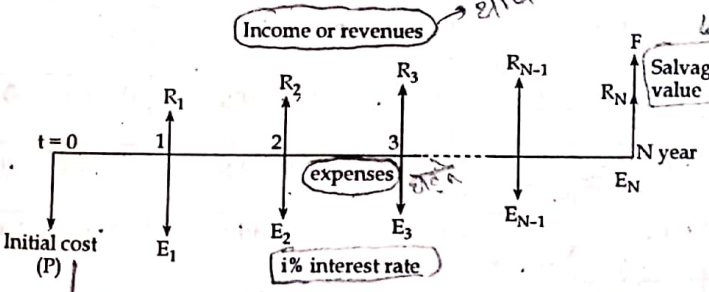


Fig: Cash flow diagram.

3.3.1 INTEREST FACTOR AND SYMBOLS OF SINGLE CASH FLOWS

To find	Given	Factor	Factor name	Functional symbol
F	P	$(1+i)^N$	Single payment compound amount	(F/P, i%, N)
P	F	$(1+i)^{-N}$	Single payment present worth	(P/F, i%, N)
F	A	$\frac{(1+i)^N-1}{i}$	Uniform series compound amount	(F/A, i%, N)
A	F	$\frac{i}{(1+i)^N-1}$	Sinking fund	(A/F, i%, N)
P	A	$\frac{(1+i)^N-1}{i(1+i)^N}$	Uniform series present worth	(P/A, i%, N)
A	P	$\frac{i(1+i)^N}{(1+i)^N-1}$	Capital recovery	(A/P, i%, N)

NOTE

To find F, when P, i and N are given,

$$F = P(1+i)^N$$

Here, $(1+i)^N$ is called single payment compound amount factor. It is denoted by (F/P, i%, N) and it is read as 'finding F given P at i% interest for N periods.'

3.3.2 INTEREST FACTORS AND SYMBOLS FOR CONTINUOUS COMPOUNDING AND DISCRETE CASH FLOWS

To find	Given	Factor	Factor name	Functional symbol
F	P	e^{rN}	Continuous compounding compound amount	(F/P, r %, N)
P	F	e^{-rN}	Continuous compounding present worth	(P/F, r%, N)
F	A	$\frac{e^{rN}-1}{e^r-1}$	Continuous compounding compound amount	(F/A, r%, N)
P	A	$\frac{e^{rN}-1}{e^{rN}(e^r-1)}$	Continuous compounding present worth	(P/A, r%, N)
A	F	$\frac{e^r-1}{e^{rN}-1}$	Continuous compounding sinking fund	(A/F, r%, N)
A	P	$\frac{e^{rN}(e^r-1)}{e^{rN}-1}$	Continuous compounding capital recovery	(A/P, r%, N)

3.3.3 Interest Calculation for Uniform Gradient

Let, G be uniform gradient amount, then

i) $F = \frac{G}{i}\left[\frac{(1+i)^N-1}{i}\right] - \frac{NG}{i}$

i.e., $F = \frac{G}{i}(F/A, i\%, N) - \frac{NG}{i}$

ii) $A = G\left[\frac{1}{i} - \frac{N}{(1+i)^N-1}\right]$

iii) $P = G\left[\frac{(1+i)^N-1-Ni}{i^2(1+i)^N}\right]$

3.3.4 GEOMETRIC GRADIENT SERIES

If 'g' is the percentage change in a payment from one period to next, the total amount of the Nth payment on the basis of first payment A_1 will be

$$A_N = A_1(1+g)^{N-1}$$

Then, $P = \frac{A_1}{i-g}[1-(F/P, g\%, N)(P/F, i\%, N)]$

i.e., $P = A_1(P/A, g, i, N)$

Similarly, $P = \frac{NA_1}{1+i}$ (If i = g)

NOTE

For the value of interest factor, refer to the table named as "Interest factors for discrete compounding" located at last portion of the book. You can directly put the values of interest factor in the numerical calculation.

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BOARD EXAM SOLVED PROBLEMS

. Define interest. [18/F]

Ans: Refer topic 3.1.1

. Define effective interest rate and nominal interest rate. [15/F, 18/S, 18/F]

Ans: Refer topic 3.1.4 and 3.1.5

. Differentiate between effective and nominal interest rate. [12/F, 13/F, 16/S, 18/S]

S.N.	Effective interest rate	Nominal interest rate
i.	Represents interest that affects the real value of money after one corresponding period.	Represents the interest rate that is convertible more than once in a corresponding period.
ii.	It is greater than nominal interest rate.	It is less than effective interest rate.
iii.	$i = \left(\frac{T}{P}\right)^{\frac{1}{Y}} - 1$	$R = N\left(\frac{T}{P}\right)^{\frac{1}{NY}} - N$
iv.	Often referred to as the annual percentage yield (APY)	Often referred to as the annual percentage rate (APR)
v.	Effective interest rate, i, is the actual rate that applies for a stated period of time which takes into account the effect of compounding.	Nominal interest rate, r, is an annual interest rate without considering the effect of compounding.
vi.	Effective interest rates can be used in the time value formulas or equations	Nominal interest rate cannot be used in the time value formulas or equations.
vii.	*For example*, for an interest rate of 5.6% per month, the real interest rate is $\left(1 + \frac{0.0140}{4}\right)^4 - 1$ = 1.41% per quarter	*For example*, for an interest rate of 5.6% per month, the nominal interest rate is $= \frac{5.6}{4}$% per quarter = 1.40% per quarter

4. Explain about time value of money. [13/F, 15/F, 16/S, 18/F]

Ans: Time value of money is the idea that money that is available at the present time is worth more than the same amount in the future, due to its potential earning capacity. It is founded on time preference.

The time value of money 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.

Option A: Rs. 10,000 → Rs. 10,000 + interest

Option B: Rs.10,000 – interest → Rs. 10,000

By receiving Rs. 10,000 today (option A), you are poised to increase the future value of your money by investing and gaining interest over a period of time. If you receive the money three years down the line (option B), you don't have time on your side, and the payment received in three years would be your future value.

5. How does compound interest different from simple interest? Why does bank use concept of compound interest instead of simple interest? [18/F]

S.N.	Simple interest	Compound interest
i.	This is calculated only on original principal.	This is calculated on interest earned and the principal.
ii.	Interest earned is not reinvested. Hence, it is not used in interest calculations for the following periods.	Interest earned during the previous period is added to the principal. The total amount will become new principal and all the money will earn interest.
iii.	Principal remains constant.	Principal goes on changing during entire borrowing period.
iv.	Interest charged on principal only.	Interest charged on principal plus accumulated interest.
v.	Simple interest is linear in nature.	Compound interest is exponential in nature.

Interest can compound either frequently (daily or monthly) or infrequently (quarterly, semi-annually or yearly). The more often your interest compounds, the more interest you will earn on your investment in compound interest rate. When it comes to investing, compound interest is better since it allows funds to grow at a faster rate than they would in an account with a simple interest rate. So, bank use concept of compound interest instead of simple interest.

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6. **Describe about cash flow diagram.** **[17/S]**

Ans: Refer topic 3.3

7. **What is the effective interest rate if the nominal rate is 9% per year, a 365 day is used and the compounding period is (i) yearly (ii) quarterly (iii) daily (iv) hourly (v) continuously:** **[15/F]**

Solution:

Nominal interest rate (r) = 9%

We know,

$$i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$$

i) i_{eff} - yearly $= \left(1 + \frac{0.09}{1}\right)^1 - 1 = 9\%$

ii) i_{eff} - quarterly $= \left(1 + \frac{0.09}{4}\right)^4 - 1 = 9.30\%$

iii) i_{eff} - daily $= \left(1 + \frac{0.09}{365}\right)^{365} - 1 = 9.42\%$

iv) i_{eff} - hourly $= \left(1 + \frac{0.09}{8760}\right)^{8760} - 1 = 9.42\%$

v) i_{eff} - continuous $= e^r - 1$

$= e^{0.09} - 1$

$= 9.42\%$

8. **Sarita wants to deposit Rs. 15,000 in every year into a bank at an interest rate of 12% per year, compounded semi-annually. What will be the maturity amount after 5 years?** **[13/F]**

Solution:

No. of years (N) = 5

Interest rate (r) = 12% compounded semiannually

Amount deposited every year (A) = Rs. 15.000

Future amount after 5 year (F) =?

We know,

$$i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$$

$$= \left(1 + \frac{0.12}{2}\right)^2 - 1 \quad [\because m = 2; \text{ compounded semi annually}]$$

$\therefore$ $i_{eff} = 12.36\%$

Then,

$\therefore$ F = A (F/A, i%, N)

or, F = Rs. 15,000 × (F/A, 12.36%, 5)

or, $F = \text{Rs. } 15{,}000 \times \left[\frac{(1 + 0.1236)^5 - 1}{0.1236}\right]$

or, F = Rs. 95,976.67

Hence, maturity amount after 5 years is Rs. 95,976.67

9. **How many deposits of Rs. 5,000 each should make per month so that the final accumulation amount will be Rs. 1,00,000 if the bank interest rate is 12% per year?** **[14/F]**

Solution:

Monthly deposit (A) = Rs. 5,000

Future amount (F) = Rs. 1,00,000

Interest rate (i_y) = 12% per year

$i_{monthly} = (1 + i_y)^{1/m} - 1$

or, $i_m = (1 + 0.12)^{1/12} - 1$

or, $i_m = 0.00948$

or, $i_m = 0.948\%$

We have,

F = A (F/A, i%, N)

or, $1{,}00{,}000 = 5{,}000\left[\frac{(1 + i)^N - 1}{i}\right]$

or, $1{,}00{,}000 = 5{,}000\left[\frac{(1 + 0.00948)^N - 1}{0.00948}\right]$

or, $0.1896 = (1.00948)^N - 1$

or, $1.1896 = (1.00948)^N$

Taking $\log_e$ on both sides,

or, $\log_e(1.1896) = N \times \log_e(1.00948)$

or, $0.0754009 = N \times 0.0040977$

$\therefore$ N = 18.4 months

Hence, it needs 18 deposits.

10. **A father deposits a sum of Rs. 1,00,000 in a bank for his son's education who will be admitted to a professional course after 5 years. The bank pays 12% interest rate per year, compounded monthly. Find the future amount of the deposited money at the time of admitting his son in the professional course.** **[14/F, 12/S]**

Solution:

Principal amount (P) = Rs. 1,00,000

N = 5years

r = 12% compounded monthly

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So $\boxed{i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1}$ $\quad i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$

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

$= 0.01268$

$\therefore \quad i = 12.68\%$

We know,

$F = P\,(F/P, i\%, N)$

$= 1,00,000\,(F/P, 12.68\%, 5)$

$= 1,00,000 \times \frac{1}{(1+i)^{-N}}$ ← formula $F = P(1+i)^N$

$= 1,00,000 \times \frac{1}{(1+0.1268)^{-5}}$

$\therefore \quad F = \text{Rs. } 1,81,673$

Hence, future amount is Rs. 1,81,673

F = ?
P = given.

11. **Sabina deposits a sum of Rs. 10,00,000 in a bank at an interest rate of 12% per year. What will be the future amount after 5 years? If compounded:** **[16/F]**

i) **Weekly**
ii) **Quarterly**
iii) **Annually**

(i) $i_{eff} = ?$

$F = P(1+i)^N = ?$

Solution:

P = Rs. 10,00,000

N = 5 years

r = 12%

i. $i_{weekly} = \left(1 + \frac{0.12}{52}\right)^{52} - 1 = 12.74\%$

or, $F = P(1+i)^N$

$= 10,00,000 \times (1 + 0.1274)^5$

$= \text{Rs. } 18,223,36.34$

ii. $i_{quarterly} = \left(1 + \frac{0.12}{4}\right)^4 - 1 = 12.55\%$

or, $F = P\,(1+i)^N$

$= 10,00,000\,(1 + 0.1255)^5$

$= \text{Rs. } 18,06,111$

iii. $i_{annual} = \left(1 + \frac{0.12}{1}\right)^1 - 1 = 12\%$

or, $F = P(1+i)^N$

$= 10,00,000\,(1 + 0.12)^5$

$= \text{Rs. } 17,62,342$

12. **You wish to study your son in medical college after 20 years (N). Recently government has fixed total 35 lakh (F) to complete MBBS studies. How much do you need to deposit on each year to meet your desire if bank provides 10% (r) interest rate per year for your fixed account?** **[17/S]**

A = ?

Solution:

N = 20 years

r = 10% per year = i

F = Rs. 35,00,000

A = ?

r = Per year
A = Per year } !! r = i

We know,

$A = F\,(A/F, i\%, N) = 35,00,000\,(A/F, 10\%, 20)$

$= 35,00,000 \times 0.01746$

$\therefore \quad A = \text{Rs. } 61,110$

Hence, I must deposit Rs. 61.110 each year for 20 years

13. **Ram invested at high yield account aimed to get the double of his investment at the end of 10 years. Compute the effective interest year he received on the account.** **[17/S]**

$i_{eff} = ?$

Solution:

N = 10 years

$i_{eff} = ?$

Let, Present investment (P) = P
Future sum (F) = 2P } care

We know,

$F = P(1+i)^N$

or, $2P = P(1+i)^N$

or, $2 = (1+i)^{10}$

or, $2^{1/10} = (1+i)$

or, $1.0718 = 1 + I$

or, $i = 0.0718$

$\therefore \quad i = 7.18\%$

Hence, effective interest rate is 7.18% per year.

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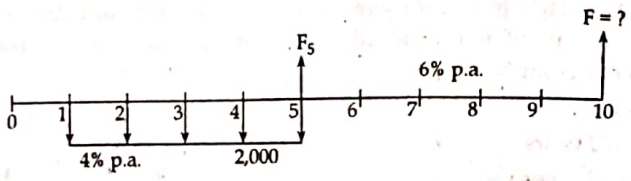
14. **An individual makes five annual deposits of Rs. 2,000 in a savings account that pays interest at a rate of 4% interest rate change to 6% per year. Five years after last deposit, the accumulated money is withdrawn from account. How much is withdrawn? [13/S]**

Solution:

A = Rs. 2,000 annually

i = 4% per year

N = 5 years + 5 years



$F_5 = A\,(F/A, i\%, N)$

$= 2{,}000 \times (F/A, 4\%, 5)$

$= 2{,}000 \times 5.4163$

$= \text{Rs. } 10{,}832.60$

Now,

$F_{10} = F_5 \times (F/P, i\%, N)$

$= 10{,}832.60 \times (F/P, 6\%, 5)$

$= \text{Rs. } 14{,}496.18$

Hence, Rs. 14,496 is withdrawn.

15. **A managed 40 years now had borrowed Rs. 5,00,000 from bank for his further studies at the age of 20 years. Interest was changed at 11% per year compounded quarterly. He wishes to pay loan in semiannual equal installments with the loan. He has just clear his loan now what amount did he pay in each installments? [12/F, 16/S]**

Solution:

P = Rs. 50,000

i = 11% compounded quarterly

$$i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$$

$$= \left(1 + \frac{0.11}{4}\right)^4 - 1$$

$= 11.46\%$

$$i_{semi\text{-}annually} = (1 + i_{eff})^{1/m} - 1$$

$= (1 + 0.1146)^{1/2} - 1$

$= 5.58\%$

Now,

$F = P(F/P, i\%, N)$

$= 50{,}00{,}000\,(F/P, 5.58\%, 40) = 50{,}00{,}000 \times (1 + 0.0558)^{40}$

$\therefore$ F = Rs. 4,38,76,938

Using uniform series compound factor,

$F = A\,(F/A, i\%, N)$

or, $4{,}38{,}76{,}938 = A\,(F/A, 5.58\%, 30)$

or, $$4{,}38{,}76{,}938 = A \times \left[\frac{(1 + 0.0558)^{30} - 1}{0.0558}\right]$$

or, $$A = \frac{4{,}38{,}76{,}938}{73.451}$$

$\therefore$ A = Rs. 5, 97, 360

Hence, he paid Rs. 5,97,360 on each installment. [Hint: He paid each installment semi-annually after 5 years from receiving the loan. So, N = 2 × 15 times = 30 times]

16. **Calculate the future worth of the following cash flows deposited at 8% compounded continuously for 5 years. [17/F]**

i) Rs. 50,000 at the beginning of each year

ii) Rs. 50,000 at the end of each year

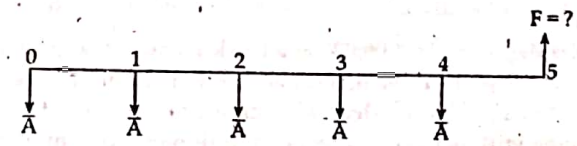
Solution:

N = 5 years

r = 8% compounded continuously

$\bar{A}$ = Rs. 50,000

i) Rs. 50,000 at the beginning of each year:

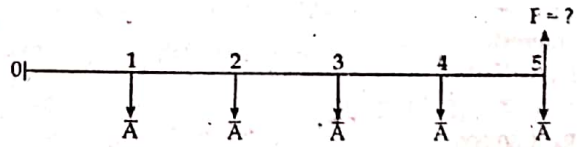


$F = \bar{A}\,(F/\bar{A}, r\%, N) \times e^r$

$$= 50{,}000\left[\frac{e^{rN} - 1}{r}\right] \times e^r = 50{,}000\left[\frac{e^{0.08 \times 5} - 1}{0.08}\right] \times e^{0.08}$$

$\therefore$ F = Rs. 3,32,992

ii) Rs. 50,000 at the end of each year:



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$$F = \bar{A}\,(F/\bar{A}, r\%, N)$$
$$= \bar{A}\left(\frac{e^{rN} - 1}{r}\right)$$
$$= 50{,}000\left(\frac{e^{0.08\times 5} - 1}{0.08}\right)$$
$$\therefore F = \text{Rs. } 3{,}07{,}390$$

17. A 30 years old person is planning for his retired life. He plans to invest an equal sum of Rs. 25,000 at the end of every year. The bank gives 6% interest rate compounded semi-annually. How much money can be withdrawn from his account when he is 60 years old? [12/S]

Solution:

A = Rs. 25,000 every year

r = 6% compounded semi-annually

F = ?

N = 30 years

$$\therefore \quad i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1 = \left(1 + \frac{0.06}{2}\right)^2 - 1$$
$$= 6.09\%$$

Now,

$$F = A\,(F/A, i\%, N)$$
$$= 25{,}000\,(F/A, 6.09\%, 30)$$
$$= 25{,}000 \times \left[\frac{(1 + 0.0609)^{30} - 1}{0.0609}\right]$$
$$\therefore \quad F = \text{Rs. } 20{,}08{,}048$$

Hence, he can draw Rs. 20,08,048 from his account when he is 60 years old.

18. Rabindra deposits Rs. 1,00,000 at a bank account that provides 12% interest for 5 years How much balance will Rabindra have at the end of 5th year, if bank calculates interest on simple interest basis? How much will he have if interest is compounded annually? [12/S]

Solution:

Principal (P) = Rs. 1,00,000

Interest = 12% per year

No. of year, N = 5 year

Future amount, F = ?

We have,

i) Simple interest,

$$F = P\,(1 + i \times N)$$
$$= 1{,}00{,}000 \times (1 + 0.12 \times 5)$$
$$= \text{Rs. } 1{,}60{,}000$$

ii) Compound interest,

$$F = P\,(1 + i)^N$$
$$= 1{,}00{,}00 \times (1 + 0.12 \times 5)$$
$$= \text{Rs. } 1{,}60{,}000$$

iii) Compound interest,

$$F = P\,(1 + i)^N$$
$$= 1{,}00{,}000 \times (1 + 0.12)^5$$
$$= \text{Rs. } 1{,}76{,}235$$

The future value under compound interest system is always higher than that of simple interest system because the compound interest is calculated on the interest earned and the principal while simple interest rate is calculated only on the original principal amount.

19. If you have Rs. 10,00,000 loan now from a bank, how much Rs. should you pay as installment per two month for 5 years if bank interest rate is 12% per year? [18/F]

Solution:

P = Rs. 10,00,000

N = 5 years

A = ?

i = 12% per year

$$i_{monthly} = (1 + i)^{1/12} - 1$$

But, installment is paid per two months in a year,

$$i_{mon} = (1 + i)^{1/6} - 1$$
$$= (1 + 0.12)^{1/6} - 1$$
$$= 1.907\%$$

Now,

$$A = P\,(A/P, i\%, N)$$
$$= 10{,}00{,}000\,(A,P, 1.907\%, 30)$$
$$= 10{,}00{,}000\left[\frac{i(1 + i)^N}{(1 + i)^N - 1}\right]$$
$$= 10{,}00{,}000 \times 0.44075$$
$$\therefore A = \text{Rs. } 44{,}075$$

Here,

Total no. of months = 5 × 12 = 60 months

But installment is paid per 2 months so

$$N = \frac{60}{2} = 30$$

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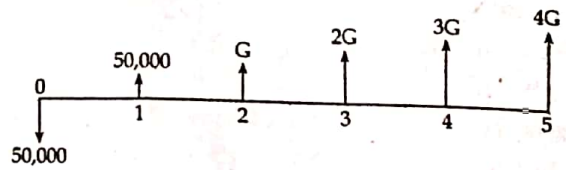
Hence, Rs. 44,075 should be paid as installment per two months for 5 years for the loan of 10,00,000 if interest rate is 12% per year.

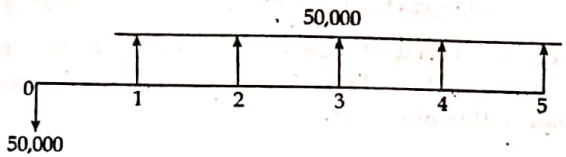
20. Find the value of G if i = 12%. [14/S]

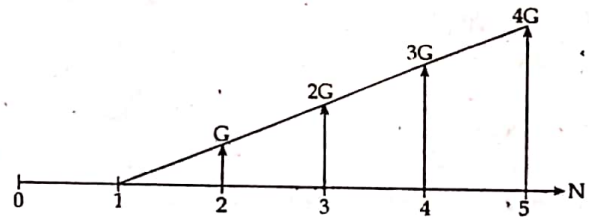


Solution:

i = 12%

G =?





Applying uniform series PW factor and gradient series PW factor,

$$50{,}000 = 5{,}000\,(P/A, 12\%, 5) + G\,(P/G, 12\%, 5)$$

or, $$50{,}000 = 5{,}000 \times \left[\frac{(1+i)^N - 1}{i\,(1+i)^N}\right] + G\left[\frac{(1+i)^N - 1 - Ni}{i^2(1+i)^N}\right]$$

or, $$50{,}000 = 5{,}000 \times 3.6048 + G \times 6.3971$$

or, $$G = \frac{31{,}976}{6.3971}$$

$\therefore$ G = Rs. 5,000

Hence, value of G is Rs. 5,000

21. What is the future equivalent of Rs. 40,00,000 per year that flows continuously for 11 years if nominal interest is 12% compounded continuously? [11/F]

Solution:

$\bar{A}$ = Rs. 40,00,000

N = 11 year

r = 12% per year

F =?

By using continuous compounding,

$$F = \bar{A}\,(F/\bar{A}, r\%, N)$$

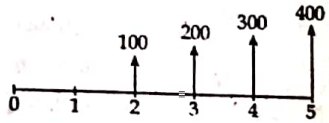
$$= \bar{A}\left(\frac{e^{rN} - 1}{r}\right)$$

$$= 40{,}00{,}000\left(\frac{e^{0.12\times 11} - 1}{0.12}\right)$$

$\therefore$ F = Rs. 9,14,47,380

Future equivalent is Rs. 9,14,47,380

22. For the cash flow diagram given below, what should be the value of k on left hand cash flow diagram to be equal to right hand cash flow diagram if i = 12%? [15/S]



Solution:

i = 12%

k =?

We have,

$$F = G\left[\frac{(1+i)^N - 1}{i}\right] - \frac{NG}{i}$$

or, $$F = \frac{100}{0.12}\left[\frac{(1+0.12)^5 - 1}{0.12}\right] - \frac{5 \times 100}{0.12}$$

or, F = Rs. 1,127

Now,

$$A = F\,(A/F, i\%, N) \quad [\therefore \text{ For 1st figure}]$$

$$= F(A/F, 12\%, 3)$$

$$= 1127 \times 0.2963$$

$$= \text{Rs. } 334$$

Hence, value of k is Rs. 334

23. Ramesh, an engineer is planning to place 20% of his salary, which is Rs. 2,50,000 per year at present, each year in mutual fund. He expects 7% of his salary increase each year for next 15 years. If the mutual fund will average 10% annual return, what will be the sum amount at the end of 15 years? If salary increases by Rs.25,000 per year. What will be the amount? [18/S]

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Solution:

No. of year, N = 15 years

Increment rate of salary = 7% per year = g

Present salary = Rs. 2,50,000

% of salary for deposit = 20%

Year	Total salary increase @ 7% per year	20% deposit
0	2,50,000	50,000
1	2,67,500	53,500
2	2,86,225	57,245
3	3,06,260	61,252
4	3,17,699	65,540
5	3,50,638	70,127
6	3,75,182	75,036
7	4,01,445	80,289
8	4,29,546	85,909
9	4,49,615	91,923
10	4,91,788	98,357
11	5,26,213	1,05,242
12	5,63,048	1,12,609
13	6,02,461	1,20,492
14	6,44,633	1,28,926
15	6,89,758	1,37,951

Here,

P = Rs. 50,000

A' = Rs. 53,500

g = 7%

i = 10% = annual return rate

N = 15 year

We know,

$$F = P\,(F/P, i\%\ N) + A'\,(F/A', g, i, N)\,(F/P, i, N)$$

$$= 50{,}000\,(F/P, 10\%, 15) + 53{,}500\,(F/A', 7\%, 10\%, 15) \times (F/P, 10\%, 15)$$

$$= 2{,}08{,}860 + \frac{18163.77}{0.03} \times 4.1772$$

$\therefore$ F = Rs. 27,37,984.

If salary increases by Rs. 25,000 per year,

Year	Salary increased by Rs. 25,000 per year	20% deposit
0	2,50,000	50,000
1	2,75,000	55,000
2	3,00,000	60,000
3	3,25,000	65,000
4	3,50,000	70,000
5	3,75,000	75,000
6	4,00,000	80,000
7	4,25,000	85,000
8	4,50,000	90,000
9	4,75,000	95,000
10	5,00,000	1,00,000
11	5,25,000	1,05,000
12	5,50,000	1,10,000
13	5,75,000	1,15,000
14	6,00,000	1,20,000
15	6,25,000	1,25,000

Now, P = Rs. 50,000

A = Rs. 55,000

G = Rs. 5,000

We know,

$$F = P\,(F/P, i\%, N) + A\,(F/A, i\%, N) + G\,(F/G, i\%, N)$$

$$= 50{,}000\,(F/P, 10\%\ 15) + 55{,}000\,(F/A, 10\%, 15) + 5{,}000 \times (F/G, 10\%, 15)$$

$$= 50{,}000 \times 4.1772 + 55{,}000 \times 31.7725 + \frac{G}{i}\left[\frac{(1+i)^N - 1}{i}\right] - \frac{NG}{i}$$

$$= 2{,}08{,}860 + 17{,}487.50 + \frac{5000}{0.10}\left[\frac{(1+0.10)^{15} - 1}{0.10}\right] - \frac{15 \times 5000}{0.10}$$

$$= 2{,}08{,}860 + 17{,}47{,}487.50 + 15{,}88{,}624 - 7{,}50{,}000$$

$\therefore$ F = Rs. 27, 94, 971.50

24. How many rupees Ms. Ashmita should deposit now so that she can withdraw Rs. 2,00,000 every five years if the bank interest rate is 10% per year?

Solution:

i = 10% per

Interest rate for the end of each 5 year =

$$i_5 = (1 + i)^N - 1$$

$$= (1 + 0.10)^5 - 1$$

$\therefore$ i_5 = 61.051% for each year

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As, Ms. Ashmita can withdraw Rs. 2,00,000 every 5 years for infinite period, applying CW method,

$$CW = \frac{AW}{i_5} = \frac{2,00,000}{0.6105} = \text{Rs.}3,27,595$$

Hence, Ms. Ashmita should deposit Rs. 3,27,595 now for getting Rs. 2,00,000 every 5 year.

25. Find the compound amount, if the investment is done Rs. 5,000 with the interest rate 12% per year and compounded weekly for 2 years. [10/F]

Solution:

P = Rs. 5,000

N = 2 years

r = 12% per year compounded weekly

$$i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1 = \left(1 + \frac{0.12}{52}\right)^{52} - 1$$

$\therefore$ $i_{eff} = 12.74\%$

So, $F = P(1 + i)^N$

$= 5,000 \times (1 + 0.1274)^2$

$\therefore$ F = Rs. 6,3 54.488

Hence, compounded amount is Rs. 6,354.48

26. Ram invested Rs. 15,000 in a high yield account. At the end of 30 years, he closed the account and received Rs. 5,39,250. Compute the effective interest rate he received on the account. [10/F]

Solution:

P = Rs. 15,000

N = 30 years

F = Rs. 5, 39, 250

i =?

We have,

$P = F(1 + i)^{-N}$

or, $15,000 = 5,39,250\,(1 + i)^{-30}$

or, $0.027816 = (1 + i)^{-30}$

or, $(1 + i) = \sqrt[-30]{0.027816}$

or, $1 + i = 1.12682$

or, $i = 0.12682$

$\therefore$ $i = 12.68\%$

Hence, effective interest rate is 12.68% compounded annually.

ADDITIONAL PROBLEMS

1. Find out the effective and nominal interest rate per year if the monthly interest rate is 1.85%

Solution:

$i_{monthly} = 1.85\%$

$i_{eff} = (1 + i_{mon})^{12} - 1 = (1 + 0.0185)^{12} - 1 = 24.60\%$

Hence, effective interest rate is 24.60% per year and

$$i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$$

or, $0.2460 = \left(1 + \frac{r}{12}\right)^{12} - 1$

or, $0.2460 + 1 = \left(1 + \frac{r}{12}\right)^{12}$

or, $1.246 = \left(1 + \frac{r}{12}\right)^{12}$

or, $(1.246)^{1/12} = 1 + \frac{r}{12}$

or, $1.0185 - 1 = \frac{r}{12}$

or, $r = 12 \times 0.0185$

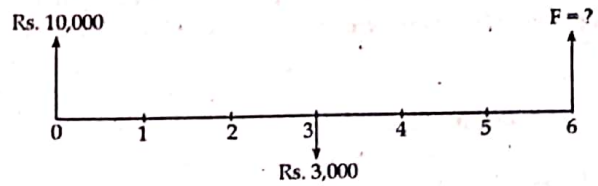
or, $r = 0.22196$

$\therefore$ $r = 22.20\%$

Hence, nominal interest rate is 22.20% per year

2. Pragya deposits Rs. 10,000 now in a bank which gives 7% interest rate per year. She draws Rs. 3,000 at the end of 3rd year. What will be the remaining amount at the end of 6th year?

Solution:



i = 7% per year

At the end of 3rd year, accumulated amount is,

$F = P(1 + i)^N$

$= 10,000\,(1 + 0.07)^3$

= Rs. 12,250.43

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And after drawing Rs. 3000, the remaining deposit amount at the end of 3rd year will be,

$$= \text{Rs. } 12{,}250.43 - \text{Rs. } 3{,}000$$

Hence, at the end of 6th year,

$$F = P_3(1+i)^{6-3}$$

$$= 9250.43 \times (1+0.07)^3$$

$$\therefore \quad F_6 = \text{Rs. } 11{,}332.18$$

3. If Prashansa wish to draw Rs. 22,000 per month for 2 years. How much should she deposit at present for that when rate of interest is 8% per year?

Solution:

A = Rs. 22,000 per month

i = 8% per year

N = 2 years = 2 × 12 months

We have,

$$i_{monthly} = (1+i_{eff})^{1/12} - 1$$

$$= (1+0.08)^{1/12} - 1$$

$$\therefore \quad i_{monthly} = 0.00643$$

Then,

$$P = A\,(P/A, i\%, N)$$

$$= \text{Rs. } 22{,}000\,[P/A, 0.00643, 2 \times 12]$$

$$= \text{Rs. } 22{,}006 \times \left[\frac{(1+0.00643)^{24} - 1}{0.00643 \times (1+0.00643)^{24}}\right]$$

$$= \text{Rs. } 22{,}000 \times 22.1739$$

$$\therefore \quad P = \text{Rs. } 4{,}87{,}828$$

Hence, Prashansa must deposit Rs. 4,87,828 at present.

4. Bank 'A' offers 6% per year but compounded daily. Bank 'B' offers 6.5% per year but compounded monthly, which one do you prefer? Why?

Solution:

Effective interest rate for Bank 'A'

$$i_A = \left(1+\frac{r}{m}\right)^m - 1 = \left(1+\frac{0.06}{365}\right)^{365} - 1$$

$$\therefore \quad i_A = 6.183\%$$

and, effective interest rate for bank 'B'

$$\therefore \quad i_B = \left(1+\frac{0.065}{12}\right)^{12} - 1 = 6.70\%$$

Hence, effective interest of bank B > Bank A. So, I would prefer Bank 'B'.

5. If a saving bank pays 2% interest every three months, what are the nominal and effective interest rate per year?

Solution:

$$i_{quarterly} = 2\% = 0.02$$

$$\therefore \quad i_{eff} = (1+i_{quarterly})^4 - 1$$

$$= (1+0.02)^4 - 1$$

$$= 8.24\%$$

We know,

$$i_{eff} = \left(1+\frac{r}{m}\right)^m - 1$$

$$\text{or,} \quad 0.0824 = \left(1+\frac{r}{4}\right)^4 - 1$$

$$\text{or,} \quad 0.0824 + 1 = \left(1+\frac{r}{4}\right)^4$$

$$\text{or,} \quad 1.0824 = \left(1+\frac{r}{4}\right)^4$$

$$\text{or,} \quad \frac{r}{4} = (1.0824)^{1/4} - 1$$

$$\text{or,} \quad r = 4 \times 0.01999$$

$$\text{or,} \quad r = 0.07996$$

$$\therefore \quad r = 8\% \text{ per year}$$

Hence, nominal interest rate = 8% per year

Effective interest rate = 8.24% per year

6. Suppose Sagar make a series of annual deposit into a bank account that pays 10% interest. The initial deposit at the end of the first year is Rs. 1,200. The deposit amount decline by Rs. 200 in each of the next four years. How much would he have immediately after the 5th deposit?

Solution:

N = 5 years

i = 10% per year

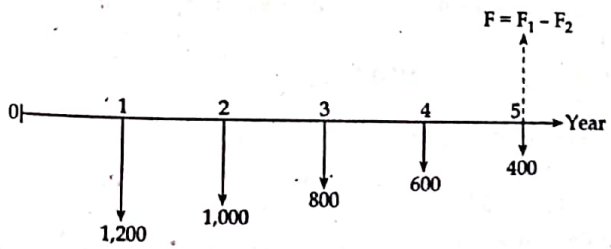

Fig: Original cash flow.

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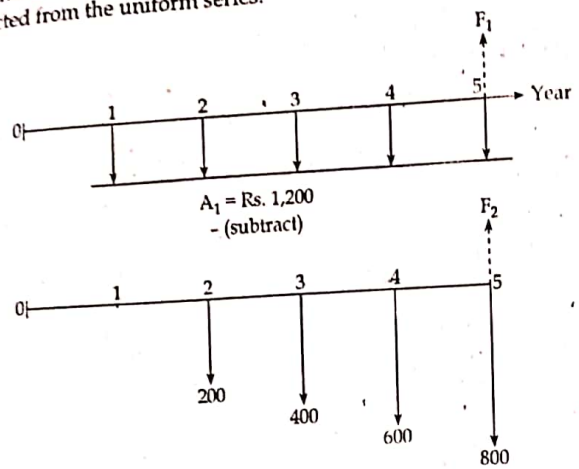
The cash flow includes a decreasing gradient series. For a decreasing gradient series, the solution is obtained by separating the flow into two components: a uniform series and an increasing gradient that is subtracted from the uniform series.



Hence, $F = F_1 - F_2$

$= A_1 (F/A, i\%, 5) - G (P/G, i\%, N) (F/P, i\%, N)$

$= 1{,}200 \times 6.105 - 200 \times 0.6862 \times 1.611$

$=$ Rs. 5.115

7. **You have just purchased 100 shares of general electrical stock at Rs. 600 per share. You will sell the stock when its market price has doubled. If you expect the stock price to increase 20% per year, how long do you anticipate waiting before selling the stock?**

Solution:

P = Rs. 600 × 100 = Rs. 60,000

F = Rs. 1,200 × 100 = Rs. 1,20,000

i = 20% per year

N = ?

We know, using the single payment compounded amount factor,

$F = P(1 + i)^N$

or, $1{,}20{,}000 = 60{,}000 \times (1 + 0.20)^N$

or, $2 = (1.2)^N$

Taking in on both sides,

or, $\ln(2) = N \times \text{in}(1.2)$

or, $0.693 = N \times 0.1823$

∴ N = 3.80 years

Hence, it will take 3.80 years

8. **How long does it take for an investment to triple if the interest rate is 8% compounded weekly?**

Solution:

Let, P = P

F = 3P

r = 8% compounded weekly

$$i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$$

$$= \left(1 + \frac{0.08}{52}\right)^{52} - 1$$

$= 8.322\%$

N = ?

We have,

$F = P(1 + i)^N$

or, $3P = P(1 + 0.08322)^N$

or, $3 = (1.0832)^N$

or, $N \ln(1.0832) = \ln(3)$

or, $N = \frac{1.0986}{0.0799} = 13.75$ years

Hence, it takes 13.75 years to triple the investment.

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

Solution:

P = Rs. 10,00,000

i = 18% per year

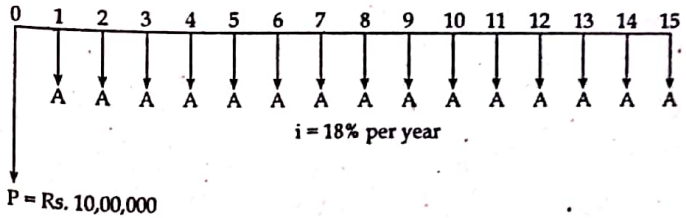
N = 15 years

A = ?

We know,

$A = P(A/P, i\%, N) = 10{,}00{,}000\ (A/P, 18\%, 15) = 10{,}00{,}000 \times 0.1964$

∴ A = Rs. 1,96,400



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Hence, the bank has to pay Rs. 1,96,400 per year up to 15 years and total amount to be paid to bank is

= Rs. 1,96,400 × 15

= Rs. 2,946,000

10. **What will be the maturity amount of Rs. 100,000 after 5 years for nominal interest rate of 7% when compounded quarterly?**

Solution:

P = Rs. 1,00,000

N = 5 years

r = 7% compounded quarterly

$$i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$$

$$= \left(1 + \frac{0.07}{4}\right)^4 - 1$$

= 7.19% per year

Now,

$\therefore$ $F = P(1 + i)^N$

= Rs. 1,00,00 $(1 + 0.0719)^5$

= Rs. 1,00,000 × 1.4148

= Rs. 1,41,478

Chapter 4

BASIC METHOD OF ENGINEERING ECONOMIC STUDIES

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4.1 MINIMUM ATTRACTIVE RATE OF RETURN (MARR)

MARR is the minimum interest rate that encourages the investor to invest in financial projects. MAAR is the interest rate at which a firm can always earn or borrow money under a normal operating environment. It is the rate at which NPW analysis should be conducted. Also, termed as hurdle rate for an investment usually, selection of the MARR is a policy decision made by top management. MARR shows how much an investor is interested in investment. MARR is determined from the opportunity cost view point.

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4.2 PAYBACK PERIOD METHOD

The payback period is the length of time required to recover the cost of an investment. It is one of the simplest investment appraisal techniques.

4.2.1 SIMPLE PAYBACK PERIOD (θ)

Simple payback period denotes the time period required to breakeven on an investment without considering time value of money.

$$SPP(\theta) = \frac{\text{Initial investment}}{\text{Net cash inflows per period}}$$

$$\theta = \sum_{C=1}^{\theta} (R_C - E_C) - I \geq 0$$

where,

R_C = revenues for the Cth year

E_C = expenses for the Cth year

when θ = N, the salvage value is included in determination of payback period.

4.2.2 DISCOUNTED PAYBACK PERIOD (θ')

Discounted payback period denotes the number of years required to recover the investment from discounting cash flows *i.e.*, considering time value of money.

$$\theta' = \sum_{C=1}^{\theta} (R_C - E_C)(P/F, i\%\ C) - I = 0$$

where,

I = Initial investment

A discounted payback period gives the number of years it takes to break even from undertaking the initial expenditure by discounting future cash flows and recognizing the time value of money.

4.3 EQUIVALENT WORTH METHODS

This method converts all cash flows into equivalent worth at present or future time by using an interest rate equal to MARR.

4.3.1 PRESENT WORTH (PW) METHOD

It is based on the concept of equivalent worth of all cash flows to the base point in time called the present. In this method, all the cash inflows and outflows are discounted to the beginning point of time at an interest rate for the economic study. It is also known as net present value (NPV).

It is calculated as:

$$PW(i\%) = \sum_{C=1}^{N} F_C (1+i)^{-C}$$

where,

i = effective interest rate or MARR

C = index for each compounding period

F_C = future cash flow at the end of period C

N = no. of compounding periods.

Decision criteria

If PW (i%) > 0, accept the project

If PW (i%) < 0, reject the project

If PW (i%) = 0, remain indifferent

4.3.2 FUTURE WORTH (FW) 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. It is the equivalent worth of all cash flows at the end of study period. It is calculated as,

$$FW(i\%) = \sum_{C=1}^{N} F_C (1+i)^{N-C}$$

Decision criteria

If FW (i%) > 0, accept the project

If FW (i%) = 0, remain indifferent

If FW (i%) < 0, reject the project

4.3.3 ANNUAL WORTH METHOD

It provides basis for measuring investment worth into a series of equal payments at the end of each period. The AW of a project is annual equivalent revenue or savings minus annual equivalent expenses, less its annual capital recovery (CR) amount.

It is calculated as:

$$AW(i\%) = R - E - CR(i\%)$$

where,

R = Annual equivalent revenue

E = annual equivalent expenses

CR = annual equivalent capital recovery amount

Decision criteria

If AW (i%) > 0, accept the project

If AW (i%) < 0, reject the project

If AW (i%) = 0, remain indifferent

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Capital asset includes initial investment amount (I) and salvage value (S) of any business operation, so, CR cost can be calculated as,

$$CR(i\%) = I(A/P, i\%, N) - S(A/F, i\%, B)$$

or $$CR(i\%) = (I - S)(A/F, i\%, N) + I(i\%)$$

or, $$CR(i\%) = (I - S)(A/P, i\%, N) + S(i\%)$$

4.4 RATE OF RETURN METHOD

This method is especially relevant to evaluate mutually exclusive alternative projects. It is a relative percentage method which measures the yield as a percentage of investment over the life of a project.

4.4.1 INTERNAL RATE OF RETERN (IRR)

IRR is the interest rate at which the net present value of all cash flows both positive and negative from a project or investment equals zero.

i.e., $PW_{inflow} = PW_{outflow}$

or, $PW_{inflow} - PW_{outflow} = 0$

Based on PW formulation

$$PW(i\%) = \sum_{C=0}^{N} R_C (P/F, i'\% C) - \sum_{C=0}^{N} E_C (P/F, i'\% C) = 0$$

where,

R_C = revenues for the Cth year

E_C = expenses for the Cth year

N = project life

Based on FW formulation,

$$FW(i\%) = \sum_{C=0}^{N} R_C (F/P, i'\%, N - C) - \sum_{C=0}^{N} E_C (F/P, i'\%, N - C) = 0$$

Based on AW formulation

$$AW(i\%) = \sum_{C=0}^{N} R_C (F/P, i'\%, N - C)(A/F, i'\%, N) - \sum_{C=0}^{N} E_C (F/P, i'\% N - C)(A/F, i'\%, N) = 0$$

❑ Steps for calculating IRR:

Step 1: Develop an equation for equivalent worth of any point of time indicating rate of interest i'% whose value is to be found out.

Step 2: Equate the developed equation to zero

Step 3: Solve it to get i'% which is required IRR.

Decision criteria

If IRR > MARR, accept the project

If IRR < MARR, reject the project

If IRR = MARR, remain indifferent

❑ Drawbacks of IRR method:

i) When the algebraic sign of the cash flows changes more than one in the series, it is possible to obtain multiple rates of return.

ii) IRR method does not consider the scale of investment. It can be misleading when choosing between mutually exclusive projects that have substantially different outlays.

iii) The IRR method is based on the assumptions that the recovered funds, if not consumed in each time period are reinvested at i'% rather than at MARR which is not always practical.

iv) Time consuming and may produce inaccurate results due to the use of linear interpolation formula for non-linear function.

4.4.2 EXTERNAL RATE OF RETURN (ERR) OR MODIFIED RATE OF RETURN (MIRR)

ERR method directly takes into account the interest rate (∈) external to a project at which net cash flows generated or required by the project over its life can be reinvested or borrowed. ERR method eliminated the drawback of reinvestment assumption to some extent.

ERR is i'% at which

$$\sum_{C=0}^{N} E_C (P/F, \in\%, C)(F/P, i'\%, N) = \sum_{C=0}^{N} R_C (F/P, \in\%, N - C)$$

where,

∈ = external reinvestment rate per period.

Decision rule

If ERR > MARR, accept the project

If ERR < MARR, reject the project

If ERR = MARR, remain indifferent

Steps for calculating ERR

Step 1: All net cash outflows are discounted to time zero at ∈ % per compounding period.

Step 2: All net cash inflows are compounded to period N at ∈%

Step 3: Calculate ERR by making equivalence between the above two quantities.

4.5 BENEFIT COST RATIO METHOD (BCR)

BCR method is defined as the ratio of the equivalent worth of benefits to the equivalent worth of costs. It is an indicator used in cost benefit analysis, that attempts to summarize the overall value for money of a project. It is also known as the saving investment ratio.

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Two commonly used formulation of B/C ratio are as follows:

1. Conventional B/C ratio

It is the ratio of gross benefits to costs.

i) With PW formulation

$$B/C \text{ ratio} = \frac{PW(B)}{PW(I) - PW(S) + PW(O \text{ and } M)}$$

ii) With FW formulation:

$$B/C \text{ ratio} = \frac{FW(B)}{FW(I) - FW(S) + FW(O \text{ and } M)}$$

iii) With AW formulation:

$$B/C \text{ ratio} = \frac{AW(B)}{AW(I) - AW(S) + AW(O \text{ and } M)}$$

2. Modified B/C ratio

It is the ratio of net benefits to costs

i) With PW formulation:

$$B/C \text{ ratio} = \frac{PW(B) - PW(O \text{ and } M)}{PW(I) - PW(S)}$$

ii) With AW formulation:

$$B/C \text{ ratio} = \frac{AW(B) - AW(O \text{ and } M)}{AW(I) - AW(S)} = \frac{AW(B) - AW(O \text{ and } M)}{CR}$$

iii) With FW formulation:

$$B/C \text{ ratio} = \frac{FW(B) - FW(O \text{ and } M)}{FW(I) - FW(S)}$$

where,

B = Benefits of the proposed project

S = salvage value of the proposed project

CR = capital recovery amount

O and M = operation and maintenance cost of proposed project

I = Initial investment of the proposed project

Decision criteria

If B/C ratio > 1, accept the project

If B/C ratio < 1, reject the project

If B/C ratio = 1, remain indifferent

BOARD EXAM SOLVED PROBLEMS

1. Difference between IRR and ERR. **[18/F]**

S.N.	IRR	ERR
i.	It is the discount rate that makes the net present value of all cash flows from a particular project equals to zero.	ERR method directly takes into account the interest rate (ϵ) external to a project at which net cash flows generated by the project over its life can be reinvested or borrowed.
ii.	IRR sometime gives multiple rate of return.	ERR never gives multiple rate of return.
iii.	It is time consuming method.	It is not time consuming method.

2. Define payback period, simple payback period and discounted payback period. **[12/F, 18/F, 17/F]**

Ans: Refer topic 4.2, 4.2.1, 4.2.2

3. Define cost benefit ratio. **[12/S, 14/F]**

Ans: Refer topic 4.5

4. Define life cycle cost and explain it categories. **[10/F, 16/F, 17/S]**

Ans: 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 cost is defined as the sum of all expenditures associated with the item or project during its entire life service.

Life cycle cost consists following three categories:

i) Initial cost

ii) Operating and maintenance costs

iii) Disposal costs

i) Initial costs:

Initial costs is the total investment required to get the item or project ready for service and such costs are non-recurring nature over the life of the item or project. The initial or first cost may consists following elements:

- Machine equipment costs
- Land and building costs
- Manufacturing costs
- Installation costs
- Development and engineering design costs etc

ii) Operating and maintenance costs:

Operating and maintenance costs are recurring costs that are necessary to operate and maintain an item or project during its useful life. This costs consists of following elements:

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- RAW material cost
- Transportation cost
- Labour wages and salaries cost
- Cost for spares, corrective maintenance
- Overhead items cost (tax, insurance premium, overtime expenses etc)

iii) Disposal costs:

Disposal cost is the cost or gain of getting rid of assets after use. It may include the net remaining worth, as well as the cost of transferring or destroying the assets. It includes following elements:

- Labour cost for removal of the item
- Material costs (tool, fuel, packing material etc)

The salvage value is determined by deducting the cost of disposal from the market value of the asset at the time of disposal. Salvage value may be positive or negative.

Life cycle costs = First costs
+
Lifetime operating costs
+
Lifetime maintenance costs
+
Disposal costs
-
Residual value

5. **Find the present equivalent from the cash flow given if interest rate is 11% per year using uniform gradient method.** **[14/F]**

End of year	Cash flow (Rs)
1	400
2	600
3	800
4	1000
5	1200
6	1400

Solution:

i = 11% per year

G = Rs. 200

PW (i%) = A_0(P/A, i%, N) + G (P/G, i%, N)

= 400 × (P/A, 11%, 6) + 200 (P/G, 11%, 6)

= 400 × 4.2305 + 200 × 9.2972

= 1692.20 + 1859.44

PW(11%) = Rs. 3,551.64

6. **For the project given below:** **[15/S]**

Initial investment	Rs. 90,000
Project life	6 years
Annual revenue	Rs. 27,000
Salvage value	Rs. 10,000
Annual expenses	Rs. 8,000

i) **What is the IRR for the project?**

ii) **If MARR = 15%, is the project feasible?**

Solution:

I = Rs. 90,000

N = 6 years

R = Rs. 27,000

S = Rs. 10,000

E = Rs. 8,000

MARR = 15%

We know,

Setting the given information into PW formulation

PW = 90,000 + (27,000 – 8,000) (P/A, i%, 6) + 10,000 × (P/F, i%, 6)

IRR is that rate which makes PW = 0.

PW = – 90,000 + 19,000 (P/A, i'%, 6) + 10,000 (P/F, i'%, 6) = 0

If i' = 10%,

PW (10%) = –90,000 + 19,000 × 4.3553 + 10,000 × 0.5645

= Rs. – 1604.3 (–ve)

If i' = 8%

PW (8%) = –90,000 + 19,000 × 4.6229 + 10,000 × 0.6302

= Rs. 4,137 (+ve)

Now, $IRR = i_1' + \frac{PW_1}{PW_2 - PW_1} \times (i_2' - i_2') = 8 + \frac{4137}{4137 + 1604.30} \times (10 - 8)$

∴ IRR = 9.441%

Since, IRR (9.441%) < MARR (15%), the project is unfeasible.

7. **Calculate simple and discounted payback period using MARR = 15%.** **[15/S]**

Period	Cash flow (Rs.)
0	– 85,000
1	15,000
2	25,000
3	35,000
4	45,000
5	45,000
6	35,000

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Solution:

Simple payback period:

EOY	Net cash flow	Cumulative cash flow
0	- 85,000	- 85,000
1	15,000	- 70,000
2	25,000	- 45,000
3	35,000	-10,000
4	45,000	35,000
5	45,000	8,000
6	35,000	1,15,000

Payback period lies between 3 and 4 years.

Hence, simple payback period, $\theta = 3 + \frac{10000}{45000} = 3.23$ years

And,

Discounted payback period:

EOY	Net cash flow, F	Discounted cash flow into present @ 15%, P	Cumulative cash flow (Rs)
0	- 85,000	- 85,000	- 85,000
1	15,000	13,043.48	- 71, 956.52
2	25,000	18,903.59	- 53,052.93
3	35,000	23,013.06	- 30,039.87
4	45,000	25,728.89	- 4,310.98
5	45,000	22,373	18,062.02
6	35,000	15,131.46	33,193.50

$P = F(1 + i)^{-N}$

Here, cumulative cash flow turns positive in period 5. Hence, discounted payback period lies between 4 and 5.

By interpolating,

$$\theta' = 4 + \frac{4310.98}{22373} = 4 + 0.1926 = 4.20 \text{ years}$$

Hence, discounted payback period is 4.20 years

8. **A new machine costing Rs. 250,000 is estimated to have life of 10 years and expected annual revenue is Rs. 50,000 with annual cost Rs. 12,000. Determine the investment decision based on PW formulation to this machine, if salvage value is Rs. 70,000 and MARR is 10% per year. Also, Make cash flow diagram.** **[14/5]**

Solution:

N = 10 years

I = Rs. 250,000

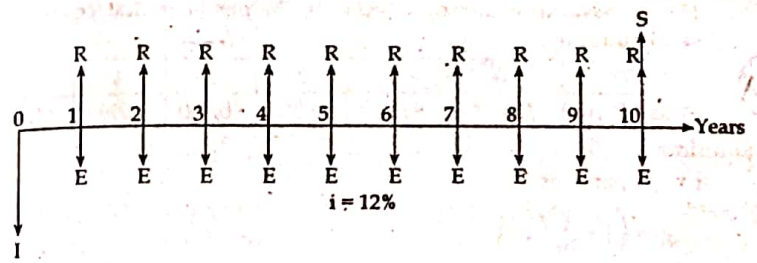
Annual revenue, AR = Rs. 50,000

Annual cost AE = Rs. 12,500

Salvage value, S = Rs. 70,000

MARR = 10% per year

Cash flow diagram:



PW (i%) = – I + (A – E) (P/A, i%, N) + S (P/F, i%, N)

= – 250,000 + (50,000 – 12,500) × (P/A, 10%, 10) + 70,000 × ~~0.355~~ 0.3855

∴ PW = Rs. 7407.50

Since, PW (10%) > O, the investment is acceptable.

9. **Find present equivalent from the cash flow given if interest rate is 11% per year using uniform gradient method.** **[11/5]**

End of year	Cash flow
1	- 40,000
2	- 50,000
3	- 60,000
4	- 70,000
5	- 80,000
6	- 1,00,000

Solution:

i = 11% per year

F = P(F/A, i%, N) + G (F/G, i%, N)

$$F_5 = -40{,}000\,(F/A, 11\%, 5) + \frac{G}{i}\left[\frac{(1+i)^N - 1}{i}\right] - \frac{NG}{i}$$

$$= -40{,}000 \times 6.2278 + \frac{(-10000)}{0.11}\left[\frac{(1+0.11)^5 - 1}{0.11}\right] - 5 \times \frac{(-10{,}000)}{0.11}$$

= –249,112 – 566,164 + 454,546

∴ F_5 = – 609,842 -, -360730

and, $F_6 = F_5 \times (F/P, 11\%, 1)$

= –609,842 × 1.110

= Rs. – 676,926

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Thus,

$\therefore$ $PW(11\%) = F_6(P/F_6, 11\%, 6)$

$= -676{,}926 \times 0.5346$

$= \text{Rs.} - 361{,}884$

10. From the following cash flow information, calculate PW, AW and FW by assuming rate of interest is 7% per year that compounds semi annually. [15/F]

EOY	0	1	2	3	4	5
Cash flow	-3,00,000	80,000	90,000	90,000	90,000	1,20,000

Solution:

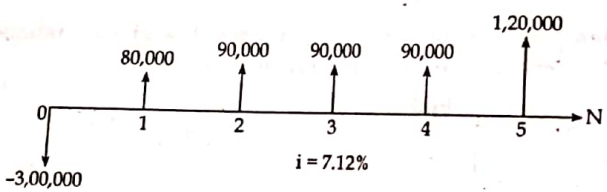
$r = 7\%$ per year

$$i_{eff} = \left(1 + \frac{r}{m}\right)^m - 1$$

$$= \left(1 + \frac{0.07}{2}\right)^2 - 1$$

$= 0.0712$

$= 7.12\%$



$PW = -3{,}00{,}000 + 80{,}000 \times (1.0712)^{-1} + 90{,}000\,(1.0712)^{-2} + 90{,}000\,(1.0712)^{-3}$

$+ 90{,}000\,(1.0712)^{-4} + 120{,}000 \times (1.0712)^{-5}$

$= -300{,}000 + 74682.6 + 78{,}433.5 + 73{,}220 + 68{,}353.5 + 85{,}080$

$\therefore PW(7.12\%) = \text{Rs. } 79{,}769.5$

Now,

$AW(7.12\%) = PW(A/P, i\%, N)$

$= 79{,}769.5 \times (A/P, 7.12\%, 5)$

$$= 79{,}769.5 \times \left[0.0712 \times \frac{(1 + 0.0712)^5}{(1 + 0.0712)^5 - 1}\right]$$

$= 79{,}769.5 \times 0.2447$

$\therefore$ $AW(7.12\%) = \text{Rs. } 19{,}517.58$

and $FW(7.12\%) = PW(F/P, i\%, N)$

$= PW(F/P, 7.12\%, 5)$

$= 79{,}769.5 \times (1 + 0.0712)^5$

$\therefore$ $FW(7.12\%) = \text{Rs. } 1{,}12{,}509.62$

11. Calculate present worth, future worth and annual worth from the following net cash flows. MARR is 12% per year. [13/F]

End of year	Net cash flow
0	- 5,000
1	- 500
2	0
3	1,200
4	1,200
5	1,220
6	1,320

Solution:

MARR = 12% per year

$PW(12\%) = -5{,}000 - 500\,(1.12)^{-1} + 0 + 1{,}200\,(1.12)^{-3} + 1{,}200\,(1.12)^{-4}$

$+ 1{,}220(1.12)^{-5} + 1{,}320\,(1.12)^{-6}$

$= -2{,}468.90 \times 0.2432$

$= \text{Rs.} - 600.4$

$FW(12\%) = PW(F/P, 12\%, 6)$

$= -2{,}468.90 \times 1.9376$

$= \text{Rs.} - 4{,}872.60$

12. Find both types of B/C ratio using PW formulation for a project having first investment cost Rs. 1,00,000, project life 10 years, salvage value Rs. 20,000, annual benefit Rs. 75,000, annual O and M cost Rs. 15,000 and MARR = 10%. [15/F,11/S]

Solution:

Investment (I) = Rs. 1,00,000

Salvage value (S) = Rs. 20,000

Annual benefit (B) = Rs. 75,000

Annual expenses (O and M) = Rs. 15,000

MARR = 10% per year

Project life (N) = 10 years

We known,

$PW(B) = B(P/A, i\%, N)$

$= 75{,}000 \times (P/A, 10\%, 10)$

$= 75{,}000 \times 6.1446$

$= \text{Rs. } 4{,}60{,}845$

$PW(O \text{ and } M) = 15{,}000 \times (P/A, 10\%, 10)$

$= 15{,}000 \times 6.1446$

$= \text{Rs. } 92{,}169$

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$$PW(S) = 20{,}000 \times (P/F, 10\%, 10)$$
$$= 20{,}000 \times 0.3885$$
$$= \text{Rs. } 7{,}776$$

Now

$$\text{Conventional BCR} = \frac{PW(B)}{I - PW(S) + PW(O \text{ and } M)}$$
$$= \frac{4{,}60{,}845}{1{,}00{,}000 - 7{,}776 + 92{,}169}$$
$$= 2.4992 > 1$$

$$\text{Modified BCR} = \frac{PW(B) - PW(O \text{ and } M)}{I - PW(S)}$$
$$= \frac{4{,}60{,}845 - 92{,}169}{1{,}00{,}000 - 7{,}776}$$
$$= 3.99 > 1$$

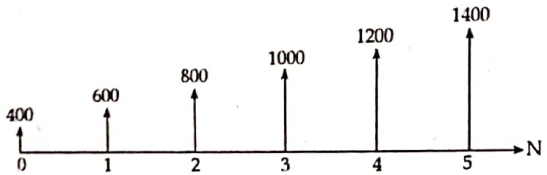
Since, BCR > 1, project is feasible to invest.

13. Find PW from the cash flow given if interest rate is 11% per year using uniform gradient method. *[14/F]*

EOY	Cash flow
1	400
2	600
3	800
4	1,000
5	1,200
6	1,400

Solution:

i = 11% per year



$$\therefore \quad PW(11\%) = 400\,(P/A, 11\%, 6) + 200\,(P/G, 11\%, 6)$$
$$= 400 \times 4.2305 + 200 \times 9.2972$$
$$= \text{Rs. } 3{,}551.64$$

14. Find out the both types of B/C ratio using PW and AW method. *[13/F; 14/F,16/F,16/S,12/S,10/F]*

Initial investment = Rs. 4,00,000
Annual benefit = Rs. 1,50,000

Annual cost = Rs. 30,000
MARR = 12% per year
Useful life, = 8 years
Salvage value = Rs. 50,000

Solution:

I = Rs. 4,00,000
N = 8 years
MARR = 12% per year
AB = Rs. 1,50,000
S = Rs. 50,000
O and M = Rs. 30,000

i) With PW formulation

$$PW(I) = \text{Rs. } 4{,}00{,}000$$
$$PW(B) = 1{,}50{,}000\,(P/A, 12\%, 8)$$
$$= 1{,}50{,}000 \times 4.9676$$
$$= \text{Rs. } 7{,}45{,}140$$
$$PW(S) = 50{,}000\,(P/F, 12\%, 8)$$
$$= 50{,}000 \times 0.4039$$
$$= \text{Rs. } 20{,}195$$
$$PW(O \text{ and } M) = 30{,}000\,(P/A, 12\%, 8)$$
$$= 30{,}000 \times 4.9676$$
$$= \text{Rs. } 1{,}49{,}028$$

Thus,

$$\therefore \quad \text{Conventional B/C ratio} = \frac{PW(B)}{PW(I) - PW(S) + PW(O \text{ and } M)}$$
$$= \frac{7{,}45{,}140}{4{,}00{,}000 - 20{,}195 + 1{,}49{,}028}$$
$$= 1.409 > 1$$

$$\therefore \quad \text{Modified B/C ratio} = \frac{PW(B) - PW(\text{oand m})}{PW(I) - PW(S)}$$
$$= \frac{7{,}45{,}140 - 1{,}49{,}028}{4{,}00{,}000 - 20{,}195}$$
$$= 1.659 > 1$$

ii) Using AW formulation:

$$AW(I) = 4{,}00{,}000\,(A/P, 12\%, 8)$$
$$= 4{,}00{,}000 \times 0.2013$$
$$= \text{Rs. } 80{,}520$$
$$AW(B) = \text{Rs. } 1{,}50{,}000$$
$$AW(O \text{ and } M) = \text{Rs. } 30{,}000$$
$$AW(S) = 50{,}000\,(A/F, 12\%, 8)$$
$$= 50{,}000 \times 0.0813 = \text{Rs. } 4{,}065$$

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$$\therefore \quad \text{Conventional B/C ratio} = \frac{AW\ (B)}{AW\ (I) - AW\ (S) + AW\ (O \text{ and } M)}$$

$$= \frac{1,50,000}{80,520 - 4,065 + 30000}$$

$$= 1.409 > 1$$

And,

$$\therefore \quad \text{Modified B/C ratio} = \frac{AW\ (B) - AW\ (O \text{ and } M)}{AW\ (I) - AW\ (S)}$$

$$= \frac{1,50,000 - 30,000}{80,520 - 4,065}$$

$$= 1.569 > 1$$

Since, B/C ratio > 1, investment is feasible.

15. Evaluate the IRR for the following project and decide whether the project is acceptable or not? Also draw the unrecovered investment balance diagram. *[14/F, 11/F, 10/F]*

Initial investment = Rs. 5,00,000
Annual revenue = Rs. 1,20,000
Salvage value = Rs. 30,000
Useful life year = 10 year
MARR = 8%

Solution:

I = Rs. 5,00,000
AR = Rs. 1,20,000
S = Rs. 30,000
N = 10 years
MARR = 8% per year

Using PW formulation,

PW (i%) = -I + R (P/A, i%, N) + S(P/F, i%, N)

PW (i%) = -5,00,000 + 120,000 (P/A, i%, 10) + 30,000 × (P/F, i%, 10)

IRR is that rate at which PW = 0,

Let, i' = 10%

PW (20%) = -500,000 + 120,000 × 4.195 + 3,000 × 0.1115 = 7,945 (+ve)

Let, i' = 21%,

PW (21%) = -5,00,000 + 120,000 × 4.054 + 30,000 × 0.1486 = Rs. - 9.062 (-ve)

Now,

$$IRR = i'_1\% + \frac{PW_1}{PW_2 - PW_1} \times (i'_2 - i'_1)\%$$

$$= 20\% + \frac{7,945}{7,945 + 9,062} \times (21 - 20\%) = 20\% + 0.467\%$$

$\therefore$ IRR = 20.467%

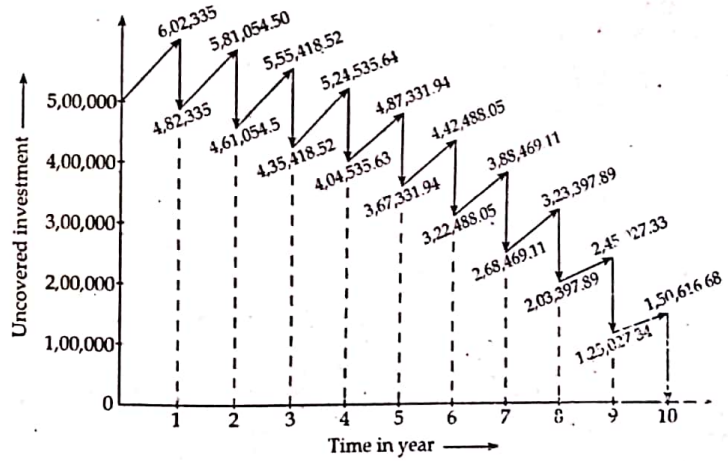
Since, IRR (20.467%) > MARR (8%), the project is feasible.

Investment Balance diagram:

Unrecovered investment calculation in tabular form:

$\therefore$ EOY value = $(1 + i)^N$ × Beginning of year value

EOY	Cash flow	Unrecovered investment		Unrecovered investment (Revenue-expenses)
		Beginning of year	EOY @ 20.467%	
0	- 5,00,000	-	- 5,00,000	- 5,00,000
1	1,20,000	- 5,00,000	- 6,02,335	- 4,82,335
2	1,20,000	- 4,82,335	- 5,81,054.50	- 4,61,054.5
3	1,20,000	- 4,61,054.5	- 5,55,418.52	- 4,35,418.52
4	1,20,000	- 4,35,418.52	- 5,24,535.64	- 4,04,535.63
5	1,20,000	- 4,04,535.63	- 4,87,331.94	- 3,67,331.94
6	1,20,000	- 3,67,331.94	- 4,42,488.05	- 3,22,488.05
7	1,20,000	- 3,22,488.05	- 3,88,469.11	- 2,68,469.11
8	1,20,000	- 2,68,469.11	- 3,23,397.89	- 2,03,397.89
9	1,20,000	- 2,03,397.89	- 2,45,027.33	- 1,25,027.34
10	1,50,000	- 1,25,027.34	- 1,50,616.68	- 616.68



16. Evaluate the IRR of the following project, identify whether the project is feasible or not. Also, draw investment balance diagram. *[14/S, 13/S, 10/F]*

Initial investment = Rs. 10,00,000
Annual revenues = Rs. 2,40,000

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Annual cost = Rs. 60,000
Useful life year = 10 years
MARR = 10%

Solution:
Using PW formulation,

$$PW(i\%) = -I + (R - E)(P/A, i\%, N)$$
$$= -10,00,000 + (240,000 - 60,000) \times (P/A, i\%, 10)$$
$$= -10,00,000 + 1,80,000\ (P/A, i\%, 10)$$

IRR is that rate which makes PW = 0

$$PW = -10,00,000 + 1,80,000\ (P/A, i'\%, 10) = 0$$

If i'% = 10%

$$PW = -10,00,000 + 1,80,000 \times 6.1446 = \text{Rs. } 1,06,028\ (+ve)$$

If i'% = 13%

$$PW = -10,00,000 + 1,80,000 \times 5.4262 = \text{Rs. } -23,284\ (-ve)$$

Now,

$$IRR = i_1'\% + \frac{PW_1}{PW_1 - PW_2} \times (i_2' - i_1')\%$$
$$= 10\% + \frac{1,06,028}{1,06,028 + 23,284} \times (13 - 10)\%$$
$$= 10\% + 2.46\%$$

$\therefore$ IRR = 12.46%

Since IRR (12.46%) > MARR (10%), the project is feasible.

Unrecovered investment calculation in table:

EOY	Cash flow	Unrecovered investment		Unrecovered investment (revenue-expenses)
		Beginning of year	EOY @ 12.46%	
0	-10,00,000	- 10,00,000	-10,00,000	- 10,00,000
1	1,80,000	- 10,00,000	- 1124600	- 9,44,600
2	1,80,000	- 9,44,600	- 10,62,298	- 8,82,298
3	1,80,000	- 8,82,298	- 9,92,232	- 8,12,232
4	1,80,000	- 8,12,232	- 9,13,436	- 7,33,436
5	1,80,000	- 7,33,436	- 8,24,822	- 6,44,822
6	1,80,000	- 6,44,822	- 7,25,167	- 5,45,167
7	1,80,000	- 5,45,167	- 6,13,095	- 4,33,095
8	1,80,000	- 4,33,095	- 4,87,058	- 3,07,058
9	1,80,000	- 3,07,058	- 3,45,318	- 1,65,318
10	1,80,000	- 1,65,318	- 1,85,916	-5,916

Hence, unrecovered investment is Rs. 5916. (Draw investment balance diagram as previous question)

(ii)

17. Determine the IRR of the following project. Also present unrecovered investment balance in graph and table. [15/F]

Initial investment = Rs. 1,50,000
Life span = 5 yrs.
Annual revenue = Rs. 5,000
Annual cost = Rs. 3,000
Salvage value = Rs. 2,000
MARR = 8%

Solution:

N = 5 years
I = Rs. 1,50,000
S = Rs. 2,000
MARR = 8% per year
AR = Rs. 5,000
AE = Rs. 3,000

Using PW formulation,

$$PW = -1,50,000 + (5,000 - 3,000)(P/A, i\%, 5) + 2,000 \times (P/F, i\%, 5)$$
$$PW(10\%) = -150,000 + 2,000\ (P/A, i\%, 5) + 2,000 \times (P/F, i\%, 5)$$

IRR is that rate which makes PW = 0

$$PW = -1,50,000 + 2,000\ (P/A, i\%, 5) + 2,000 \times (P/F, i\%, 5) = 0$$

Let i' = 10%

$$PW(10\%) = -150,000 + 2,000 \times 3.7908 + 2,000 \times 0.6209$$
$$= \text{Rs. } -1,41,176\ (-ve)$$

Let i' = 7%

$$PW\ (7\%) = -1,50,000 + 2,000 \times 4.1002 + 2,000 \times 0.7130$$
$$= \text{Rs. } -1,40,370\ (-ve)$$

Let, i' = 1%

$$PW\ (1\%) = -1,50,000 + 2,000 \times 4.8534 + 2,000 \times 0.9515$$
$$= \text{Rs. } -1,38,390\ (-ve)$$

Since, the investment is very high comparative to the annual revenue and salvage value. So, PW(i%) is always negative. *i.e.*, question should be corrected to get IRR.

18. Find simple and discounted payback periods and justify investment with the given cash flow information. [15/F, 17/F]

Initial investment = Rs. 4,00,000
Annual revenue = Rs. 1,50,000
Annual cost = Rs. 30,000
Annual life = 5 year
Annual MARR = 10%
Salvage value = Rs. 1,00,000

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Solution:

I = Rs. 4,00,000
AR = Rs. 1,50,000
AE = Rs. 30,000
S = Rs. 1,00,000
MARR = 10%
N = 10%

i) Simple payback method:

Year	Net cash flow (Rs.)	Cumulative cash flow (Rs.)
0	- 4,00,000	- 4,00,000
1	1,20,000	- 2,80,000
2	1,20,000	- 1,60,000
3	1,20,000	- 40,000
4	1,20,000	80,000
5	2,20,200	3,00,000

Net cash flow = R – E
= 150,000 – 30,000
= 1,20,000

Hence, cumulative cash flow turns to be positive in period 4. Thus, payback period lies between period 3 and 4. By interpolating,

$$\theta = 3 + \frac{40,000}{1,20,000}$$

$\therefore$ $\theta = 3.33$ years

ii) Discounted payback period:

Year	Net cash flow, F	Cumulative cash flow into present @ 10%; P	Cumulative cash flow
0	- 4,00,000	- 4,00,000	- 4,00,000
1	120,000	1,09,091	- 2,90,909
2	1,20,000	99,174	- 1;91,735
3	1,20,000	90,158	- 1,01,577
4	1,20,000	81,961	- 19,616
5	2,20,000	136,603	1,43,987

1,20,000

$PW = F(1 + i)^{-N}$

$PW_1 = 1,20,000\ (1 + 0.10)^{-1}$ = Rs. 1,09,091

$PW_2 = 1,09,091\ (1 + 0.10)^{-2}$ = Rs. 99,174

$PW_3 = 99,173.55\ (1 + 0.10)^{-3}$ = Rs. 90,158

$PW_4 = 90,152.77\ (1 + 0.10)^{-4}$ = Rs. 81,961

$PW_5 = 2,20,000\ (1 + 0.10)^{-5}$ = Rs. 1,36,603

$\therefore$ Hence, discounted payback period $= 4 + \frac{19,616}{1,36,603}$

$\theta' = 4.144$ years

Since the investment is recovered with the given life span, the project is feasible.

any one method use.

19. **Determine conventional and modified B/C ratio for the given projects if interest rate is 11%.** **[11/F, 13/S,17/S]**

Investment = Rs. 10,000
Life of project = 8 year
Annual benefits = Rs. 4,600
Annual cost = Rs. 3,000
Salvage value = Rs. 2,500

AW use (short cut)

Solution:

I = Rs. 10,000
N = 8 year
AB = Rs. 4,600
AE = Rs. 3,000
S = Rs. 2,500

Using annual worth method,

AW (I) = 10,000 × (A/P, 11%, 8)
= 10,000 × 0.1943
= Rs. 1943

AW (B) = Rs. 4,600

AW (O and M) = Rs. 3,000

AW (S) = Rs. 2,500 × (A/F, 11%, 8)
= 2,500 × 0.0843
= Rs. 210.75

$$\text{Conventional BCR} = \frac{\text{AW (B)}}{\text{AW (I)} - \text{AW (S)} + \text{AW (O and M)}}$$

$$= \frac{4,600}{1,943 - 210.75 + 3,000}$$

$= 0.972 < 1$

$$\text{Modified BCR} = \frac{\text{AW (B)} - \text{AW (O and M)}}{\text{AW (I)} - \text{AW(S)}}$$

$$= \frac{4,600 - 3,000}{1,943 - 210.75}$$

$= 0.924 < 1$

Since, B/C ratio < 1, reject the project

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20. Evaluate IRR of the following project, identify whether the project is feasible or not 13/F, 12/F

Initial investment = Rs. 25,000

Annual revenue = Rs. 8,000

Salvage value = Rs. 5,000

Useful life = 5 years

MARR = 20%

Solution:

PW = – 25,000 + 8,000 (P/A, i%, 5) + 5,000 (P/F, i%, 5)

IRR is that rate which makes PW =0

Let, i' = 20%

PW (20%) = – 25,000 + 8,000 × 2.9906 + 5,000 × 0.4019 = Rs. 934 (+ ve)

Let, i' = 21%

PW (21%) = –25,000 + 8,000 × 2.9259 + 5,000 × 0.3855 = Rs. 334 (+ve)

Let, i' = 22%

PW (22%) = –25,000 + 8,000 × 2.8634 + 5,000 × 0.3699 = Rs. –243.30(–ve)

$$\text{So, IRR} = 21\% + \frac{334}{334 + 243.30} \times (22 - 21)\% = 21\% + 0.5786\%$$

∴ IRR = 21.5786%

Since IRR (21.578%) > MARR (20%) so, the project is feasible.

21. **Find both types of B/C ratio using AW formulation of the following projects and find whether the project is feasible or not.** **[14/S, 12/F]**

Initial investment = Rs. 5,00,000

Annual revenue = Rs. 80,000

Salvage value = Rs. 10,000

Life = 20 years

MARR = 10%

Annual O and M = Rs. 15,000

Solution:

AW (I) = 5,00,000 (A/P, 10%, 20)

= 5,00,000 × 0.1175

= Rs. 58,750

AW (B) = Rs. 80,000

AW (S) = 10,000 (A/F, 10%, 20)

= 10,000 × 0.0175

= Rs. 175

AW (O and M) = Rs. 15,000

$$\text{Conventional BCR} = \frac{80,000}{58,750 - 175 + 15,000} = 1.087 > 1$$

And,

$$\text{Modified BCR} = \frac{80,000 - 15,000}{58,740 - 175} = 1.1096 > 1$$

Since, BCR is greater than 1, the project is feasible.

22. **A multipurpose hydroelectric project under consideration of the government, whose estimated benefits and costs expected to be derived from the project are listed as.** **[18/S]**

End of year	Annual cash flow (Rs.)
Initial cost	18,00,00,000
Annual power sales	1,20,00,000
Annual flood control saving	50,00,000
Annual irrigation benefits	80,00,000
Annual recreation benefits	40,00,000
Annual O and M costs	50,00,000

Suggest, based on B/C ratio, the government about implementing the project for 40 years. MARR = 15%

Solution:

I = Rs. 18,00,00,000

AR = 1,20,00,000 + 50,00,000 + 80,00,000 + 40,00,000

= Rs. 2,90,00,000

AE = 50,00,000

N = 40 years

MARR = 15%

PW (B) = 2,90,00,000 × (P/A, 15%, 40)

= 2,90,00,000 × 6.6418

= Rs. 19,26,12,200

PW (O and M) = 50,00,000 (P/A, 15%, 40)

= 50,00,000 × 6.6418

= Rs. 3,32,09,000

Now,

$$\text{Conventional BCR} = \frac{19,26,12,200}{18,00,00,00 + 3,32,09,000 - 0} = 0.904 < 1$$

And

$$\text{Modified BCR} = \frac{19,26,12,200 - 3,32,09,000}{18,00,00,000 - 0} = 0.886 < 1$$

Since, B/C ratio smaller than 1, it is not feasible to implement this project for 40 years.

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23. An investment of Rs. 100,000 can be made in a project that will produce uniform annual revenue of Rs. 62,100 for 5 years and then have a market salvage value of Rs. 20,000. Annual expenses will be Rs. 30,000 each year. Company accepts project that earns 10% or more, evaluate IRR of this project and suggest whether the project is feasible or not? Also draw an investment balance diagram. [18/S]

Solution:

I = Rs. 1,00,000

AR = Rs. 62,100 per year

N = 5 year

S = Rs. 20,000

AE = Rs. 30,000 per year

MARR = 10%

We know,

Using PW formulation,

$$PW = -1,00,000 + (62,100 - 30,000)(P/A, i\%, 5) + 20,000 \times (P/F, i'\%, 5)$$

IRR is that rate which makes PW = 0

$$PW = -1,00,000 + 32,100\,(P/A, i\%, 5) + 20,000 \times (P/F, i'\%, 5) = 0$$

If i' = 10%,

$$PW\,(10\%) = -1,00,000 + 32,100 \times 3.7908 + 20,000 \times 0.6209$$
$$= \text{Rs. } 34,102.68$$

If i' = 15%

$$PW\,(10\%) = -1,00,000 + 32,100 \times 3.7908 + 20,000 \times 0.6209$$
$$= \text{Rs. } 34,102.68$$

If i' = 15%

$$PW\,(15\%) = -1,00,000 + 32,100 \times 3.3522 + 20,000 \times 0.4972$$
$$= \text{Rs. } 17,549.62$$

If i' = 20%

$$PW\,(20\%) = -1,00,000 + 32,100 \times 2.9906 + 20,000 \times 0.4019$$
$$= \text{Rs. } 4036$$

If i' = 21%

$$PW\,(21\%) = -1,00,000 + 32,100 \times 2.9259 + 20,000 \times 0.3855$$
$$= \text{Rs. } -686.86\ (-ve)$$

$$\therefore\ IRR = i'_1 + \frac{PW_1}{PW_1 - PW_2} \times (i'_2 - i'_1)$$

$$= 21 + \frac{1,631.39}{1,631.39 + 686.86} \times (22 - 21)$$

$$= \text{Rs. } +1,631.39\ (+ve)$$

If i' = 22%

$$PW\,(22\%) = -1,00,000 + 32,100 \times 2.8634 + 20,000 \times 0.3699$$
$$= \text{Rs. } -686.86\ (-ve)$$

$$\therefore\ IRR = i'_1 + \frac{PW_1}{PW_1 - PW_2} \times (i'_2 - i'_1)$$

$$= 21 + \frac{1,631.39}{1,631.39 + 686.86} \times (22 - 21)$$

$$= 21 + 0.7037$$

$$= 21.703\%$$

Since, MARR (10%) < IRR (21.703%), the project is feasible.

Unrecovered investment calculation in tabular form:

EOY	Cash flow	Unrecovered investment		Unrecovered investment (Revenue – Expenses)
		Beginning of year	EOY @ 21.70%	
0	1,00,000	–	– 1,00,000	– 1,00,000
1	32,100	– 1,00,000	– 1,21,700	– 89,600
2	32,100	– 89,600	– 1,09,043	– 76,943.20
3	32,100	– 76,943.20	– 93,640	– 61,540
4	32,100	– 61,540	– 74,894.18	– 42,794.18
5	52,000	– 42,794.18	– 52,080	– 80

Unrecovered balance diagram at IRR = 21.703%

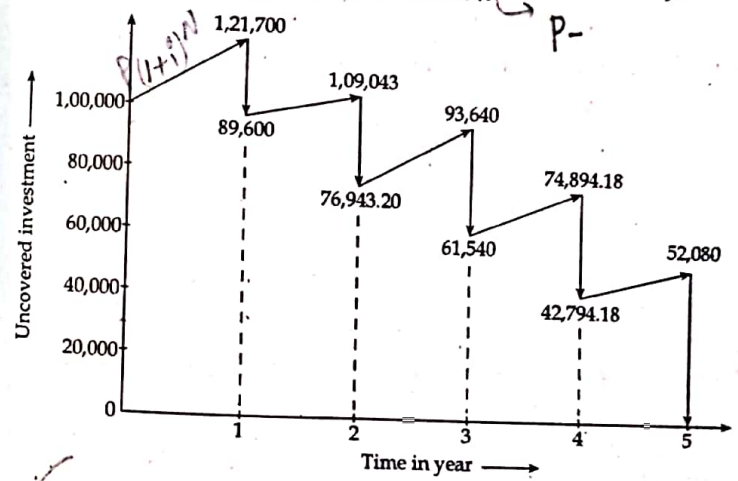

Fig: Investment Balance diagram.

24. Evaluate the following project by the simple payback period, present worth and future worth method. The cash flow of the project are as follows: If the MARR is 12% per year. [16/F, 17/F]

End of year	Net cash flow (Rs.)
0	- 700
1	- 400
2	125
3	200
4	800
5	220
6	320

Solution: **Simple payback method:**

EOY	Net cash flow	Cumulative cash flow
0	- 700	- 700
1	- 400	- 1,100
2	125	-975
3	200	-775
4	800	25
5	220	245
6	320	565

Simple payback period

$$\theta = 3 + \frac{775}{800} = 3.968 \text{ years}$$

Since, payback period is within the useful life, this project is feasible.

Present worth method:

$\therefore$ PW (12%) = -700 + (- 400 (1.12)$^{-1}$ + 125(1.12)$^{-2}$ +200 (1.12)$^{-3}$ + 800 (1.12)$^{-4}$ + 220 (1.12)$^{-5}$ + 320 (1.12)$^{-6}$

= Rs. - 19.767

$\therefore$ FW (12%) = PW (F/P, 12%, 6)

= -19.767 × 1.9376

= Rs. - 38.31

Case

25. Evaluate IRR of the following and identify whether the project is feasible or not. **[16/F]**

(VI)

Initial investment = Rs. 6,00,000

Annual revenue = Rs. 2,50,000

Annual cost = Rs. 50,000

Useful life = Rs. 10 years

MARR = 10% per year

Repair and maintenance at 4th and 8th year = Rs. 30,000

Case

Solution:

Using PW formulation,

PW = - 6,00,000 +(2,50,000 - 50,000) (P/A, i%, 10) - 30,000 × (P/F, i%, 8) - 30,000 (P/F, i%, 4)

IRR is that rate which makes PW = 0

PW = -6,00,000 + 2,00,000 (P/A, i'%, 10) - 30,000 (P/F, i%, 8) - (P/F, i%,4) = 0

If i' = 10%

PW (10%) = -6,00,000 + 2,00,000 × 6.1446 - 30,000 × 0.4665 - 30,000 × 0.6830

= Rs. 5,94,435

If I' = 30%

PW (30%) = -6,00,000 + 2,00,000 × 3.0915 - 30,000 × 0.0943 - 30,000 × 0.3501

= Rs. 4,968 (+ve)

If i' = 35%

PW (35%) = -6,00,000 + 2,00,000 × 2.7150 - 30,000 × 0.0906 - 30,000 × 0.3011

= Rs. - 68,751 (-ve)

Thus,

$$IRR = i_1' + \frac{PW_1}{PW_1 - PW_2} \times (i_2' - i_1')$$

$$= 30 + \frac{4,968}{4,968 + 68,751} \times (35 - 30)$$

$$= 30 + 0.3369 = 30.336\%$$

Since, IRR (30.336%) > MARR (10%), the project is feasible.

ERR

26. Find IRR, MIRR, discounted payback period of the following project (assume MARR = 10%) **[16/S]**

Year	0	1	2	3	4	5
Amt (Rs)	15,000	1,000	2,000	4,000	5,000	8,000

Solution:

i) IRR:

Using PW formulation:

PW = -15,000 + 10,00 (P/F, i%, 1) + 2,000 (P/F, i%, 2) + 4,000 × (P/F, i%, 3) + 5,000 (P/F, i%, 4) + 8,000 (P/F, i%, S)

IRR → PW (i%) = 0

or; - 15,000 + 1,000 (P/F, i' 1) + 2,000 (P/F, i'%, 2) + 4,000 (P/F, i'%, 3) + 5,000 (P/F, i'%, 4) + 8,000(P/F, i'%, 5) = 0

If i' = 10%

PW(10%) = - 15,000 + 1,000 × 0.9091 + 2,000 × 0.8264 + 4,000 × 0.7513 + 5,000 × 0.6830 + 8,000 × 0.6209

= Rs. - 1050.50

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If i = 8%

PW (8%) = Rs. – 46.50 (–ve)

If i = 7%

PW (7%) = Rs. 465.10 (+ve)

Hence,

$$IRR = 7\% + \frac{465.10}{465.10 + 46.50} \times (8 - 7)\% = 7\% + 0.909$$

$\therefore$ IRR = 7.909%

ii) MIRR/ERR

Discounting all the cash outflows to present time at $\in$ = 15% (assume E_C = 15%)

= 15,000

ΣE_C = Rs. 15,000

Compounding all the cash inflows to future time at $\in$ = 15%

= 1,000 (F/P, 15%, 4) + 2,000 (F/P, 15%, 3) + 4,000 (F/P,15%, 2) + 5,000 (F/P, 15%, 1) + 8,000

= 1,000 × 1.7490 + 2,000 × 1.5209 + 4,000 × 1.3225 + 5,000 × 1.1500 + 8,000

$\therefore$ ΣR_C = Rs. 23,830.80

We have,

ΣE_C (F/P, i'% 5) = 23830.80

or, 15,000 × (F/P, i'% 5) = 23,830.80

or, 15,000 × $(1 + i'\%)^5$ = 23,830.80

or, $(1 + i')^5 = 1.5887$

or, 1 + i' = 1.0970

$\therefore$ i' = 0.09700

$\therefore$ ERR → i'% = 9.70%

iii) Discounted payback period:

EOY	Net cash flow, F	Discounted cash flow into present @ 10%, PW	Cumulative cash flow
0	– 15,000	– 15,000	– 15,000
1	1,000	909.09	– 14,090.90
2	2,000	1,652.89	– 12,438.00
3	4,000	3,005.25	– 9,433
4	5,000	3415	– 6,018
5	8,000	4967	– 1,051

Here, PW = F $(1 + i)^{-N}$

Since, the investment amount is not recovered within the given time, discounted payback period cannot be calculated.

(VI)

27. Pokhara photocopy center is considered to purchase a new photocopy machine costing Rs. 1,00,000 and expected salvage value Rs. 30,000 at the end of 10th year. The machine will save Rs. 20,000 by consuming electricity of Rs. 6,000 per year. Find IRR and interpret your result when MARR is 8% per year. [17/F]

Solution: → Decision (feasible or not)

Investment (I) = Rs. 1,00,000

Salvage value (S) = Rs. 30,000

No. of year (N) = 10 years

Annual revenue (R) = Rs. 20,000

Annual expenses (E) = Rs. 6,000

MARR = 8% per year

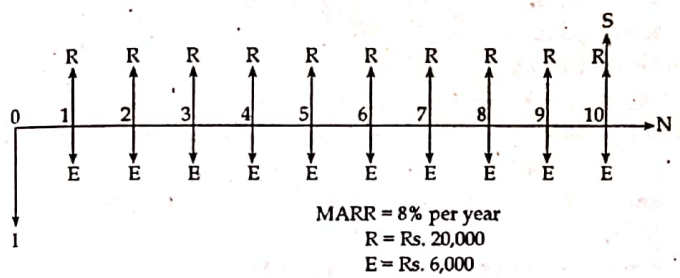

Fig: Cash flow diagram.

We know,

Setting the given information into PW formulation,

PW = – 100,000 + (20,000 – 6000) (P/A, i%, N) + 30,000 × (P/F, i%, N)

IRR is that rate which makes PW = 0,

PW = –1,00,000 + 14,000 (P/A, i'%, 10) + 30,000 × (P/F, i'%, 10)

If i' = 10%

PW = – 1,00,000 + 14,000 × 6.1446 + 3,000 × 0.3855 = Rs. – 2,410.6

If i' = 9%

PW (9%) = – 1,00,000 + 14,000 × 6.4177 + 30,000 × 0.4224 = Rs. 2,519.80

Now,

$$IRR = 9\% + \frac{2,519.80}{2,519.80 + 2,410.6} \times (10 - 9)\%$$

= 9% + 0.5110%

= 9.5110%

Since, IRR (9.5110%) > MARR 8%), hence the purchase of photocopy machine is feasible.

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A company is investing the purchase of new equipment. Interest rate is 9% per year. The cash flow for the equipment is as follows: Initial investment is Rs. 50,000, annual operating cost Rs. 2,000 annual income Rs. 9,000 and salvage value Rs. 10,000, life 10 years

i) Is the investment worth under taking?

ii) What should be the minimum annual benefit for making if a worthy of investment at 9% rate of return? [17/F]

MARR

Solution:

Interest rate = 9% per year

I = Rs. 50,000

AR = Rs. 9,000

AE = Rs. 2,000

S = Rs. 10,000

N = 10 years

Using PW formulation,

PW (i%) = – I + (R – E) (P/A, i%, N) + S(P/F, i%, N)

PW (i%) = 50,000 + (9,000 – 2000) (P/A, 9%, 10) + 10,000 × (P/F, 9%,10)

= Rs. –852.10

i) **Since, PW (9%) < 0, this investment is not worth undertaking**

OR

Or,

For making the project worthy investment,

i.e., PW (i%) ≥ 0

IRR method

According to question, given annual benefit is

Rs. (9,000 – 2000) = Rs. 7,000

IRR is that rate which makes PW = 0

PW = –50,000 + 7,000 (P/A, i'%, 10) + 10,000 (P/F, i'%,10) = 0

If i' = 10%

PW (10%) = –50,000 + 7,000 × 6.1446 + 10,000 × 0.3855

= Rs. –3,132.80

If i' = 9%

PW (9%) = –50,000 + 7,000 × 6.4177 + 10,000 × 0.4224

= Rs. – 852.10 (–ve)

If I' = 8%

PW (8%) = 50,000 + 7,000 × 6.7101 + 10,000 × 0.4632

= Rs. 1,602 (+ve)

So,

$$IRR = 8\% + \frac{1,602}{1,602 + 852.10} \times (9 - 8)\%$$

= 8% +0.652%

∴ IRR = 8.652%

Since, IRR (8.652) < MARR (9%), project is not feasible

ii) **For minimum benefit annually (B)**

PW (9%) = –50,000 + B (P/A, 9%, 10) + 10,000 (P,F, 9%, 10)

or, 0 = –50,000 + B × 6.4177 + 10,000 × 0.4224

or, 45,776 = B × 6.4177

∴ B = Rs. 7,132.7735

B = R – E → Revenue → benefit

Hence, minimum annual benefit should be Rs. 7132.7735.

29. **Find IRR and unrecovered value.** [17/S]

Investment = Rs. 2,50,000

Salvage value = Rs. 50,000

Net annual revenue = Rs. 70,000

No. of years = 5

VIII

Solution:

I = Rs. 2,50,000

S = Rs. 50,000

N = 5 years

R = Rs. 70,000

Let, MARR = 10%

We have,

Using PW setting

PW = –250,000 + 70,000 (P/A, i%, 5) + 50,000 (P/F, i%, 5)

IRR is that rate which makes PW = 0,

or, PW = –250,000 + 70,000 (P/A, i'%, 5) + 50,000 (P/F, i'%, 5) = 0

If i' = 10%

PW (10%) = –2,50,000 + 70,000 × 3.7908 + 50,000 × 0.6209 = Rs. 46,401

If i' = 13%

PW (13%) = –2,50,000 + 70,000 × 3.5172 + 50,000 × 0.5428 = Rs. 23,344 (+ve)

If i' = 16%

PW (16%) = –2,50,000 + 70,000 × 3.2743 + 50,000 × 0.4761 = Rs. 3,006 (+ve)

If i' = 18%

PW (18%) = –2,50,000 + 70,000 × 3.1272 + 50,000 × 0.4371 = Rs. –9,241 (–ve)

So,

$$IRR = 16\% + \frac{3,006}{3,006 + 9,241} \times (18 - 16)\% = 16\% + 0.4908\%$$

∴ IRR = 16.50%

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Unrecovered value:

EOY	Cash flow	Unrecovered investment: Beginning of year, P	Unrecovered investment: EOY @ 16.50% F	Unrecovered investment (revenue – expenses)
0	-2,50,000	-	- 250,000	- 2,50,000
1	70,000	- 2,50,000	- 2,91,250	- 2,21,250
2	70,000	- 2,11,250	- 2,57,756	- 1,87,756
3	70,000	- 1,87,756	- 2,18,736	- 1,48,735
4	70,000	- 1,48,735	- 1,73,276	- 1,03,276
5	1,20,000	- 1,03,276	- 1,20,317	- 316

Hence, unrecovered value is Rs. 316

$\therefore$ $F = P(1+i)^N$

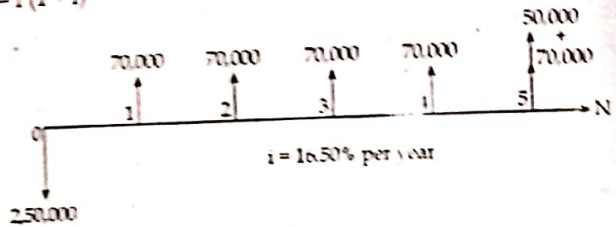


Fig: Cash flow diagram.

30. A project has the following cash flow: [17/5]

Years	Cash flows (Rs.)
0	- 500
1	+ 202
2	- X
3	196
4	350
5	451

MARR = 10%, ERR = 14.14%, find the value of X.

Solution:

ERR = 14.14% = i'%

MARR = 10%

Assume, $\epsilon = 12\%$

Discounting all cash flows to year zero at $\epsilon = 12\%$

$= 500 + x\,(P/F, 12\%, 2)$

$= 500 + x\,(1 + 0.12)^{-2}$

$\Sigma E_c = 500 + x \times 0.7972$

Compounding all cash inflows to year 5 at 12%

$= 202\,(1.12)^{+4} + 196\,(1.12)^{+2} + 350\,(1.12)^{1} + 451$

$\Sigma R_c = 1{,}406.70$

Establishing the economic equivalence of the two equation at i%,

or, $\Sigma E_c\,(F/P, i'\%, N) = \Sigma R_c$

or, $(500 + x \times 0.7972) \times (F/P, i'\%, 5) = 1{,}406.70$

or, $(500 + x \times 0.7972) \times 1.9373 = 1{,}406.70$

or, $500 \times 1.9373 + x \times 0.7972 \times 1.9373 = 1{,}406.70$

or, $x \times 1.5444 = 1{,}406.70 - 968.633$

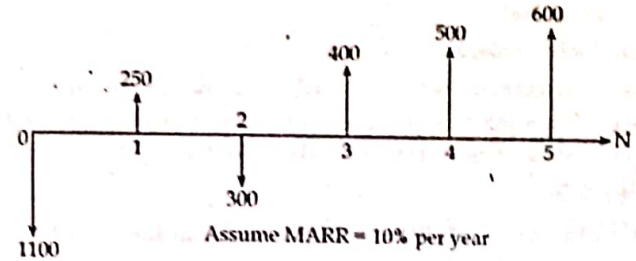
$\therefore$ $x = 284$

Hence, the value of x is Rs. 284.

31. Calculate both IRR and ERR of the following cash flow. Explain why these values are different. [18/T]

Year	0	1	2	3	4	5
Cash flow	- 1,100	250	- 300	400	500	600

Solution:



i) IRR:

Using PW formulation,

$PW = -1100 + 250\,(P/F\,i\%, 1) - 300\,(P/F, i\%, 2) + 400 \times (P/F, i\%, 3) + 500\,(P/F, i\%, 4) + 600\,(P/F, i\%, 5)$

IRR is that rate which makes PW = 0

If i = 10%

$PW\,(10\%) = -1100 + 250 \times 0.9090 - 300 \times 0.8264 + 400 \times 0.7513 + 500 \times 0.6830 + 0.6209 \times 600$

$= -106.11$ (-ve)

If i = 8%

PW (8%) = -31.225 (-ve)

If i = 7%

PW (7%) = 7.315 (+ve)

Hence, IRR lies between 7% and 8%

$$IRR = 7\% + \frac{7.315}{7.315 + 31.225} \times (8 - 7)\% = 7\% + 0.1898\% = 7.189\%$$

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Discounting all cash duff laws to year zero at ∈ = 12%

= 1,100 + 300 (P/F, 1%, N)

= 1,100 + 300 (P/F, 12, 2)

= 1,100 + 300 × 0.7972

ΣE_c = Rs. 1,339.16

Compounding all cash outflow to year 5 at ∈ = 12%

ΣR_c = 250 (F/P, 12%, 4) + 400 (F/P, 12%, 2) + 500 × (F/P, 12%, 1) + 600

ΣR_c = Rs. 2,055.14

We have,

ERR ⇒ ΣE_c (F/P, i'%, N) = ΣR_c

or, 1,339.16 × (F/P, i'%, 5) = 2,055.14

or, $(1 + i')^5 = 1.5347$

or, $(1 + i') = \sqrt[5]{1.5347}$

or, i' = 1.0894 − 1

∴ i'% = 8.944%

Hence, ERR = 8.944%

When the algebraic sign of the cash flow changes more than once in the series, it is possible to obtain multiple rates of return and in IRR the reinvestment assumption is taken. So, the value of IRR and ERR are different.

32. Find both types of BCR using FW formulation where initial investment is Rs. 5,00,000, annual income is Rs. 100,000 and decrease by Rs. 10,000 per year; annual cost is Rs. 20,000 and increases by Rs. 2,000 per year; useful life = 10 years and salvage value is Rs. 1,50,000 Marr = 11%. [18/F]

Solution:

MARR = 11%

I = Rs. 5,00,000

AR = Rs. 1,00,000

AE = Rs. 20,000

Annual income decreases by Rs. 10,000 per year

Annual cost increases by Rs. 2,000 per year

S = Rs. 150,000

We have,

$PW(B) = 1,00,000\,(1.11)^{-1} + 90,000\,(1.11)^{-2} + 80,000\,(1.11)^{-3} + 70,000\,(1.11)^{-4} + 60,000\,(1.11)^{-5} + 50,000\,(1.11)^{-6} + 40,000 \times (1.11)^{-7} + 30,000\,(1.11)^{-8} + 20,000\,(1.11)^{-9} + 10,000\,(1.11)^{-10}$

$= 90,090.09 + 73,046.02 + 58,495.31 + 46,111.16 + 35,607.08 + 26,732.04 + 19,266.3 + 13,017.18 + 7,818.50 + 3,521.8$

= Rs. 3,73,703.

Or, Using gradient formula,

PW (B) = 1,00,000 (P/A, 11%, 10) − 10,000 (P/G, 11%, 10)

= 1,00,000 × 5.88992 − 10,000 × 21.5217

= Rs. 3,73,703

PW (I) = Rs. 5,00,000

PW (S) = 1,50,000 × (P/F, 11%, 10) = 1,50,000 × 0.3552 = Rs. 53,280

PW (O and M) = 20,000 (P/A, 11%, 10) + 2,000 (P/G, 11%, 10)

= 20,000 × 5.8892 + 2,000 × 21.5217 = Rs. 1,60,827.40

Now,

$$\therefore \text{Conventional BCR} = \frac{PW(B)}{PW(I) - PW(S) + PW(O \text{ and } M)}$$

$$= \frac{3,73,703}{5,00,000 - 53,280 + 1,60,827.40}$$

$$= \frac{3,73,703}{5,00,000 - 53,280 + 1,60,827.40}$$

$$= 0.615$$

$$\therefore \text{Modified BCR} = \frac{PW(B) - PW(O \text{ and } M)}{PW(I) - PW(S)}$$

$$= \frac{3,73,703 - 160827.40}{5,00,000 - 53,280}$$

$$= 0.476$$

Using FW:

FW (S) = Rs. 1,50,000

FW (I) = 5,00,000 × (F/P, 11%, 10) = 5,00,000 × 2.8394 = 14,19,700

FW (B) = 1,00,000 (F/A, 11%, 10) − 10,000 (F/G, 11%, 10)

$$= 1,00,000 \times 16.7220 - \left[\frac{10,000}{i}(F/A, 11\%, 10) - \frac{NG}{i}\right]$$

$$= 16,72,200 - \frac{10,000}{0.11} \times 16.7220 + \frac{10 \times 10,000}{0.11}$$

FW (B) = Rs. 10,61,110

FW (O and M) = 20,000 (F/A, 11%, 10) + 2,000 (F/G, 11%, 10)

$$= 20,000 \times 16.7220 + \left[\frac{2,000}{0.11} \times 16.7220 - \frac{10 \times 2,000}{0.11}\right]$$

= 3,34,440 + 3,04,036 − 1,81,818

= Rs. 4,56,658

$$\text{Now, Conventional BCR} = \frac{10,61,110}{14,19,700 - 1,50,000 + 4,56,658} = 0.615$$

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And. Modified BCR = $\frac{10,61,110 - 456,658}{14,19,700 - 1,50,000} = 0.476.$

33. Calculate the simple payback period and discounted payback period from the following cash flows, if MARR = 12%. [12/S]

EOY	Net cash flow
0	- 1000
1	- 500
2	0
3	200
4	1,200
5	220
6	320

Solution: Simple payback period:

EOY	Net cash flow	Cumulative cash flow
0	- 1,000	- 1,000
1	- 500	- 1,500
2	0	- 1,500
3	200	- 1,300
4	1,200	-100
5	220	120
6	320	440

Here, cumulative cash flow turns to positive in period 5. Hence, payback period lies between 4 and 5.

$$\theta = 4 + \frac{100}{220} = 4.46 \text{ years.}$$

Discounted payback period:

EOY	Net cash flow, F	Discounted cash flow into present @ 12%, P	Cumulative cash flow
0	- 1,000	- 1,000	- 1,000
1	- 500	- 446.43	- 1,446.43
2	0	0	- 1,446.43
3	200	142.36	- 1,304.07
4	1,200	762.63	- 541.44
5	220	124.84	- 416.60
6	320	162.12	- 254.48

Cumulative cash flow does not turn to positive value in given time period. Hence, discounted payback period cannot be obtained.

ADDITIONAL PROBLEMS

1. Explain the factors affecting the determination of MARR.

Ans: Factors affecting the determination of MARR are:

i. The amount of money available for investment and the source and the cost of these funds.

ii. The number of good projects available for investment. *i.e.*, greater number of projects leads greater alternatives.

iii. The conscious risks which is associated with investment opportunities. *i.e.*, risk level

iv. The purpose of investment alternatives and their financial attractiveness. *i.e.*, is project essential or elective?

v. The types of organization involved (*i.e.*, government, private or public). In general, government organizations provides less MARR than the private organizations.

2. What is the difference between financial and economic analysis?

S.N.	Financial analysis	Economic analysis
i.	Includes only project participants.	Includes all member of society.
ii.	Uses financial prices	Uses economic prices.
iii.	The main purpose of the financial analysis is to use the project cash flow forecast to calculate suitable net return indicators, particularly from market point of view of the investor.	The economic analysis appraises the project's contribution to the economic welfare of the region or country. It is made on behalf of the whole society instead of just the owners of the infrastructure, as in the financial analysis.
iv.	It provides financing plan for the proposed investment.	It provides information for the decision rule.
v.	Taxes, fees are included on cost side because these are financial cost.	Taxes, fees are excluded from cost and benefit side because these are transfer of resources for the economic growth.
vi.	Cost measurement is monetary cost.	Cost measurement is opportunity cost.

3. For the cash flow given at 10% interest, compute the value of 'C' for net amount equal to be zero at the end of 8 years

Year	1	2	3	4	5	6	7	8
Cash flow	0	- 100	- 200	- 300	0	c	c	c

$\Sigma F_w = 0$; at the end of 8 year

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$F_W = P(1+i)^N$

$F_W = 0$

Solution:

i = 10% per year

N = 8 year

Using FW formulation,

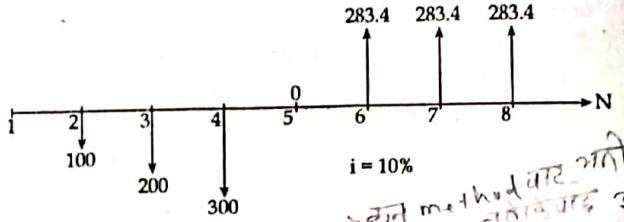
or, $0 - 100 \times (1.1)^6 - 200\,(1.1)^5 - 300\,(1.1)^4 + 0 + c(1.1)^2 + c \times (1.1)^1 + c = 0$

or, $0 - 177 - 322 - 439 + 0 + 1.21c + 1.1c + c = 0$

or, $3.31c = 938$

$\therefore$ $c = 283.4$

Hence the value of c is Rs. 283.4



→ दोनों method यहाँ आती
सामान्यतः उन्हें

4. Determine both types of B/C ratio from the following cash flow

use सिर्फ Pw, Aw & Fw

Initial investment = Rs. 3,00,000

Annual revenue = Rs. 85,000

Annual costs = Rs. 15,000

Salvage value = 20% of initial investment

Useful life = 6 years

MARR = 10% per year

Solution:

I = Rs. 30,000

R = Rs. 85,000

O and M = Rs. 15,000

MARR = 10%

N = 6 years

S = 20% of Rs. 3,00,000

= Rs. 60,000

Table or formula may be used

1 **PW formulation:**

PW (I) = Rs. 3,00,000

PW (B) = 85,000 (P/A, i%, 6)

= 85,000 (P/A, 10%, 6)

= 85,000 × 4.3553

= Rs. 3,70,200.50

PW(S) = 60,000 (P/F,10%, 6)

= 60,000 × 0.5645

= Rs. 33870

PW (O and M) = 15,000 (P/A, 10%, 6)

= 15,000 × 4.3553

= Rs. 65,329.50

Now,

$$\text{Conventional BCR} = \frac{\text{PW (B)}}{\text{PW (I)} - \text{PW (S)} + \text{PW (O and M)}}$$

$$= \frac{3,70,200.50}{3,00,000 - 33,870 + 65,329.50}$$

$= 1.11 > 1$

$$\text{and, Modified B/C ratio} = \frac{\text{PW (B)} - \text{PW (O and M)}}{\text{PW (I)} - \text{PW (S)}}$$

$$= \frac{3,70,200.50 - 65,329.50}{3,00,000 - 33,870}$$

$= 1.14 > 1$

2

AW formulation:

AW (I) = 3,00,000 (A/P, 10%, 6)

= 3,00,000 × 0.2296

= Rs. 68,880

AW (S) = S (A/F, i%, N)

= 60,000 × (A/F, 10%, 6)

= 60,000 × 0.1296

= Rs. 7776

AW (B) = Rs. 86,000

AW (O and M) = Rs. 15,000

Now,

$$\text{Conventional BCR} = \frac{\text{AW (B)}}{\text{AW (I)} - \text{AW (S)} + \text{AW (O and M)}}$$

$$= \frac{85,000}{68,880 - 7,776 + 15,000}$$

$= 1.11 > 1$

$$\text{Modified BCR} = \frac{\text{AW (B)} - \text{AW (O and M)}}{\text{AW (I)} - \text{AW (S)}}$$

$$= \frac{85,000 - 15,000}{68,880 - 7,776}$$

$= 1.14 > 1$

3

FW formulation:

FW (I) = 3,00,000 (F/P, 10%, 6)

= 3,00,000 × 1.7716

= Rs. 531,480

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FW (B) = 85,000 × (F/A, 10%, 6)
= 85,000 × 7.7156
= Rs. 655,826

FW (S) = Rs. 60,000

FW (O and M) = 15,000 (F/A, 10%, 6)
= 15,000 × 7.1156
= Rs. 115,734

$$\text{Conventional BCR} = \frac{\text{FW (R)}}{\text{FW (I)} - \text{FW (S)} + \text{FW (O and M)}}$$

$$= \frac{6,55,826}{5,31,480 - 60,000 + 1,15,734}$$

$$= 1.11 > 1$$

$$\text{Modified BCR} = \frac{\text{FW (B)} - \text{FW (O and M)}}{\text{FW (I)} - \text{FW (S)}}$$

$$= \frac{6,55,826 - 1,15,734}{5,31,480 - 60,000}$$

$$= 1.14 > 1$$

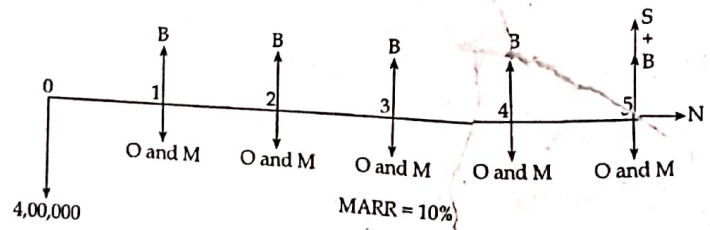
Since, BCR > 1, the investment is fruitful.

5. NEC is considering to purchase a new machine costing Rs. 4,00,000 having salvage value Rs. 1,00,000 at the end of 5th year. The use of machine will increase revenue by Rs. 1,50,000 that needs fuel cost of Rs. 30,000 per year. Find the following values when MARR = 10%

i) PW, FW and AW
ii) IRR
iii) BCR by PW
iv) Simple and discounted payback period

Solution:

I = Rs. 4,00,000
N = 5 year
B = Rs. 1,50,000 per year
O and M = Rs. 30,000 per year
MARR = 10% per year
S = Rs. 1,00,000



i) PW (10%) = –4,00,000 + (1,50,000 – 30,000) (P/A, 10%, 5)
+ 1,00,000 (P/F, 10%, 5)
= – 4,00,000 + 120,000 × 3.7908 + 1,00,000 × 0.6209
= Rs. 1,16,986

AW (10%) = –400,000 (A/P, 10% 5) + (1,50,000 – 30,000)
+ 1,00,000 (A/F, 10%, 5)
= –40,000 × 0.2638 + 1,20,000 + 1,00,000 × 0.1638
= Rs. 30,860

FW (10%) = –4,00,000 (F/P, 10%, 5) + 1,20,000 (F/A, 10%, 5) + 100,000
= –4,00,000 × 1.6105 + 1,20,000 × 6.1051 + 100,000
= Rs. 1,88,412

ii) Setting equation in PW formation

PW = –4,00,000 + 1,20,000 (P/A, i'%, 5) + 1,00,000 (P/F, i%, 5) = 0

Let, i% = 10%

PW(10%) = Rs. 1,16,986 (+ve)

Let, i% = 20%

PW(20%) = –4,00,000 + 1,20,000 × 2.9906 + 1,00,000 × 0.4019 = 0
= Rs. – 938 (–ve)

Let, i% = 19%

PW(20%) = –4,00,000 + 1,20,000 + 1,00,000 × 0.4019
= Rs. 8,812 (+ve)

Then,

$$\therefore \quad \text{IRR} = 19\% + \frac{8812}{8812 + 938} \times (20 - 21)\% = 19.90\%$$

iii) $$\text{Conventional BCR} = \frac{\text{PW (B)}}{\text{PW (I)} - \text{PW (S)} + \text{PW (O and M)}}$$

$$= \frac{5,68,620}{4,00,000 - 62090 + 113724}$$

$$= 1.25 > 1$$

$$\text{Modified BCR} = \frac{\text{PW (B)} - \text{PW (O and M)}}{\text{PW (I)} - \text{PW (S)}}$$

$$= \frac{5,68,620 - 1,13,724}{4,00,000 - 62,090}$$

$$= 1.35 > 1$$

iv) Simple payback period

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EOY	Net cash flow	Cumulative cash flow
0	– 4,00,000	– 4,00,000
1	1,20,000	– 2,80,000
2	1,20,000	– 1,60,000
3	1,20,00	–40,000
4	1,20,000	80,000
5	2,20,000	3,00,000

Hence,

$\therefore$ Simple payback period, $\theta = 3 + \frac{40,000}{1,20,000} = 3.34$ years

Now, Discounted cash flow:

EOY	Net cash flow	Discounted cash flow into present	cumulative cash flow
0	– 4,00,000	– 4,00,000	– 4,00,000
1	120,000	1,09,090.9	– 2,90,909,09
2	120,000	99,173.55	– 1,91,735.5
3	120,000	90,157.77	– 1,01,577.8
4	120,000	81,961.61	–19,316.08
5	2,20,000	1,36,602.70	1,16,986

Then,

$\therefore$ Discounted payback period $(\theta') = 4 + \frac{19,616.08}{1,36,602.70} = 4.15$ years.

6. **Check the feasibility of the following investment by using PW, AW and FW methods. What is the capital recovery amount of this project?**

I = Rs. 2,00,000
S = Rs. 50,000
N = 10 years
R = Rs. 50,000
E = Rs. 15,000
MARR = 10% per year

Solution:

PW (i%) = –I + (R – E) (P/A, i%, N) + S (P/F, i%, N)

or, PW (10%) = – 2,00,000 + (50,000 – 15,000) × (P/A, 10%, 10) + 50,000 (P/F, 10%, 10)

= – 2,00,000 + 35,000 × 6.1446 + 50,000 × 0.3855

= Rs. 34,336

$\therefore$ AW (i%) = PW (i%) × (A/P, i%, N)

AW (10%) = Rs. 34,336 × (A/P, 10%, 10)

= Rs. 34,336 × 0.1627

= Rs. 5,586.47

And,

FW (i%) = PW (i%) × (F/P, i%, N)

$\therefore$ FW (10%) = Rs. 34,336 × (F/P, 10%, 10)

= Rs. 34,336 × 2.5937

= Rs. 89,057.28

$\therefore$ Capital recovery = (I – S) (A/P, i%, N) + S (i%)

CR (10%) = R – E – AW

= Rs. (50,000 – 15,000 – 5,586.47)

= Rs. 29,413.53

Hence, project is feasible as PW, AW, FW and CR > O

7. **Evaluate the project on the basis of the PW method when the MARR is 10%**

Investment	**Rs. 1,50,000**
Salvage value	**Rs. 35,000**
Project life	**15 years**
Annual expenses	**Rs. 10,000**
Annual revenue	**Rs. 40,000**
Overhead cost at end of 5th year	**Rs. 25,000**
Overhead cost at end of 10th year	**Rs. 50,000**

Care

Solution:

I = Rs. 1,50,000
N = 15 year
S = Rs. 35,000
E = Rs. 10,000
R = Rs. 40,000
E_5 = Rs. 25,000
E_{10} = Rs. 50,000

We have,

PW (i%) = – I + (R – E) (P/A, i%, N) + S (P/ F, i%, N) – Es (P/F, i% 5) – E_{10} (P/F, i%,10)

Care

= – 1,50,000 + (40,000 – 10,000) (P/A, 10%, 15) + 35,000 × (P/F, 10%, 15) – 25,000 (P/F, 10%, 5) – 50,000 × (P/F, 10%, 10)

= –1,50,000 + 30,000 × 7.6061 + 35,000 × 0.2394 – 25,000 × 0.6209 – 50,000 × 0.3855

= –1,50,000 + 2,28,183 + 8,379 – 15,522.5 – 19,275

$\therefore$ PW (10%) = Rs. 51,764.50

And,

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FW (10%) = PW (10%) × (F/P, 10%, 15)
= Rs. 51,764.50 × 4.1772
= Rs. 2,16,231

Find both types of B/C ratio using FW formulation.
Initial investment = Rs. 2,00,000
Project life = 5 years
Salvage value = Rs. 50,000
Annual O and M costs = Rs. 20,000
MARR = 17%
Annual benefits = Rs. 50,000 at the end of year 1 and increasing by Rs. 25,000 each year for remaining years.

Solution:

FW (I) = 2,00,000 (F/P, 17%, 5)
FW (I) = 2,00,000 × 2.1930 = Rs. 4,38,489.60
FW (S) = Rs. 50,000
FW (O and M) = 20,000 (F/A, 17%, 5)
= 20,000 × 7.0144
= Rs. 1,40,288

FW (B) = Rs. 50,000 (F/A, 17%, 5) + 25,000 (F/G, 17%, 5)
= Rs. 50,000 × 7.0144 + 25,000 × 11.8494
= Rs. 3,50,720 + Rs. 2,96,235
= Rs. 6,46,955

Now,

$$\text{Conventional B/C ratio} = \frac{\text{FW (B)}}{\text{FW (I)} - \text{FW (S)} + \text{FW (O and M)}}$$

$$= \frac{6,46,955}{4,38,489.6 - 50,000 + 1,40,288}$$

= 1.23 > 1, project is accepted.

$$\text{Modified B/C ratio} = \frac{\text{FW (B)} - \text{FW (O and M)}}{\text{FW (I)} - \text{FW (S)}}$$

$$= \frac{6,46,955 - 1,40,288}{4,38,489.60 - 50,000}$$

= 1.31 > 1, project is accepted.

Chapter 5

COMPARATIVE ANALYSIS OF ALTERNATIVES

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5.1 COMPARING MUTUALLY EXCLUSIVE ALTERNATIVES HAVING SAME USEFUL LIFE BY PAYBACK PERIOD METHOD; EQUIVALENT WORTH METHOD; RATE OF RETURN METHOD AND BENEFIT COST RARIO METHOD

When the useful life of an alternative is equal to be selected study period, adjustments to the cash flows are not required. The most straight forward technique for comparing the mutually exclusive alternatives when all useful life's are equal to the study period is to determine the equivalent worth of each alternative based on total investment at i = MARR. Then,

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investment alternatives, the one with the greatest positive equivalent worth is selected. And in the case of cost alternatives, the one with the least negative equivalent worth is selected.

The economic ranking of mutually exclusive alternatives will be the same when using the three methods of equivalent worth method. Consider the general case of two alternatives A and B. If PW $(i\%)_A$ < PW $(i\%)_B$, then the AW and FW analysis will result in the same preference for alternative B. Do not compare the IRRS of mutually exclusive alternatives (or IRRs. of the difference between mutually exclusive alternative) against those of other alternatives.

When you compare exclusive alternatives with the same revenues, they are compared on a cost-only basis. In this situation (because you are minimizing costs rather than maximizing profits), you should accept the project that results in the smallest or least negative NPW. Similarly, use same decision criteria for AW, FW, PW and BCR method while comparing and selecting between multiple alternatives.

5.2 COMPARING MUTUALLY EXCLUSIVE ALTERNATIVES HAVING DIFFERENT USEFUL LIFE

When the useful likes of mutually exclusive alternatives are unequal, the repeatability assumption or co-terminated assumption or capitalized worth method can be used.

5.2.1 REPEATABILITY ASSUMPTION

It assumes that the study period is either indefinitely long or equal to common multiple of the lives of the alternatives. The cash flow associated with an alternative's initial life span are representative of what will happen in succeeding life spans.

Example

Recommend the best project from the following two projects assuming repeatability.

Project	A	B
Initial investment, Rs.	4,00,000	7,00,000
Annual Revenue, Rs.	1,75,000	2,50,000
Annual cost, Rs.	25,000	25,000
Salvage value, Rs.	40,000	70,000
Useful life	6	8
MARR	12% per year	

Solution:

Study period: L.C.M. of 6 and 8 years = 24 years

Project A: It requires 4 times repetition.

PW(12%) = –4,00,000 – 4,00,000 (P/F, 12%, 6) – 4,00,000(P/F, 12%, 12) – 4,00,000 (P/F, 12%, 18) + 150,000(P/A, 12%, 24) + 40,000 (P/F, 12%, 6) 40,000 (P/F, 12%, 12) + 40,000 (P/F, 12% 18) + 40,000 (P/F, 12%, 24)

= –4,00,000 – 400,000 × 0.50669 – 400,000 × 0.2567 + 400,000 × 0.130 + 150,000 × 7.7843 + 40,000 × 0.5066 + 40,000 × 0.2567 + 40,000 × 0.130 + 40,000 × 0.659

= Rs.4,48,693

Project B: It requires 3 times repetition.

PW(12%) = –7,00,000 – 7,00,000 (P/F, 12%, 8) – 7,00,000(P/F, 12%, 16) + (2,50,000 – 25,000) (P/A, 12%, 24) + 70,000(P/F, 12%, 8) + 70,000 (P/F, 12%, 16) + 70,000 (P/F, 12%, 24)

= –7,00,000 – 7,00,000 × 0.4039 – 7,00,000 × 0.1631 + 2,25,000 × 7.7843 + 70,000 × 0.4039 + 70,000 × 0.1631 + 70,000 × 0.659

Since PW(12%) of project B > PW(12%) of project A, the project B is highly recommended.

5.2.2 CO-TERMINATION ASSUMPTION

It is preferred if the study period is not a common multiple of the alternatives lives or repeatability is not applicable.

When Study Period > Useful Life:

Calculate the FW at the end of useful life and move this to the end of the study period using the MARR.

When Study Period < Useful Life:

Truncate the alternative at the end of the study period using an estimated or imputed market value.

Example

Using co-terminated assumption recommend the best project.

Project	A	B
I	1,50,000	2,00,000
AR	90,000	1,00,000
AE	20,000	22,000
S	5,000	1,00,000
N	2 years	4 years
MARR	10% per year	

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Solution: N = 2 = study period

For project A:

PW (10%) = –150,000 + 70,000 (P/A, 10%, 2) + 50,000 (P/F, 10%, 2)

= –150,000 + 70,000 × 1.7355 + 50,000 × 0.8264

= Rs. 12,805

For project B:

It should terminate at the end of second year *i.e.*, useful life of project A. (study period लाना है N=2 का)

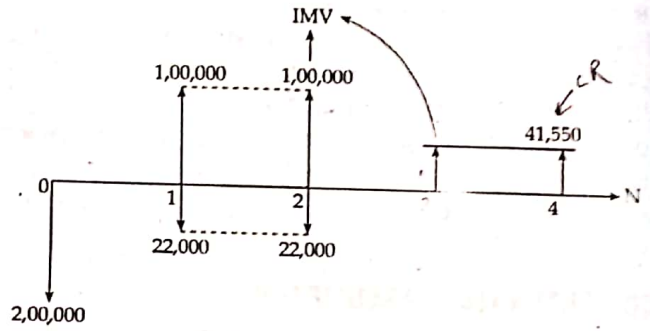
CR = 2,00,000 (A/P, 10%, 4) – 1,00,000 (A/F, 10%, 4)

= 2,00,000 × 3.155 – 1,00,000 × 0.2155

= Rs. 41,550

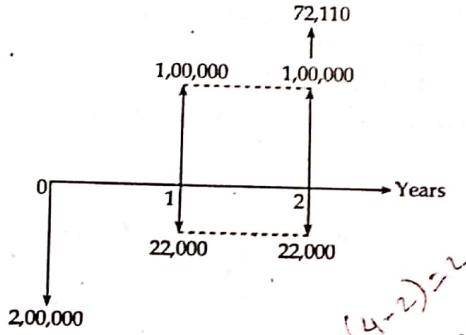
CR-I-S

CFD



PW of CR at the end of second year: 2

PW_{CR} (10%) = 41,550 (P/A, 10%, 2) = 72,110 = IMV_2



PW of project B terminating at the end of second year, (4–2) = 2 Imv = salvage value (study period)

∴ PW(10%) = 2,00,000 + 78,000 (P/A, 10%, 2) + 72,110 (P/F, 10%, 2%)

= 2,00,000 + 78,000 × 1,7355 + 72,110 × 0.8264

= Rs. –5,039

∴ PW of A > PW of B, so select project A.

12805 > –5,039

5.2.3 CAPITALIZED WORTH (CW) METHOD

Capitalized worth is the present worth of all revenues or expenses over an infinite light of time. It is a special variation of present worth. If only expenses are considered, we call it capitalized cost method.

We know,

$$PW(i\%) = A\,(P/A, i\%, N)$$

When $N \to \infty$, PW is called as capitalized worth.

Now,

$$CW(i\%) = PW_{N\to\infty}(i\%)$$

$$= A\left[\lim_{N\to\infty} \frac{(1+i)^N - 1}{i(1+i)^N}\right]$$

$$= A\left[\lim_{N\to\infty}\left(\frac{(1+i)^N - 1}{i(1+i)^N} - \frac{1}{i(1+i)^N}\right)\right]$$

$$= A\left[\lim_{N\to\infty}\left(\frac{1}{i} - \frac{1}{i(1+i)^N}\right)\right]$$

$$= A\left(\frac{1}{i} - 0\right)$$

$$\therefore\ CW(i\%) = \left(\frac{A}{i}\right)$$

Hence to find CW of any project

- Find AW of project
- Divide this AW by the MARR or interest rate.

Example

Solve by capitalized worth method and select best project.

Project	A	B
I	50,000	1,20,000
AE	10,000	10,000
AR	9,000	6,000
S	0	0
N	20	30
MARR	15%	15%

Solution:

AW_A = –50,000 (A/P, 15%, 20) + (9,000 – 10,000)

= –50,000 × 0.1598 – 1000

= Rs. –8990

AW_B = –1,20,000 (A/P, 15%, 30) + (6,000 – 10,000)

= – 1,20,000 × 0.1523 – 4,000

= Rs. –22,276

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Now, $CW_A = \frac{AW_A}{i} = \frac{-8,990}{0.15} = -59,933.33$

$CW_B = \frac{AW_B}{i} = \frac{-22,276}{0.15} = -1,48,506.67$

Both have negative value. But least negative value is of project A compares to project B. So, select project A.

5.3 COMPARING MUTUALLY EXCLUSIVE, CONTINGENT AND INDEPENDENT PROJECTS IN COMBINATION

In the real world of engineering practice, however, it is typical for us to have two or more choices of projects that are not independent of one another in seeking to accomplish a business objective. Often, various projects or investment under consideration do not have the same duration or do not match the desired study period. Adjustments must be made to account for the differences.

5.3.1 INDEPENDENT PROJECT

An independent project is one where the decision is to accept or reject the project has no effect on any other project being considered by the company. The cash flows of an independent project have no effect on the cash flow of other projects or divisions of the business. For two independent projects, we can have four investment alternatives:

- To accept the both project
- To reject the both project
- To accept only the first project
- To accept only the second project

For example; The decision to replace a company's computer system would be considered independent of a decision to build a new factory.

5.3.2 DEPENDENT PROJECT

The projects related to one another in such a way that the acceptance or rejection of one project influences the acceptance of other projects are called dependent projects. Two such types of dependencies are mutually exclusive projects contingent projects.

5.3.2.1 Mutually Exclusive

Mutually exclusive projects are those when one project is chosen all other are excluded in the group. Such cases come into decision making process mostly because of limitation of capital to invest.

For example; Buying Vs leasing an automobile for business use, when one alternative is accepted the other is excluded.

5.3.2.2 Contingent Project

Two or more projects are said to be contingent if the acceptance of one project requires the acceptance of another project.

For example; The purchase of a computer printer is dependent upon the purchase of a computer, but the computer may be purchased without purchasing the printer.

Formulation of mutually exclusive combination of projects:

i) Independent projects case

Suppose there are two independent projects A and B. Then,

Mutually exclusive combination	Project		Explanation
	A	B	
1	0	0	Accept none
2	1	0	Accept A
3	0	1	Accept B
4	1	1	Accept A and B

ii) Mutually exclusive project case

Suppose there are three mutually exclusive projects A, B and C. Then,

Mutually exclusive combination	Project			Explanation
	A	B	C	
1	0	0	0	Accept none
2	1	0	0	Accept A
3	0	1	0	Accept B
4	0	0	1	Accept C

iii) Contingent project case

Let, there are three projects A, B and C where A is contingent on the acceptance of both B and C, and C is contingent on the acceptance of B. then,

Mutually exclusive combination	Project			Explanation
	A	B	C	
1	0	0	0	Accept none
2	0	1	0	Accept B
3	0	1	1	Accept B and C
4	1	1	1	Accept A, B and C

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BOARD EXAM SOLVED PROBLEMS

1. What do you mean by dependent, independent and mutually exclusive project? Explain with examples. [16/F, 16/S, 11/S]

Ans: Refer topic 5.3.1, 5.3.2, 5.3.2.1.

2. Write short notes on mutually exclusive projects and its combination. [17/S]

Ans: Refer topic 5.3.2.1

A company is considering two independent sets of mutually exclusive projects. That is, project A_1 and A_2 are mutually exclusive as are B_1 and B_2. However, the selection of any project from the set of projects A_1 and A_2 is independent of the selection of any project from the set of project B_1 and B_2. Mutually exclusive combination for two independent sets of mutually exclusive projects.

Mutually exclusive combination	Project				Explanation
	A_1	A_2	B_1	B_2	
1	0	0	0	0	Accept none
2	1	0	0	0	Accept A_1
3	0	1	0	0	Accept A_2
4	0	0	1	0	Accept B_1
5	0	0	0	1	Accept B_2
6	1	0	1	0	Accept A_1 and B_1
7	1	0	0	1	Accept A_1 and B_2
8	0	1	1	0	Accept A_2 and B_1
9	0	1	0	1	Accept A_2 and B_2

3. Two mutually exclusive projects are shown below select the best project by using PW method. [13/S]

Project	M	N
Capital Investment, Rs.	5,00,000	7,00,000
Net annual revenue, Rs.	1,10,000	1,10,000
Salvage value	40,000	40,000
Useful life (years)	3	4
MARR	10% per years	

Solution:

Study period: LCM of 3 and 4 = 12 years.

Project A:

It requires 4 times repetition.

Using PW formulation:

$$PW(10\%) = -5,00,000 - 5,00,000\,(P/F, 10\%, 3) - 5,00,000\,(P/F, 10\%\ 6) - 5,00,000\,(P/F, 10\%, 9) + 1,10,000(P/A, 10\%, 12) + 40,000\,(P/F, 10\%, 3) + 40,000\,(P/F, 10\%, 6) + 40,000\,(P/F, 10\%, 9) + 40,000\,(P/F, 10\%, 12)$$

$$= -5,00,000 - 5,00,000 \times 0.7513 - 5,00,000 \times 0.5645 - 50,000 \times 0.4241 + 1,10,000 \times 6.8317 + 40,000 \times 0.7513 + 40,000 \times 0.5645 + 40,000 \times 0.4241 + 40,000 \times 0.3186$$

$$= \text{Rs. } -5,38,103$$

Project B:

It requires 3 times repetition

$$PW(10\%) = -7,00,000 - 7,00,000\,(P/F, 10\%, 4) - 7,00,000\,(P/F, 10\%, 8) + 1,10,000\,(P/A, 10\%, 12) + 40,000\,(P/F, 10\%, 4) + 40,000\,(P/F, 10\%, 8) + 40,000\,(P/F, 10\%, 12)$$

$$= -7,00,000 - 7,00,000 \times 0.6830 - 7,00,000 \times 0.4665 + 1,10,000 \times 6.8137 + 40,000 \times 0.6830 + 40,000 \times 0.4665 + 40,000 \times 0.3180$$

$$= \text{Rs. } -6,96,419$$

Both projects have negative value *i.e.*, both are not preferable but if decision is to be made we should go for lesser negative value *i.e.*, project A is best.

4. Calculate PW of the following two mutually exclusive projects by using repeatability assumption when MARR is 10%. [14/F, 16/F]

Project	A	B
Initial cost, Rs.	4,00,000	6,00,000
Annual revenue, Rs.	30,000	35,000
Annual costs, Rs.	3,000	4,000
Useful life (years)	3	9
Salvage value	4,000	7,000

Solution:

Study period: LCM of 3 and 9 = 9 years

Project A:

It requires 3 time repetition

Net annual revenue = 30,000 – 3,000 = Rs. 27,000

$$PW\,(10\%) = -4,00,000 - 4,00,000\,(P/F, 10\%, 3) - 4,00,000\,(P/F, 10\%, 6) + 27,000\,(P/A, 10\%, 9) + 4,000\,(P/F, 10\%, 3) + 4,000\,(P/F, 10\%, 6) + 4,000\,(P/F, 10\%, 9)$$

$$= -4,00,000 - 4,00,000 \times 0.7513 - 4,00,000 \times 0.5645 + 27,000 \times 5.7590 + 4,000 \times 0.7513 + 4,000 \times 0.5645 + 4,000\ 0.4241$$

$$= \text{Rs. } -7,62,593$$

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Project B:

It requires 1 time repetition

PW (10%) = -6,00,000 + (35,000 – 4,000) (P/A, 10% 9) + 7,000 (P/F, 10%, 9)

= -6,00,000 + 31,000 × 5.7590 + 7,000 × 0.4241

= Rs. –4,18,502

Both projects have negative value in which project B has less negative value. Hence, project B is best.

5. **A Company needs a machine and has found two quantities with cash flows shown below. Select the best quotation using PW method.** [15/S]

Project	Quotation A	Quotation B
Purchase price	12,500	15,000
Annual O and M costs	5,000	4,000
Salvage value	2,000	1500
Life in years	3	4
MARR	10%	

Solution:

Study period: LCM of 2 and 4 = 12 years

For project A:

It requires 4 time repetition

PW (10%) = –12,500 – 12,500 (P/F, 10%, 3) – 15,500 (P/F, 10%, 6)

– 12500 (P/F, 10%, 9) – 5,000 (P/A, 10%, 12) + 2,000 (P/F, 10%, 3)

+ (2,000 (P/F, 10%, 6) + 2,000 (P/F, 10%, 9) + 2,000 (P/F, 10%, 12)

= –12,500 – 12,500 × 0.7513 – 12,500 × 0.5645 – 12500 × 0.4241

– 5,000 × 6.8137 + 2,000 × 0.7513 + 2,000 × 0.5645 + 2,000

× 0.4241 + 2,000 × 0.3186

= Rs. –64,200

For project B:

It requires 3 times repetition.

PW (10%) = –15,000 – 15,000 (P/F, 10%, 4) – 15,000 (P/F, 10%, 8)

– 4,000 (P/A, 10%, 12) + 1,500 (P/F, 10%, 4)

+ 1,500 (P/F, 10%, 8) + 1,500 (P/F, 10%, 12)

= –15,000 – 15,000 × 0.6830 – 15,000 × 0.4665 – 4,000 × 6.8137

+ 1,500 × 0.6830 + 1,500 × 0.4665 + 1,500 × 0.3186

= Rs. –28, 276.90

Although both project has negative value, quotation B has less negative value, hence quotation B has best value.

6. **Following are the two independent projects, determine which project is worthful by using BCR. Assume that MARR is 10%.** [15/S]

Project	A	B
Initial investment	3,50,000	4,50,000
Annual benefits	1,50,000	4,50,000
Annual O and M costs	30,000	40,000
Life in years	4	5
Salvage value	50,000	75,000

Solution:

Using BCR method

Project A:

PW (10%) of benefits = (1,50,000 – 30,000) (P/A, 10%, 4) + 50,000 (P/F, 10%, 4)

= 1,20,000 × 3.3699 + 50,000 × 0.6830

= Rs. 4,38,538

PW (10%) of costs = Rs. 3,50,000

$$\text{B/C ratio} = \frac{\text{PW (10\%) of benefits}}{\text{PW (10\%) of costs}}$$

$$= \frac{4,38,538}{3,50,000}$$

= 1.26 > 1, project is accepted.

Project B:

PW (10%) of benefits = (1,75,000 – 40,000) (P/A, 10%, 5) + 75,000 × 3.7908

+ 75,000 × 0.209

= 1,35,000 × 3.7908 + 75,000 × 0.6209

= Rs. 5,58,325.50

PW (10%) of costs = Rs. 4.50,000

$$\text{B/C ratio} = \frac{5,58,325.50}{4,50,000}$$

= 1.24 > 1, project is accepted.

Although the both project has value greater than 1, project A has higher BCR value, hence project A is worthful.

7. **Compare the following two mutually exclusive projects by using co-terminated assumption when MARR = 10%.** [15/F]

Project	A	B
Initial cost	1,50,000	2,00,000
Annual revenue	90,000	1,00,000
Annual O and M cost	20,000	22,000
Life in years	5	8
Salvage value	50,000	1,00,000

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Solution:

Using FW for mulation,

FW of A:

FW (10%) = -1,50,000 (F/P, 10%, 5) + (90,000 – 20,000) (F/A, 10%, 5) + 50,000

= -1,50,000 × 1.6105 + 70,000 × 6.1051 + 50,000

= Rs. 2,35,782

FW of B:

CR (10%) = 2,00,000 (A/P, 10%, 8) – 1,00,000 (A/F, 10%, 8)

$$= 2,00,000 \times 0.1874 - 1,00,000 \times \left[\frac{0.10}{(1+0.10)^8 - 1}\right]$$

= 2,00,000 × 0.1874 – 1,00,000 × 0.0874

= Rs. 28,740

PW of CR at the end of 5th year remaining 3 years.

PW_{CR} (10%) = CR (P/A, 10%, 3)

= 28740 × 2.4869

= Rs. 21,473.50

Hence,

FW of B = – 2,00,000 (F/P, 10%, 5) + (1,00,000 – 22,000) (F/A, 10%, 5) + 21,473.50

= – 2,00,000 × 1.6105 + 78,000 × 6.1051 + 21,473.50

= Rs. 1,75,571.30

Since, FW (10%) of A > FW (10%) of B, the project A is best.

8. **Use repeatability assumptions to recommend the best project from following information. 16/S.** [12/S]

Project	Quotation A	Quotation B
Initial investment, Rs.	40,000	50,000
Net annual revenue, Rs.	15,000	20,000
Salvage value, Rs.	5,000	6,000
Life in years	3	5
MARR	15%	

Solution:

LCM of 3 and 5 years = 15 years

Project A:

It requires 5 times repetition.

PW (15%) = –40,000 – 40,000 (P/F, 15%, 3) – 40,000 (P/F, 15%, 6) – 40,000 (P/F, 15%, 9) – 40,000 (P/F, 15%, 12) + 15,000 (P/A, 15%, 15) + 5,000 (P/F, 15%, 3) + 5,000 (P/F, 15%, 6) + 5,000 (P/F, 15%, 9) + 5,000 (P/F, 15%, 12) + 5,000 (P/F, 15%, 15)

= –40,000 – 40,000 × 0.6575 – 40,000 × 0.4323 – 40,000 × 0.2843 – 40,000 × 0.1869 + 15,000 × 5.8474 + 5,000 × 0.6575 + 5,000 × 0.4323 + 5,000 × 0.2843 + 5,000 × 0.1869 + 5,000 × 0.1229

= Rs. –6309.50

Project B:

It requires 3 times repetition

PW (15%) = –50,000 – 50,000 (P/F, 15%, 5) – 50,000 (P/F, 15%, 10) + 20,000 (P/A, 15%, 15) + 6,000 (P/F, 15%, 5) + 6,000 × (P/F, 15%, 10) + 6,000 (P/F, 15%, 15)

= –50,000 – 50,000 × 0.4972 – 50,000 × 0.2472 + 20,000 × 5.8474 + 6,000 × 0.4972 + 6,000 × 0.2472 + 6,000 × 0.1229

= Rs. 24,931.80

Since, PW(15%) of project B > PW (15%) of project A, hence project B is best project.

9. **What are the methods used to analyze the projects of same useful life and different useful life?** [11/S, 17/S]

Assuming infinite project life, recommend one of the following mutually exclusive projects if MARR = 10%.

Project	Quotation A	Quotation B
Initial investment, Rs.	750,000	18,00,000
Salvage value, Rs.	150,000	2,70,000
Annual costs, Rs.	1,35,000	90,000
Useful life in years	30	75

Solution:

AW of project A:

AW_A (10%) = –750,000 (A/P, 10%, 30) – 135,000 + 150,000 (A/F, 10%, 30)

= –750,000 × 0.1061 – 135,000 + 150,000 × 0.0061

= Rs. – 2,13,660

AW of project B:

AW_B (10%) = –18,00,000 (A/P, 10%, 75) – 90,000 + 2,70,000 (A/F, 10%, 75)

= –18,00,000 × 0.1001 – 90,000 + 2,70,000 0.0001

= Rs. –2,70,153

Capitalized worth:

$$CW_A(10\%) = \frac{AW_A(10\%)}{i} = \frac{-213660}{0.10} = \text{Rs. } -2136600$$

$$CW_B(10\%) = \frac{AW_B(10\%)}{i} = \frac{-270153}{0.10} = \text{Rs. } -2701530$$

Here, CW_A (10%) > CW_B (10%). Hence, select project A so as to reduce the cost.

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10. Recommend the best project from the following two projects assume repeatability. [18/S, 14/S]

Project	Quotation A	Quotation B
Initial investment, Rs.	4,00,000	7,00,000
Annual revenue, Rs.	1,75,000	2,50,000
Annual cost, Rs.	25,000	35,000
Salvage value, Rs.	40,000	70,000
Useful life, year	6	8
MARR	12%	

Solution:

Study period: LCM of 6 and 8 years = 24 years.

Project A:

It needs 4 times repetition

$$PW(12\%) = -4,00,000\,[1 + (P/F, 12\%, 6)\,(P/F, 12\%, 12) + (P/F, 12\%, 18)] + 40,000\,[(P/F, 12\%, 6) + (P/F, 12\%, 12) + (P/F, 12\%, 18) + (P/F, 12\%, 24)] + (175,000 - 25000)\,(P/A, 12\%, 24)$$

$$= -4,00,000\,[1 + 0.5066 + 0.2567 + 0.1300] + 40,000\,[0.5066 + 0.2567 + 0.1300 + 0.0659] + [(175,000 - 25000) \times 7.7843]$$

$$= \text{Rs. } 4,48,693$$

Project B:

It needs 3 times repetition

$$PW(12\%) = -7,00,000\,[1 + (P/F, 12\%, 8) + (P/F, 12\%, 16)] + 70,000\,[(P/F, 12\%, 8) + (P/F, 12\%, 16) + (P/F, 12\%, 16) + (P/F, 12\%, 24) + [(2,50,000 - 35,000)\,(P/A, 12\%, 24)]$$

$$= -7,00,000\,[1 + 0.1039 + 0.1631] + 70,000\,[(0.4039 + 0.1631 + 0.0659 + 215,000 \times 7.7843$$

$$= \text{Rs. } 6,21,013.50$$

Here, PW_B (6,21,013.50) > PW_A (4,48,693), so project is best to select.

11. Consider the following three sets of mutually exclusive alternatives. [18/S]

EOY	Alternatives		
	D_1 (Rs.)	D_2 (Rs.)	D_3 (Rs.)
0	-2000	-1000	-3000
1	15000	800	1500
2	1000	500	2000
3	800	500	1000

Which project would you select based on BCR method on incremental investment assuming that MARR = 15%

B/C

Solution:

Put of cost of alternative - 1 (D_1) = 2,000
PW of cost of alternative - 2 (D_2) = 1,000
PW of cost of alternative - 3 (D_3) = 3,000

From above calculation, the order of alternatives from lowest equivalent cost to highest equivalent cost is D_2, D_1 and D_3.

The lowest equivalent cost alternative D_2 is first compared against do-noting alternative *i.e.*, the B/C ratio of alternative D_2 on its cash flow is calculated.

$$\text{B/C ratio of } D_2 = \frac{\text{PW of benefits}}{\text{Initial investments + PW of expenses}}$$

$$= \frac{800\,(1 + 0.15)^{-1} + 500(1 + 0.15)^{-2} + 500\,(1 + 0.15)^{-3}}{1,000}$$

$$= \frac{1,402.48}{1,000}$$

$$= 1.403$$

As the B/C ratio of alternative D_1 is greater than 1.0, D_1 now becomes the base alternative and is compared against the next higher equivalent cost alternative. *i.e.*, Alternative D_1. Now the incremental benefits and incremental cost between D_2 and D_1 are calculated and incremental BCR is obtained.

Incremental annual benefits between D_2 and D_1:

PW (15%) benefits of D_1 $= 14,000 \times 1.15^{-1} + 10,000 \times 1.15^{-2} + 800 \times 1.15^{-3}$
$= \text{Rs. } 2,586.50$

PW (15%) benefits of D_2 $= 800 \times 1.15^{-1} + 500 \times 1.15^{-2} + 500 \times 1.15^{-3}$
$= \text{Rs. } 1,402.48$

PW (15%) benefits of D_3 $= 1500 \times 1.15^{-1} + 2,000 \times 1.15^{-2} + 1,000 \times 1.15^{-3}$
$= \text{Rs. } 3,474.15$

Hence, PW of incremental benefits between D_2 and D_1

$= \text{Rs. } 1,586.40 - 1402.48$

$\Delta B = \text{Rs. } 1,183.93$

PW of incremental costs between D_2 and D_1

$= \text{Rs. } (2,000 - 1,000)$

$\Delta C = \text{Rs. } 1,000$

Hence, incremental BCR between D_2 and D_1

$$= \frac{\Delta B}{\Delta C} = \frac{1,183.93}{1,000} = 1.183$$

As the incremental BCR is greater than 1.0, alternative D_1 becomes the new base alternative and alternative D_2 is removed from further analysis.

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Alternative D_1 is now compared against the next higher equivalent cost alternative. *i.e.*, alternative D_1 and D_3 is determined in the same manner as that was determined between the alternatives D_1 and D_2.

Now, PW of incremental benefits between D_1 and D_3

= Rs. (3,474.15 – 2,586.50)

= Rs. 887.65

PW of incremental costs between D_1 and D_3

= Rs. (3,000 – 2000)

= Rs. 1,000

Hence, incremental BCR between D_1 and $D_3 = \frac{887.65}{1,000} = 0.8875$

Here, the incremental B/C ratio between alternatives D_1 and D_3 is 0.8875 which is less than 1.0. Thus, incremental cost associated with alternative D_3 is not justified. Hence, alternative D_1 is selected as the best alternative among D_1, D_2 and D_3 as no other alternative is left for comparison.

12. Use repeatability assumption to select the best project. MARR = 10%. *[18/F]*

Project	A	B	C
Initial investment	2000	3000	4000
Annual income	1000	1200	1500
Life	3	5	7
Salvage value	20% of initial investment		

Solution:

Study period: LCM of 3, 5 and 7 = 105 years.

Project A needs 35 times repetition.

Project B needs 21 times repetition.

Project C needs 15 times repetition.

PW cost of project A:

$$PW\ (10\%) = -2,000\,[1 + (1.10)^{-3} + (1.10)^{-6} + (1.10)^{-9} + (1.10)^{-12} + (1,10)^{-15} + (1.10)^{-18} + (1.10)^{-21} + (1,10)^{-24} + (1.10)^{-27} + (1.10)^{-30} + (1,10)^{-33} + (1.10)^{-36} + (1.10)^{-39} + (1,10)^{-42} + (1.10)^{-45} + (1.10)^{-48} + (1,10)^{-51} + (1.10)^{-54} + (1.10)^{-57} + (1,10)^{-60} + (1.10)^{-63} + (1.10)^{-66} + (1,10)^{-69} + (1.10)^{-72} + (1.10)^{-75} + (1,10)^{-78} + (1.10)^{-81} + (1.10)^{-84} + (1,10)^{-87} + (1.10)^{-90} + (1.10)^{-93} + (1.10)^{-96} + (1.10)^{-99} + (1.10)^{-102}] + 1,000 \times (P/A, 10\%, 105) + 400[(1.10)^{-3} + (1.10)^{-6} + (1.10)^{-9} + (1.10)^{-12} + \ldots + (1,10)^{-102} + (1.10)^{-105}]$$

$$= -2,000 \times 4.0116 + 1,000 \times \left[\frac{(1.10)^{105} - 1}{0.10 \times (1.10)^{105}}\right] + 4,000 \times 3.0116$$

= Rs. –8023 + 10,000 + 1204

= Rs. 3,181

PW cost of project B:

$$PW\ (10\%) = -3,000\,[1 + (1.10)^{-5} + (1.10)^{-10} + (1.10)^{-15} + (1.10)^{-20} + \ldots + (1.10)^{-95} + (1.10)^{-100}] + 1200\,(P/A, 10\%, 105) + 600\,[(1.10)^{-5} + (1.10)^{-10} + \ldots + (1.10)^{-100} + (1.10)^{-105}]$$

$$= -3,000 \times 2.638 + 120 \times 10 + 600 \times 1.638$$

= Rs. –5,731

PW cost of project C:

$$PW\ (10\%) = -4,000\,[1 + (1.10)^{-7} + (1.10)^{-14} + \ldots + (1.10)^{-91} + (1.10)^{-98}] + 1500(P/A, 10\%, 105) + 300 \times [(1.10)^{-7} + (1.10)^{-14} + \ldots + (1.10)^{-105}]$$

$$= -4,000 \times 2.05 + 1500 \times 10 + 300 \times 1.05$$

= Rs. 7,115

Here, PW (10%) of project C > PW (10%) of project A > PW (10%) of project B.

Hence, project C is the best project among three.

13. Select which project is terrible to invest among two following alternative projects whose cash flows are as follows. MARR is 12% per year. Use IRR method and incremental analysis. *[17/F, 16/F]*

Investment	A	B
Investment	50,000	1,50,000
Net annual revenue	25,000	70,000
Net annual cost	3,000	2,000
Salvage value	15,000	40,000
Useful life	7 years	7 years
Repair and maintenance cost at 3rd and 5th year.	10,000	15,000

Solution:

MARR = 12% per year

N = 7 years

IRR for project/investment A:

$$PW = -50,000 + (25,000 - 3000)\,(P/A, i\%, 7) + 15,000\,(P/F, i\%, 7) - 10,000\,(P/F, i\%, 3) - 10,000\,(P/F, i\%, 5)$$

IRR is that rate of i' which makes PW = 0

Let, i'% = 20%

$$PW\ (20\%) = -50,000 + 22,000 \times 3.6046 + 15,000 \times 0.2791 - 10,000 \times 0.5787 - 10,000 \times 0.4019$$

= Rs. 23,681.7

Let, i'% = 25%

$$PW\ (25\%) = -50,000 + 22,000 \times 3.1611 + 15,000 \times 0.2091 - 10,000 \times 0.5120 - 10,000 \times 0.3277$$

= Rs. 14,292.7

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Let, i% = 30%

PW (30%) = − 50,000 + 22,000 × 2.8021 + 15,000 × 0.1594 − 10,000 × 0.4552 − 10,000 × 0.2693

= Rs. 6,822.2

Let, i% = 35%

PW (35%) = − 50,000 + 22,000 × 2.5075 + 15,000 × 0.1224 − 10,000 × 0.4064 − 10,000 × 0.2230

= Rs. 707 (+ve)

Let, i% = 40%

PW (40%) = − 50,000 + 22,000 × 2.2628 + 15,000 × 0.0949 − 10,000 × 0.3644 − 10,000 × 0.1859

= Rs. −4298 (−ve)

Hence, IRR = 35% + $\frac{707}{707 + 4,298}$ × (40 − 35)% = 35.71%.

Since, IRR of project A > MARR of project, hence it is feasible project.

For project B

PW = − 1,50,000 + (70,000 − 2000) (P/A, i%, 7) + 40,000 (P/F, i%, 7) − 15,000 (P/F, i%, 3) − 15,000 (P/F, i%, 5)

Let, i% = 20%

PW (20%) = − 1,50,000 + 68,000 × 3.6046 + 40,000 × 0.2791 − 15,000 × 0.5787 − 15,000 × 0.4019

= Rs. 91,567.8

Let, i% = 30%

PW (30%) = − 1,50,000 + 68,000 × 2.8021 + 40,000 × 0.1594 − 15,000 × 0.4552 − 15,000 × 0.2693

= Rs. 36,051.3

Let, i% = 35%

PW (35%) = − 1,50,000 + 68,000 × 2.5075 + 40,000 × 0.1224 − 15,000 × 0.4064 − 15,000 × 0.2230

= Rs. 19,965 (+ve)

Let, i% = 40%

PW (40%) = − 1,50,000 + 68,000 × 2.2628 + 40,000 × 0.0949 − 15,000 × 0.3644 − 15,000 × 0.1859

= Rs. − 588 (−ve)

Hence,

IRR = 35% + $\frac{15965}{15965 + 588}$ × (40 − 35)%

= 35% + 4.822%

= 39.82%

Since, IRR of project B > MARR, hence it is feasible project and IRR of project B > IRR of project A, it is feasible to invest on project B.

Performing the incremental analysis:

Selecting project A as base alternative. Incremental cash flows will be.

Items	Project A	Project B	Project (B – A)
Investment	50,000	1,50,000	1,00,000
Net annual revenue	35,000	70,000	45,000
Net annual cost	3,000	2,000	−1000
Salvage value	15,000	40,000	35,000
Repair and maintenance cost 3rd and 5th year	10,000	15,000	5,000

Using PW formation,

PW = −1,00,000 + (45,000 + 1,000) (P/A, i'%, 7) + 25,000 × (P/F, i'%, 7) − 5,000 (P/F, i'%, 3) − 5,000 (P/F, i'%, 5)

Let, i'% = 20%

PW (20%) = −1,00,000 + 46,000 × (P/A, 20%, 7) + 25,000 × (P/F, 20%, 7) − 5,000 × (P/F, 20%, 3) − 5,000 × (P/F, 20%, 5)

= −1,00,000 + 46,000 × 3.6046 + 25,000 × 0.2791 − 5,000 × 0.5787 − 5,000 × 0.4019

= Rs. 67,887.60

Let, i' % = 30%

PW (30%) = −1,00,000 + 46,000 × 2.8021 + 25,000 × 0.1594 − 5,000 × 0.4552 − 5,000 × 0.1594

= Rs. 29,808.6

Let, i' % = 40%

PW (40%) = −1,00,000 + 46,000 × 2.2628 + 25,000 × 0.0949 − 5,000 × 0.3644 − 5,000 × 0.1859

= Rs. 3714.80

Let, i' % = 50%

PW (30%) = −1,00,000 + 46,000 × 1.8829 + 25,000 × 0.585 − 5,000 × 0.2963 − 5,000 × 0.1317

= Rs. −14,064.10

Hence IRR = 40% + $\frac{3,714.80}{3,714.80 + 14,064.10}$ × (50 − 40)%

= 40% + 2.089%

= 42.089 % > MARR (12%)

Hence, the extra investment in the project B is justified. Hence, select project B for more profit.

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ADDITIONAL PROBLEMS

1. **Select the best project using ERR when MARR = 18% and E = 12% per year.**

Year	Project A	Project B
0	–40,000	–60,000
1	–38,000	25,0[illegible]
2	35,000	4[illegible]0
3	35,000	–5[illegible]000
4	35,000	50,000
5	35,000	75,000

Solution:

Project A:

Discounting all cash outflows to year zero at 12%

$= 40,000 + 38,000\ (P/F, 12\%, 1)$

$= 40,000 + 38,000 \times 0.8929$

$\Sigma E_C = 7,390.20$

Compounding all cash inflows to year 5 at 12%

$= 35,000\ (F/A, 12\%, 4)$

$= 35,000 \times 4.7793$

ΣR_C = Rs. 1,67,275.50

We know,

$\Sigma E_C\ (F/P, i'\%, N) = \Sigma R_C$

or, $7,390.20 \times (F/P, i'\%, 5) = 1,67,275.50$

or, $(1 + i')^5 = 2.2626$

or, $(1 + i') = 1.177$

$\therefore$ $i'\% = 17.70\ \%$

Hence, ERR of project A = 17.70% < MARR.

Project B:

Discounting all cash outflows to year zero at 12%

$= 60,000 + 50,000\ (P/F, 12\%, 3)$

$= 60,000 + 50,000 \times 0.7118$

$\Sigma E_C = 95,590$

Compounding all cash inflows to year 5 at 12%

$= 25,000\ (F/A, 12\%, 4) + 40,000\ (F/P, 12\%, 3) + 50,000 \times (F/P, 12\%, 1) + 75000$

$= 25,000 \times 1.8735 + 40,000 \times 1.4049 + 50,000 \times 1.12 + 75,000$

ΣR_C = Rs. 2,26,533.50

We know,

$\Sigma E_C\ (F/P, i'\%, N) = \Sigma R_C$

or, $95,590 \times (F/P, i'\%, 5) = 2,26,533.50$

or, $(1 + i')^5 = 2.3698$

or, $(1 + i') = 1.188$

or, $i' = 0.188$

$\therefore$ $i'\% = 18.80\%$

ERR of project B = 18.80% > MARR

Hence, only project B is feasible and no incremental analysis is necessary. So, project B is best.

2. **Select the best project using AW and ERR method. Useful life is 10 years and MARR = 10%. Perform incremental analysis if necessary.**

Project	A	B
Initial investment	24,00,000	35,50,000
Annual revenue	8,20,000	12,00,000
Annual expresses	1,10,000	1,40,000
Salvage value	2,25,000	3,50,000

Solution:

Using AW method

Project A:

PW (10%) = $-24,00,000\ (A/P, 10\%, 10) + (8,20,000 - 1,10,000) + 2,25,000\ (A/F, 10\%, 10)$

$= -24,00,000 \times 0.1627 + 7,10,000 + 2,25,000 \times 0.0627$

= Rs. 3,33,627.50

Project B:

AW (10%) $= -35,50,000\ (A/P, 10\%, 10) + (12,00,000 - 1,40,000) + 3,50,000\ (A/F, 10\%, 10)$

$= -35,50,000 \times 0.1627 + 10,60,000 + 3,50,000 \times 0.0627$

= Rs. 5,04,360

Here, AW (10%) of project B > AW (10%) of project B. Hence, project B is best to select.

Using ERR method:

Assuming external reinvestment rate (∈) = 12%.

Project A:

Discounting all the cash outflows to present time at 12%

ΣE_C = Rs. 24,00,000

Compounding all the cash inflows to future time at 12%

$= (8,20,000 - 1,10,000)\ (F/A, 12\%, 10) + 2,25,000$

$= 7,10,000 \times 17.5487 + 2,25,000$

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$\therefore$ ΣR_C = Rs. 1,26,84,577

We know,

ΣE_C (F/P, i'%, N) = ΣR_C

or, $24,00,000 (1 + i')^{10} = 1,26,84577$

or, $(1 + i')^{10} = 5.285$

or, $1 + i' = 5.285$

or, $1 + i' = 1.1811$

$\therefore$ i'% = 18.11

Hence, ERR (18.11%) > MARR (10%), so acceptable.

Project B:

Discounting all the cash outflows to present time at 12%

ΣE_C = Rs. 35,50,000

Compounding all the cash inflows to future time at 12%.

= (12,00,000 – 1,40,000) (F/A, 12%, 10) + 3,50,000

= 10,60,000 × 17.5487 + 3,50,000

ΣR_C = Rs. 1,89,51,659

We know

ΣE_C (F/P, i'%, N) = ΣR_C

or, $3,50,50,000 (1 + i')^{10} = 1,89,51,659$

or, $(1 + i')^{10} = 5.3384$

or, $1 + i' = 1.1822$

$\therefore$ i'% = 18.22%

Hence, ERR (18.22%) > MARR (12%), So acceptable.

Performing the incremental analysis:

Selecting project A as base alternative.

Incremental cash flows:

Items	Project A	Project B	Project B – Project A
Initial investment	24,00,000	35,50,000	11,50,000
Annual revenue	8,20,000	12,00,000	380,000
Annual expenses	1,10,000	140,000	3000
Salvage value	22,5000	3,50,000	1,25,000

Incrementing all the cash outflows to present time at 12%.

ΣE_C = Rs. 11,50,000

Compounding all the cash inflow to future time at 12%

= (380,000 – 30,000) (F/A, 12%, 10) + 1,25,000

= 350,000 × 17.5487 + 1,25,000

ΣR_C = Rs. 62,045

Establishing the equivalence between the equation at i'% by

ΣE_C (F/P, i'%, N) = ΣR_C

or, $1,15,000 (1 + i')^{10} = 62,67,045$

or, $(1 + i')^{10} = 5.449$

or, $1 + i' = 1.1847$

or, i'% = 18.47

$\therefore$ ERR = i' = 18.47% > MARR

The extra investment in the project B is justified. Hence, it is best to select project B for more profit.

3. **From the following 2 mutually exclusive projects, determine the best one project using discounted payback period method.**

Project	A	B
Initial investment (Rs.)	4,00,000	6,00,000
Net annual revenue (Rs.)	1,10,000	1,35,000

Salvage value = 20% of initial investment; N = 5 years.

Solution:

Using discounted playback period method:

Project A:

EOY	Cash flow (F)	PW of net cash flow at i = 15%	Cumulative cash flow
0	–4,00,000	–4,00000	–4,00,000
1	1,10,000	95,652	–3,04,348
2	1,10,000	83,176	–2,21,172
3	1,10,000	72,327	–1,48,845
4	1,10,000	62,893	–85,952
5	1,90,000	94,464	8,512

PW (at i = 15%) = $F(1 + i)^{-N}$

PW for 1st year = $1,10,000 \times (1 + 0.15)^{-1} = 95,625$

PW for 2nd year = $1,10,000 \times (1 + 0.15)^{-2} = 83,176$

PW for 3rd year = $1,10,000 \times (1 + 0.15)^{-3} = 72,327$

PW for 4th year = $1,10,000 \times (1 + 0.15)^{-4} = 62,893$

PW for 5th year = $1,10,000 \times (1 + 0.15)^{-5} = 94,464$

Here, cumulative cash flows turns into positive in the year 5. By interpolating,

$\therefore$ Discounted playback period (θ') = $4 + \frac{85,952}{94,464} = 4.909$ years.

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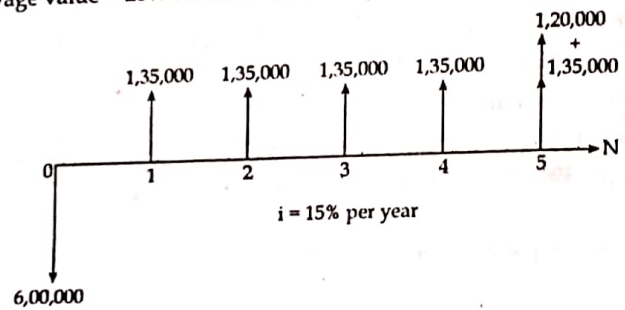
Project B:

EOY	Cash flow (F)	PW of net cash flow at i = 15%	Cumulative cash flow
0	-6,00,000	-6,00000	-6,00,000
1	1,35,000	1,17,391	-4,82,609
2	1,35,000	1,02,079	-3,80,530
3	1,35,000	88,765	-2,91,765
4	1,35,000	77,187	-2,14,578
5	2,55,000	1,26,780	-87,798

∵ Salvage value = 20% of Rs. 6,00,000 = Rs. 1,20,000



Here, cumulative cash flow does not change into positive in 5 years. It indicates that the required payback period is more than 5 years.

Hence, we should choose project A as a best one which has payback period of 4.90 years.

Chapter 6

RISK ANALYSIS

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6.1 ORIGINAL SOURCES OF PROJECT RISKS

Risk is the possibility of loss or injury. Project risk is an uncertain event or condition that, if it occurs, has an effect on atleast one project objective. The term project risk is used to refer variability in a project's NPW. A grater project risk means a greater variability in a project's NPW *i.e.*, risk is the potential for loss. Three are four major sources of risk and uncertainty that affect project's Net present value *i.e.*, engineering economy studies.

1. Study Period

Longer study period generally increases the uncertainty of a capital investment and economic return. While shorter study period generally decreases the uncertainty of a capital investment and economic return. Hence, study period is a source of project risk.

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2. **Nature of Business**

Nature of business is another source of risk and uncertainty. All business are of not same nature because some types of business operation are less stable than others while some are more stable than others. The level of risks depend upon the nature of business. *For example*, mining projects are more risky than horticulture projects with the expectation of income generation and stability.

3. **Cash Flow Estimate**

The accuracy of the cash inflow estimate is difficult to determine. A cash flow enables us to create a short term forecasts that enables us to determine how we are going to get money for the project and how we are going to pay for our expenses. The estimate would become uncertain of fair degree of reliance is not adopted.

4. **Rate of Interest**

Change in interest rate affect the public's demand for goods and services and thus, aggregates investment spending. A decrease in interest rates lowers the cost of borrowing, which encourages business to increase investment spending. Change in interest rate is a major rate of interest and its stability, current health of economy and future expectation of economic conditions are responsible.

6.2 METHOD OF DESCRIBING PROJECT RISKS

There are three methods for describing project risk:

i) Breakeven analysis
ii) Sensitivity analysis
iii) Scenario analysis

6.2.1 BREAKEVEN ANALYSIS (BEA)

Breakeven analysis in economics, business and cost accounting refers to the point in which total and total revenue are equal. A breakeven point analysis is used to determine the number of units or revenue needed to cover total costs (fixes and variable costs). It is the most common methodology used for economic evaluation of new investment alternatives.

Breakeven analysis for a single project

Total cost (C_T) = Fixed cost (C_F) + Variable cost (C_V)

The linear relationship assumed for the variable costs.

$$C_V = V_C(X)$$

where,

V_C = Variable cost per unit output

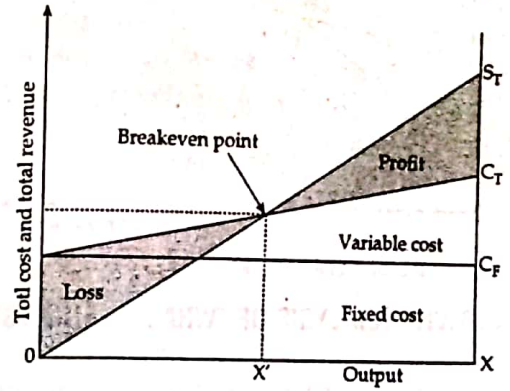
X = Quantity of product

Hence,

$$C_T = C_F + V_C(X)$$

The total sales revenue (S_T) during the same period is $S_T = S_P(X)$

where, S_P = selling price per unit output.



In above figure, at breakeven output volume (X')

$$S_T = C_T$$

or, $S_P(X') = C_F + V_C(X')$

or, $C_F = X'(S_P - V_C)$

or, $X' = \dfrac{C_F}{S_P - V_C}$

Hence, to determine breakeven point or output volume.

$$\therefore \quad X' = \frac{C_F}{S_P - V_C}$$

To reach a breakeven position, the selling price has to be greater than the variable cost per unit. At the breakeven point, the organization will neither make profit nor incur any loss.

Steps to determine breakeven point of common variable

- Define the common variable and its dimensional units
- Use PW or AW method to express the total cost of each alternative as a function of the common variable
- Equate the two relations and solve for the breakeven value of the variable

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- If the predicted level is below than breakeven value, select alternative with the higher variable costs. If the predicted level is above than breakeven value, select the alternative with lower variable costs.

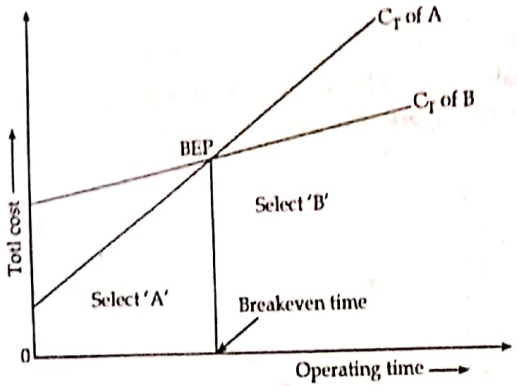

Fig: BEA and mutually exclusive project.

6.2.2 SENSITIVITY ANALYSIS OR "WHAT IF" ANALYSIS

Sensitivity analysis reveals how much the NPW of a project will project change in response to a given change in one input parameter. A convenient and useful way to present the results of a sensitivity analysis is to plot sensitivity graphs. The slope of the line show how sensitive the NPW is to change in each of the input. The sleeper the slope, the more sensitive the NPW is to a change in a particular variable/parameter.

Hence, sensitivity graph identify the crucial variables that affect the final outcome most. Graphical displays provides a useful means to communicate the relative sensitivities of the different variables to the corresponding NPW value.

6.3.3 SCENARIO ANALYSIS

Scenario analysis is the process of calculating the value of a specific investments under a variety of scenarios i.e., future possibilities. A more comprehensive approach to deal with uncertainty than sensitivity analysis and breakeven analysis is scenario analysis. It examines several possible situations, usually worst, care, most likely case and best case.

Scenario analysis is a way of structuring thinking about the future of identifying potential problems and also of increasing preparedness handle them. It is a technique that considers that sensitivity of NPW due to change in key variables at a time and the range of likely values of those variables.

BOARD EXAM SOLVED PROBLEMS

1. **What do you mean by project risk? Explain briefly about the methods of project risk management.** **[17/F]**

Ans: There are host of external factors which may play a role in determining the outcome regarding whether Q project has been successful or not. These are called project risk. Project risk is defined as, "An uncertain event or condition that if it occurs has a positive or negative effect on a project's objectives.

Method of project risk management are:

Risk management is a method of controlling the uncertainties in a project that is anything that may stop the project from achieving its goals. The aim of risk management is to minimize uncertainties and ensure that the project is delivered on time.

i) Identify the risks:
Risk identification is the first and most important step. It involves an exchange of opinions about each step of the project.

ii) Analyze the risks:
The analysis of identified risk is a lengthy process, but it forms the foundation of all ensuring risk management Determine what drives each of the identified risks. Readily available or specially desired software can facilitate this analysis.

iii) Prioritize risks:
This is the process where a risk manager has to decide which risks he will take action against and those resources available to the project.

iv) Create action plans:
Action plans begin by preventing risks or reducing the impact of identifiable risks. This ensures the use of correct materials instead of a cheap substitutes during a production process.

v) Risk transfer:
Insurance coverage is the classic version of risk transfer. The insurance provider indemnities against any loss after an agreed deductible.

vi) Monitor progress:
The final step is a continuous monitoring of project's starts to identify any changes in risks. Project managers should hole reviews revenues of ongoing risks and amend action or contingency plans accordingly.

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2. Write the notes on Breakeven analysis. **[12/F, 13/F, 14/F]**

Ans: Refer topic 6.2.1.

Advantages of breakeven analysis:

- Simple to conduct and understand.
- Can cope with changing circumstances.
- Shows profit and loss at different level of output.

Disadvantages of breakeven analysis:

- Assumes that all output is sold at a given price.
- Assumes production and sales are the same.
- Breakeven charts may be time consuming to prepare.
- No semi-variable costs.
- Relies in accuracy and quality of data.

Factor affecting breakeven

Internal factors:

- Employing extra sales staff
- Price increases
- Automation replaces direct labour

External factor

- Recession cuts demand.
- Price war forces price cut.
- Inflation pushes up direct costs.

3. Write short notes on sources of project risk. **[18/S]**

Ans: Refer topic 6.1 and 6.2.2.

Advantages of sensitivity analysis:

- It compels the decision maker to identify the variables which affect the cash flow forecasts. This helps him in understanding the investment project in totality.
- It helps to expose inappropriate forecasts and thus guides the decision maker to concentrate on relevant variables.

Disadvantages of sensitivity analysis:

- It does not provide clear cut results. The terms optimistic and pessimistic could mean different things to different people.
- It fails to focus on the interrelationship between underlying variables. *For example*; sales volume may be related to price and cost but we analyze each variable differently.

5. Define the sensitivity analysis.

Ans: Refer topic 6.2.2. **[17/S]**

6. From the following information, find how many hours/year would be the motors have to be operated at full load for annual cost to be equal? MARR = 15% per year. **[11/F]**

Motor	A	B
Purchase cost	Rs. 1,25,000	Rs. 1,60,000
Efficiency	74%	92%
Life	10 years	10 years
Maintenance cost	Rs. 5000/year	Rs. 2500/year

Annual tax and insurance = 1.5% of investment for both motors.

Electricity cost = Rs. 5/KWhr

Power of both motors = 100 Hp.

Solution:

For motor A:

Capital recovery cost = 1,25,000 (A/P, 15%, 10)

= 1,25,000 × 0.1993

≈ Rs. 24,912.50

Maintenance cost = Rs. 5000

Tax and insurance = 1.5% of 1,25,000 = Rs. 1,875

Operating expenses for power (electricity cost):

We know,

$$\text{Efficiency, } \eta = \frac{\text{Output}}{\text{Input}}$$

$$\therefore \quad \text{Input} = \frac{\text{Output}}{\eta}$$

Let, 'x' be the number of hours of operation per year operating expenses

= Input × Rate × Hours of operation

$$= \frac{\text{Output}}{\eta} \times \text{Rate} \times \text{Hours of operation}$$

$$= \frac{(100 \times 0.746)}{0.74} \times 5 \times x \qquad [\because 1 \text{ Hp} = 0.746 \text{ KW}]$$

$= 504.054 \times x$

Therefore, total annual cost for motor A

= Rs. (24,912.50 + 5,000 + 1,875 + 504.054 x)

= Rs. 31,787.50 + 504.054 x (1)

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For motor B:

Capital recovery cost = 1,60,000 (A/P, 15%, 10)
= 1,60,000 × 0.7993
= Rs. 31,888

Maintenance cost = Rs. 2,500

Tax and insurance = 1.5% of 1,60,000 = Rs. 2,400

Now, operating expenses = $\frac{(100 \times 0.746)}{0.92}$ = 405.44x

Therefore, total annual cost for motor B
= Rs. (31,888 + 2,400 + 2,500 + 405.43x)
= Rs. 36,788 + 405.43x (2)

To get breakeven point

AW of A = AW of B

or, 31,787.50 + 504.054x = 36,788 + 405.44x

or, 98.614 x = 5,000.50

or, $x = \frac{5,000.50}{98.614}$

∴ x = 50.707 hours per year.

Hence, the motors have to be operated for 50.70 hours per year at full load for the annual costs to be equal.

7. **Following information has been obtained regarding two motors. [12/F]**

Motor	A	B
Size	100 Hp	120 Hp
Cost (Rs.)	1,30,000	1,56,000
Life in year	20	20
Salvage value (Rs.)	0	0
Efficiency	89.50%	93%
Annual maintenance cost (Rs.)	8000	250
Electricity cost (Rs.)	6/KWhr	6/KWhr

Annual tax and insurance = 2% of investment for both motors.

i) **At what operating how are they equivalent?**

ii) **If the motor have to be operated 55 hrs a year, which on should be selected? Take MARR = 10% per year.**

Solution:

For motor A:

Capital recovery cost = 1,30,000 (A/P, 10%, 20)
= 1,30,000 × 0.1175
= Rs. 15,275

Maintenance cost = Rs. 8000

Tax = 2% of 1,30,000 = Rs. 2600

We know,

$$\text{Efficiency } (\eta) = \frac{\text{Output}}{\text{Input}}$$

$$\text{or, Input} = \frac{\text{Output}}{\text{Efficency}}$$

Let 'x' be the numbers of hours of operation per year.

Operating expenses
= Input × Rate × Hours of operation

$= \frac{\text{Output}}{\eta} \times \text{Rate} \times \text{Hours of operation}$

$= \left(\frac{100 \times 0.746}{0.895}\right) \times 6 \times x$

= 500.12 x

Total annual cost for motor A (AW of A)
= Rs. 15,275 + 8,000 + 0 + 2,600 + 500.12x
= Rs. 25,875 + 500.12x (1)

For motor B:

Capital recovery cost = 1,56,000 (A/P, 10%, 20)
= 1,56,000 × 0.1175
= Rs. 18,330

Maintenance cost = Rs. 2,500

Tax = 2% of 1,56,000 = Rs. 3,120

Operating expenses = $\left(\frac{120 \times 0.746}{0.93}\right) \times 6 \times x$ = 5.77.55 x

Total annual cost for motor A (AW of B):
= Rs. 18,330 + 250 + 3120 + 0 + 577.55x
= Rs. 21,700 + 577.55x (2)

To get breakeven point

AW of A = AW of B

or, 25,875 + 500.12x = 21,700 + 577.55x

or, 77.43x = 4175

∴ x = 54 years

i) Hence the motors should be operated for 54 hours per year at full load for the annual costs to be equal.

ii) If annual operation is more than 55 years, motor B is selected.

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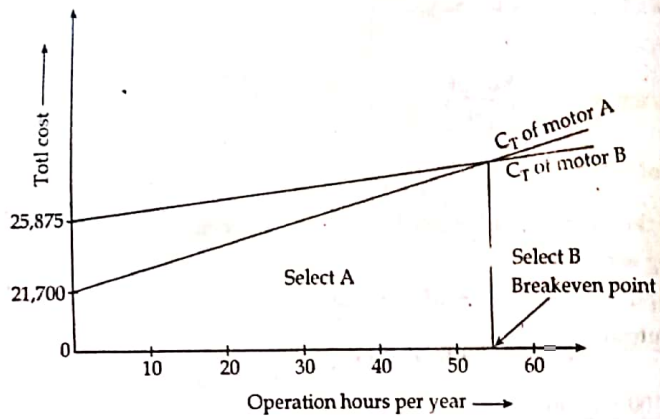

8. Perform the sensitivity analysis of the following project over the range of ± 25% in (i) initial investment (ii) annual revenue (iii) useful life. [15/F]

Initial investment = 11,500

Annual revenue = 3,000

Salvage value = 1,000

MARR = 10% per year

Useful life = 6 years

Solution:

N = 6 years

MARR = 20% per year

I = Rs. 11,500

R = Rs. 3,000

S = Rs. 1,000

We have

$PW(i\%) = -I + R\,(P/A, i\%, N) + S(P/F, i\%, N)$

$= -11{,}500 + 3{,}000\,(P/A, 10\%, 6) + 1{,}000\,(P/F, 10\%, 6)$

$= -11{,}500 + 3{,}000 \times 4.3552 + 1{,}000 \times 0.5644$

= Rs. 2,130

i) When initial investment (I) varies ± 25%, the PW would be

At I = +25%

PW = –11,500 × 1.25 + 3,000 × 4.3552 + 1,000 × 0.5644 = Rs. –745

At I = –25%

PW = –11,500 × 0.75 + 3,000 × 4.3552 + 1,000 × 0.5644 = Rs. 5005

ii) When annual revenue varies ± 25%, the PW would be

At AR = +25%

PW = –11,500 + 3,000 × 4.3552 × 1.25 + 1,000 × 05644 = Rs. 5396.40

At AR = –25%

PW = –11,500 + 3,000 × 4.3552 × 0.75 + 1,000 × 0.5644 = Rs. –1136.40

iii) When useful life varies ± 25%, the PW would be

At N = +25%

$PW = -11{,}500 + 3{,}000\,(P/A, 10\%, 7.5) + 1{,}000\,(P/F, 10\%, 7.5)$

$= -11{,}500 + 3{,}000 \times \left[\dfrac{(1+0.10)^{7.5}-1}{0.10\,(1+0.10)^{7.5}}\right] + 1{,}000\,(1+0.10)^{-7.5}$

$= -11{,}500 + 3{,}000 \times 5.1073 + 1{,}000 \times 0.4892$

= Rs. 4310

At N = –25%

$PW = -11{,}500 + 300\left[\dfrac{(1+0.10)^{4.5}-1}{0.10\,(1+0.10)^{4.5}}\right] + 100 \times (1+010)^{-4.5}$

$= -11{,}500 + 300 \times 3.4878 + 1{,}000 \times 0.65122$

= Rs. –385.38

Calculation table:

Parameters	PW (10%)		
	–25%	0	+ 25%
I	5,005	2,130	–745
AR	–1,136.40	2,130	5,396.40
N	–385.38	2,130	4,310

9. Perform the sensitivity analysing using PW method. (Choose the suitable range that you prefer). [15/S]

Initial investment = Rs. 1,00,000

Annual revenue = Rs. 4,00,000

Annual expenses = Rs. 5,000

Salvage value = Rs. 1,000

Life = 6 years

MARR = 12% per year

i) Initial investment

ii) Annual revenue

iii) Useful life

Solution:

$PW\,(12\%) = -1{,}00{,}000 + (4{,}00{,}000 - 5{,}000)\,(P/A, 12\%, 6) + 1{,}000 \times (P/F, 12\%, 6)$

$= -1{,}00{,}000 + 35{,}000 \times 4.1114 + 1{,}000 \times 0.5066$

= Rs. 44,496.60

Choosing variation of ± 20%

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i) Initial investment:

At I = + 20%

PW = –1,00,000 × 1.20 + 35,000 × 4.114 + 1,000 × 0.5066

= Rs, 14,405.60

At I = – 20%

PW = –1,00,00 × 0.8 + 35,000 × 4.114 + 1,000 × 0.5066

= Rs. 64,496.60

ii) Annual revenue

At AR = + 20%

PW = –1,00,000 + 35,000 × 4.114 × 1.20 + 1,000 × 0.5066

= Rs. 73,295.60

At AR = –20%

PW = –1,00,000 + 35,000 × 4.11 × 0.80 + 1,000 × 0.5066

= Rs. 15,698.60

iii) Useful life

At N = + 20%

PW = –1,00,000 + 35,000 (P/A, 12%, 7.20) + 1,000 (P/F, 12%, 7.20)

$$= -1,00,000 + 35,000\left[\frac{(1+0.12)^{7.20}-1}{0.12\,(1+0.12)^{7.2}}\right] + 1,000\,(1+0.12)^{-7.2}$$

= –1,00,000 + 35,000 × 4.6483 + 1,000 × 0.4422

= Rs. 63,143.7

At N = –20%

PW = –1,00,000 + 35,000 (P/A, 12%, 4.8) + 1,000 (P/F, 12%, 4,8)

$$= -1,00,000 + 35 \times \left[\frac{1.12^{4.8}}{0.12 \times 1.12^{4.8}}\right] + 1,000 \times 1.12^{-4.8}$$

= –1,00,000 + 35,000 × 3.4964 + 1,000 × 0.5804

= Rs. 22,954.40

Sensitivity table:

Parameters	PW (12%)		
	–20%	0	20%
AR	15,698.60	44,496.6	73,394.60
N	22,954.40	44,496.6	63,132.70
I	64,496.60	44,496.6	24,405.60

10. Analyze the sensitivity of present worth to ±40% deviation change of the project having investment = Rs. 11,500, useful life = 10 years; MARR = 10% on [17/S]

i) Interest

ii) Life

Solution:

N = 10 years

MARR = 10%

R = Rs. 5,000

E = Rs. 2,000

I = Rs. 11,500

S = Rs. 1,000

Using PW formulation,

PW(i%) = –I + (R – E) (P/A, i%, N) + S(P/F, i%, N)

PW(10%) = –11,500 + (5,000 – 2,000) (P/A, 10%, 10) + 1,000 (P/F, 10%, 10)

= –11,500 + 3,000 × 6.1446 + 1,000 × 0.3855

= Rs. 7,325.30

i) N = ± 40%

At N = +40%

PW = –11,500 + 3,000 (P/A, 10%, 14) + 1,000 (P/F, 10%, 14)

= –11,500 + 3,000 × 7.3667 + 1,000 × 0.2633

= Rs. 10,863.40

At N = –40%

PW = –11,500 + 3,000 (P/A, 10%, 6) + 1,000 (P/F, 10%, 6)

= –11,500 + 3,000 × 4.3553 + 1,000 × 0.5645

= Rs. 2,130.40

ii) Interest

At MARR = 40%

PW = –11,500 + 3,000 (P/A, 14%, 6) + 1,000 (P,F, 14%, 6)

= –11,500 + 3,000 × 3.887 + 1,000 × 0.4556

= Rs. 621.70

At MARR = –40%

PW = –11,500 + 3,000 (P/A, 6%, 6) + 1,000 (P/F, 6%, 6)

= –11,500 + 3,000 × 4.9173 + 1,000 × 0.7050

= Rs. 3,957

Sensitivity table:

Parameters	PW (10%)		
	–40%	0	40%
MARR	3,957	7,325.30	621.70
N	2,130.40	7,325.30	10,863.40

11. If sales = Rs. 80000, fixed cost = Rs. 15000, variable cost = Rs. 35000, find profit and break even volume. [17/S]

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Solution:

Fixed costs, C_F = Rs. 15,000

Variable costs, C_V = Rs. 35,000

Sales costs, S_T = Rs. 80,000

Profit = ?

Breakeven volume = ?

We know

Let production unit = 1,000 units = Q

Total cost, $C_T = C_F + C_V$

$= 15{,}000 + 35{,}000$

= Rs. 50,000

Variable cost per unit, $V_C = \frac{C_V}{Q} = \frac{35{,}000}{1{,}000} = 35$ per unit.

Selling price per unit $(S_P) = \frac{ST}{Q} = \frac{80{,}000}{1{,}000} = 80$ per unit.

$\therefore$ Breakeven output volume $= \frac{C_F}{S_P - V_C} = \frac{15{,}000}{(80-35)} = 333.33$ units

and profit = Total sales amount – Total cost

= Rs. (80,000 – 50,000)

= Rs. 30,000

12. From the following information, conduct scenario analysis based on FW formation. Assume I = 2,25,000, MARR = 13.5%, life of project is 5 years. Also give your remarks based on results of different scenarios. **[18/S]**

Variable considered	Worst case scenario	Most likely scenario	Best case scenario
Annual sales	86,000	1,10,000	1,37,000
Annual variable costs	37,000	40,000	38,000
Annual fixed costs	21,000	20,000	18,000
Salvage value	40,000	50,000	60,000

Solution:

I = Rs. 2,25,000

MARR = 13.5%

N = 5 years

i) Worst case scenario

FW(13.5%) = –2,25,000 (F/P, 13.5%) + (86,000 – 37,000 – 21,000) (F/A, 13.5%, 5) + 40000

= –2,25,000 × 1.8836 + 28,000 × 6.5448 + 40,000

= Rs. – 2,00,556.60 (loss)

ii) Most likely scenario

FW(13.5%) = –2,25,000 (F/P, 13.5%, 5) + (1,10,000 – 40,000 – 20,000) (F/A, 13.5%, 5) + 50,000

= –2,25,000 × 1.8836 + 50,000 × 6.5448 + 50,000

= Rs. –46,570 (loss)

iii) Best case scenario

FW (13.5%) = –2,25,000 (F/P, 13.5%, 5) + (1,37,000 – 38,000 – 18,000) (F/A, 13.5%, 5) + 60,000

= Rs. 1,66,318.80 (profit)

Scenario analysis indicates that there is risk for investment in worst case and most likely scenario while there is no risk for investment in best case scenario.

13. Perform sensitivity analysis of the following over a range of –10 to + 30% in initial investment, –10 to +10% in useful life and –20% to 20% in MARR. Draw sensitivity diagram and decide the most sensitive parameter. **[18/F]**

Initial cost	Annual income	Useful life	Salvage value	MARR
20 crore	3 crore	30 years	0	10%

Solution:

I = Rs. 20 crore

AR = Rs 3 crore

N = 30 years

S = Rs. 0

MARR = 10% per year

We know

PW (10%) = –20,00,00,000 + 3,00,00,000 (P/A, 10%, 30)

= –20,00,00,000 + 3,00,00,000 × 9.4269

= Rs. 8,28,07,000

i) Change in I

If I = –10%

PW = –20,00,00,000 × 0.9 + 3,00,00,000 × 9.4269

= Rs. 1,02,807,000

If I = + 10%

10 of 20 %

$= 10 \times \frac{20}{100}$

= 2

∴ MARR percentage

MARR = 12

MARR = 9%

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PW = -200000,000 × 1.1 + 3,00,00,000 × 9.4269
= Rs. 6,28,07,000

If I = -30%, PW = Rs. 14,28,07,000

If I = -30%, PW = Rs. 2,28,07,000

ii) Change in N

If N = -10%

PW = -20,00,00,000 + 3,00,00,000 (P/A, 10%, 27)
= -20,00,00,000 + 3,00,00,000 × 9.2372
= Rs. 77116000

If I = + 10%

PW = -20,00,00,000 + 3,00,00,000 × (P/A, 10%, 33)
= -20,00,00,000 + 3,00,00,000 × 9.5694
= Rs. 8,70,82,000

iii) Change in MARR

If MARR declines by 20%. *i.e.*, MARR = 8%

PW(8%) = -20,00,00,000 + 3,00,00,000 × (P/A, 8%, 30)
= -20,00,00,000 + 3,00,00,000 × 11.2578
= Rs. 137734000

If MARR increases by 20%, *i.e.*, MARR = 12%

PW(12%) = -20,00,00,000 + 3,00,00,000 × (P/A, 12%, 30)
= -20,00,00,000 + 3,00,00,000 × 8.0552
= Rs. 4,16,56,000

Parameters	PW (10%)						
	-10%	-20%	-30%	0	10%	20%	30%
I	10.28	12.28	14.28	8.28	6.28	4.28	2.28
N	7.71	-	-	8.28	8.70	4.16	-
MARR	-	13,77	-	8.28	-	4.16	-

Hence, MARR parameter of the project is highly sensitive compare to other parameter. It is followed by investment parameter and useful life parameter respectively.

14. Explain with example why the decision criteria of present worth (*i.e.*, PW or net present value) conflicts with decision criteria of IRR and how this can be overcome? [16/S]

Ans: Net present value (NPV) is an absolute measure, *i.e.*, it represents the dollar amount of value added or lost by undertaking a project. IRR on the other hand is a relative measure i.e., it is the rate of return a project offers over its life span.

NPV and IRR are two of the most widely used investment analysis and capital budgeting decision tools. Both are discounting models

i.e., they take into account the time value of money phenomena. However, each method has its strength and weakness and there are situations in which they do not agree on the ranking of acceptability of projects.

For example; There might be a situation in which project A has higher NPV but low IRR than project B. This NPV and IRR conflict depends on whether the projects are independent or mutually exclusive.

NPV Vs IRR conflict also arises due to different cash flow distribution. IRR inherently assume that any cash flows can be reinvested at the IRR. This assumptions is unrealistic be achieved. NPV on the other hand assumes reinvestment at the cost of capital, which is conservative and realistic.

For example; Project A requires $10 million investments and generates $10 million each in year 1 and year 2. It has NPV of $7.4 million @ 10% discount rate and IRR of 61.8%. Project B requires $1 million investment and generates @2 million in year 1 and $1 million in year 2. It's NPV @10% and IRR turn out to be $1.6 million and 141.4%. Based on NPV on would conclude that project A is better but IRR offers a contradictory view. This conflict arose mainly due to the size of the project.

Comparison of Strength and Weakness

NPV is theoretically sound because it has realistic investment assumption. It consists the cost of capital and provides a dollar value estimate of value added, which is easier to understand. Another very important feature of NPV analysis is its ability to notch the discount rate up and down to allow for different risk level of the project. However, NPV is dependent on the size of the project. IRR is not affected by the size of the project.

IRR is also easier to calculate because it does not require estimation of cost of capital or hurdle rate. It just requires initial investment and cash flow. However, this same convenience can become a disadvantage if projects are accepted without comparison to cost of capital. However, IRR's assumption of reinvestment at IRR is unrealistic and could result in inaccurate ranking of projects.

Conclusion

Whenever there is a conflict in ranking of project based on NPV and IRR, it is safer to always prefer the NPV ranking. This is due to the realistic assumption and theoretical soundness of the method. However, IRR is a greater complement to the NPV.

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ADDITIONAL PROBLEMS

1. The details of production costs and revenues of a project are as under:

Total cost = Rs. 90,000
Fixed cost = Rs. 30,000
Sales cost = Rs. 1,10,000
Sales volume = 10,000

Find breakeven point in terms of number of units. What should be the output if the profit desired is Rs. 50,000?

Solution:

We know

Total cost (C_T) = Fixed cost (C_F) + Variable cost (C_V)

or, $C_V = C_T - C_F$

or, $C_V = 90{,}000 - 30{,}000$

$\therefore$ C_V = Rs. 60,000

Now, variable cost per unit,

$$C = \frac{60{,}000}{10{,}000} = \text{Rs. 6 per unit}$$

Selling price per unit,

$$S_P = \frac{1{,}10{,}000}{10{,}000} = \text{Rs. 11 per unit}$$

So,

i) $$Q_{BEP} = \frac{C_F}{(S_P - V_C)} = \frac{30{,}000}{(11-6)} = 6{,}000 \text{ units}$$

ii) If the desired profit is Rs. 5,000

Profit = Total sales – Total cost

or, $50{,}000 = S_P \cdot Q - (C_F + C_V)$

or, $50{,}000 = S_P \cdot Q - (30{,}000 + V_C \times Q)$

or, $50{,}000 = S_P \cdot Q - 30{,}000 - V_C \cdot Q$

or, $50{,}000 = (S_P - V_C)Q - 30{,}000$

or, $80{,}000 = (11-6)Q$

or, $Q = \frac{80{,}000}{5}$

$\therefore$ $Q = 16{,}000$

Hence, required units for the profit to be Rs. 5,000 is 16,000 units.

2. **From the following information, calculate NPW for each scenario by assuming I = 1,25,000, MARR = 15% and N = 7 years.**

Variable considered	Worst case scenario	Most-likely scenario	Best-case scenario
Unit demand/yr	1,600	2,000	2,400
Unit price (Rs.)	48	50	53
Variable cost (Rs.)/unit	17	15	12
Fixed cost (Rs.)/yr	11,000	10,000	8,000
Salvage value	30,000	40,000	50,000

Solution:

i) Worst-case scenario

NPW(15%) = –1,25,000 + (1,600 × 48 – 1,600 × 17 – 11,000) × (P/A, 15%, 7) + 30,000 (P/F, 15%, 7)

= –1,25,000 + 60,000 × 4.1604 + 30,000 × 0.3759

= Rs. 46,868.44 (Profit)

ii) Most-likely scenario

NPW(15%) = –1,25,000 + (2,000 × 50 – 2,000 × 15 – 1,00,000) × (P/A, 15%, 7) + 40,000 (P/F, 15%, 7)

= –1,25,000 + 60,000 × 4.1604 + 40,000 × 0.3759

= Rs. 1,39,660 (Profit)

iii) Best-case scenario

NPW(15%) = –1,25,000 + (2,400 × 53 – 2,400 × 12 – 8,000) × (P/A, 15%, 7) + 50,000 (P/F, 15%, 7)

= –1,25,000 + 90400 × 4.1604 + 50,000 × 0.3759

= Rs. 2,69,895 (Profit)

Scenario analysis indicates that there is no risk for investment.

3. **An estimation of a new model generator has the following information.**

Purchase cost (Rs.)	3,00,000
Annual maintenance cost (Rs.)	8,000
Annual energy at full load	12,000 KW
Value of energy generated	Rs. 4/KWhr
Salvage value (Rs.)	80,000
MARR	10% per year

Determine how long will it operate for breakeven point?

Solution:

MARR = 10% per year

I = Rs. 3,00,000

S = Rs. 80,000

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E = Rs. 8,000

R = 12,000 × 4 = Rs. 48,000

N = ?

We know,

Using FW formulation

$$-3,00,000\ (F/P, 10\%, N) + (48,000 - 8,000)\ (F/A, 10\%, N) + 80,000 = 0$$

or, $-3,00,000 \times (1 + 0.10)N + 40,000 \times \left[\frac{(1 + 0.10)^N - 1}{0.10}\right] + 80,000 = 0$

or, $-3,00,000 \times 1.10N + 40,000 \times 1.10^N - 4,00,000 \times 1 + 80,000 = 0$

or, $1.10^N\ [4,00,000 - 3,00,000] = 32,000$

or, $(1,10)^N = \frac{3,20,000}{1,00,000}$

or, $(1.10)^N = 3.2$

Taking log on both sides

or, $N \log (1.10) = \log (3.2)$

or, $N = \frac{0.5052}{0.04139}$

∴ N = 12.205 years.

Hence, the new model generator has to operate for 12.205 years for breakeven point.

4. After what time we can obtain the breakeven point of the following project?

Initial investment	**Rs. 5,00,000**
Annual revenue	**Rs. 1,20,000**
Annual expenses	**Rs. 20,000**
Interest rate	**10%**

Solution:

Using FW formulation

or, $-5,00,000\ (F/P, 10\%) + (1,20,000 - 20,000)\ (F/A, 10\%, N) = 0$

or, $-5,00,000 \times (1 + 1.10)^N + 1,00,000 \times \left[\frac{(1 + 0.10)^N - 1}{0.10}\right] = 0$

or, $-5,00,000 \times (1.10)^N + 1,00,000 \times [(1.10)^N - 1] = 0$

or, $-5,00,000 \times 1.10^N + 1,00,000 \times 1.10^N - 1,00,000 = 0$

or, $1.10^N\ [1,00,000 - 5,00,000] = 1,00,000$

or, $1.10^N = \frac{10,00,000}{9,50,000}$

or, $1.10^N = 1.0526$

Taking log on both sides

or, $N \log (1.10) = \log (1.0526)$

or, $N = \frac{0.0227}{0.04139}$

∴ N = 0.538 years.

Hence, we can obtain breakeven point on 0.538 years.

5. Perform sensitivity analysis of the following project over the range of ±40% for

i) initial investment

ii) annual revenue

iii) useful life

Draw diagram also diagram

Initial investment = Rs. 100000

Annual revenue = Rs. 40000

Salvage revenue = Rs. 1000

MARR = 12%

Useful life = 6 years

Solution:

Using PW formulation

PW (12%) = −1,00,000 + 40,000 (P/A, 12%, 6) + 1,000 (P/F, 12%, 6)

= −1,00,000 + 40,000 × 4.1124 + 1,000 × 0.5066

= Rs. 64,962.60

i) When initial investment (I) varies ± 40%

At I = +40%

PW = −1,00,000 × 1.4 + 40,000 × 4.1114 + 1,000 × 0.5066

= Rs. 24,962.6

At I = −40%

PW = −1,00,000 × 0.6 + 40,000 × 4.1114 + 10,000 × 0.5066

= Rs. 10,4962.60

ii) When annual revenue (AR) varies ± 40%

At AR = +40%

PW = −1,00,000- + 40,000 × 4.1114 × 1.4 + 1,000 × 0.5066

= Rs. 130745

At AR = −40%

PW, = −1,00,000 + 40,000 × 4.1114 × 0.6 + 1,000 × 0.5066

= Rs. −819.80

iii) When useful life (N) varies ± 40%

At N = +40%

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$$PW = -1,00,000 + 40,000\,(P/A, 12\%, 8.4) + 1,000 \times (P/F, 12\%, 8.4)$$

$$= -1,00,000 + 40,000\left[\frac{(1.12)^{8.4} - 1}{0.12 \times (1.12)^{8.4}}\right] + 1,000 \times (1.12)^{-8.4}$$

$$= -1,00,000 + 40,000 \times 5.1168 + 10,000 \times 0.3859$$

$$= \text{Rs. } 1,05,057.90$$

At N = –40%

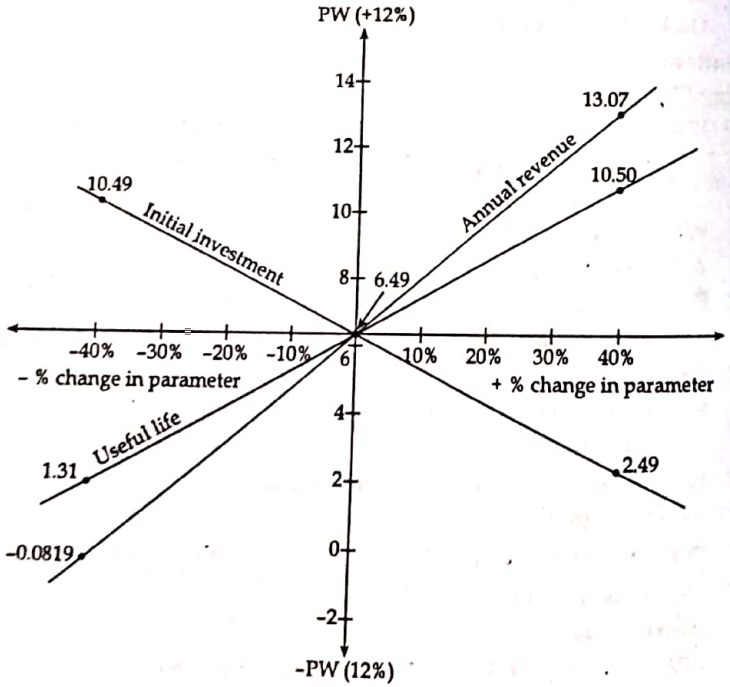
$$PW = -1,00,000 + 40,000\,(P/A, 12\%, 3.6) + 1,000 \times (P/F, 12\%, 3.6)$$

$$= -1,00,000 + 40,000 \times 2.7917 + 1,000 \times 1.5037$$

$$= \text{Rs. } 13,171.70$$

Sensitivity table (In X0000)

Parameters	PW (10%)		
	–40%	0	40%
I	10.49	6.49	2.49
AR	–0.081	6.49	13.07
N	13.17	6.49	1.31



From diagram, annual revenue (AR) parameter of the project is highly sensitive when compared to other parameters. *i.e.*, AR curve is more

steeper than other in diagram. It is followed by investment (I) parameter and useful life (N) parameter respectively.

6. **If cost of 20 watt CFL lamp is Rs. 3,000 whereas cost of 100 watt filament lamp is Rs. 40, but these bulbs have equal lighting power, which bulb do you prefer in your house? Why? Electricity cost is Rs. 15 per unit (KW-hour).**

Solution:

For CFL bulb:

Initial cost = Rs. 300

$$\text{Cost of use} = \frac{20}{1000} \times x \times 15 = 0.3x$$

Since, 1 kw = 1,000 watt

x = Number of hours lighting the lamp

∴ Total cost = Rs. (300 + 0.3x)

For filament lamp:

Initial cost = Rs. 40

$$\text{Cost of use} = \frac{100}{1,000} \times x \times 15 = 1.5x$$

∴ Total cost = Rs. (40 + 1.5x)

At breakeven situation,

Total cost of CFL lamp = Total cost of filament lamp

or, $300 + 0.3x = 40 + 1.5x$

or, $260 = 1.2x$

or, $x = \frac{260}{1.2}$

∴ x = 216 hours

In a day, we light the bulb for 4 hours in average. Hence, $x = \frac{216}{4} = 54$ days.

Since, I have to use for more than 54 days, I prefer to use CFL lamp in my house which will be less expressive in comparison to filament lamp.

7. **Find breakeven output level and current profitability position from the following information.**

Total cost = Rs. 12,00,000

Total variable cost = Rs. 4,00,000

Total income = 15,00,000 at production of 5,000 units.

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Solution:

Total cost (C_T) = Fixed cost (C_F) + Variable cost (C_V)

or, $C_F = C_T - C_V$

or, $C_F = 12,00,000 - 4,00,000$

$\therefore$ C_F = Rs. 8,00,000

Now,

$$\text{Variable cost per unit, } V_C = \frac{C_V}{Q} = \frac{4,00,000}{5,000} = 80 \text{ per unit}$$

$$\text{Selling price per unit, } S_P = \frac{S_T}{Q} = \frac{15,00,000}{5,000} = 300 \text{ per unit}$$

$$\therefore \quad \text{Breakeven output volume} = \frac{C_F}{S_P - V_C} = \frac{8,00,000}{(300 - 80)} = 3,636.36 \text{ units}$$

And

Profit = Total sales amount – Total cost

= Rs. 15,00,000 – Rs. 12,00,000

= Rs. 3,00,000

Hence, breakeven output level is 3,636.36 units and profit is Rs. 3,00,000.

Chapter 7

ECOLOGICAL LIMITS AND ECONOMIC DEVELOPMENT

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7.1.1 ECONOMIC THEORY

Economic theory is a particular way of explaining economics or an economic activity and its impact on various grounds. Economic theory involves generalization which are statements of general tendencies or uniformities of relationships among various elements of economic phenomena.

Economic theory is a broad concept for the explanation and understanding of the movement of goods in a market. Most of the traditional concept of economics is based on micro behaviour by explaining effect of individual economic event. Modern economic theory has tended to overlook about the importance of ecosystem, the use of land and environment for balancing ecological constraints that refers ecological economics.

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7.1.2 ECOLOGICAL LIMIT

The carrying capacity perspectives in particular holds that human impact on the biosphere should stay within some identifiable limits if we are to avoid abrupt shifts in its functioning and the loss of valuable life-support services. There are nine bio-physical thresholds (corresponding to domains of human influence over the earth system) that should not be transgressed. These includes biodiversity loss climate change, biochemical flows, land system change and so on. Staying within these limits would help secure the stability of the earth system in a state as close as possible to the favourable Holocene condition which is of paramount importance for the flourishing of human civilization. Hence, the suggestion that these limits define a 'safe operating space for humanity'.

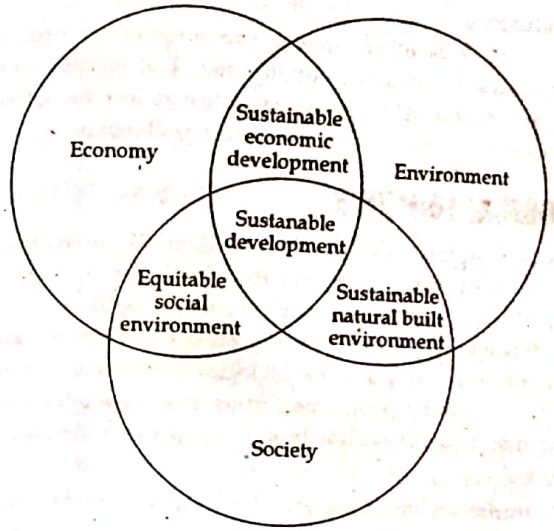
There are limits to the earth's capacity to act as a source of material inputs feeding for the economic system and sink for the wastage products. Hence functioning ecological mechanism of the earth to keep economic development with sustainable manner, there must be limiting availability of natural resources that technically refers ecological limit.

Economical constraints are limiting the availability of natural resources. In response to classical and neo-classical economics, the approaches of the two schools of thought-environmental economics and ecological economics was emerged. These two schools of thoughts are emerged in response to the challenges posed by the ecological limits on economic development. The environmental economics takes a more interdisciplinary approach of integrating ecological factors governing resources regeneration and waste absorption into the economic models.

7.2 CONCEPT OF SUSTAINABLE DEVELOPMENT

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development is a process for meeting human development goals while sustaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depends. Sustainable development ties together concern for the carrying capacity of natural systems with the social, political and economic challenges faced by humanity.

Sustainable development is a continuous process. There is an additional focus on the present generation's responsibility to regenerate, maintain and improve planetary resources for use by future generations.



Sustainable development has continued to evolved as that of protecting the world's resources while it's true agenda is to control the world's resources. Environmentally sustainable economic growth refers to economic development that meets the needs of all without leaving future generations with fewer natural resources than those we enjoy today. The essence of this form of development is a stable relationship between human activities and the nature world, which does not diminish the prospects for future generations to enjoy a quality of life at least as good as our own.

There are 3 primary objectives of sustainable development

1. Economic growth:

Building a strong, competitive economy by ensuring that sufficient land of the right type is available in the right places and at the right time to support growth and innovation, and indentifying then coordinating development requirement.

2. Environmental protection:

Contributing to protecting and enhancing our natural and developed environment, while helping to improve biodiversity, use natural resources wisely, minimizing waste and pollution and adapting to and helping to decrease climate change, including a global shift to low carbon economy.

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3. Social inclusion:

Supporting strong, vibrant and health communities by providing the supply of housing required to meet the needs of present and future generations, and by creating local services that reflect the community's needs and support its health, social and culture well-being.

7.3 ECOLOGICAL FOOTPRINT

The ecological footprint measures human demand on nature *i.e.*, the quantity of nature *i.e.*, the quantity of nature it tal s to support people or an economy. If is a measure of human impact on earth's ecosystem and reveals the dependence of the human economy on nature capital. The ecological footprint is defined as the biologically productive area needed to provide for everything people use: fruits and vegetables, fish, wood, fibers, absorption of carbondioxide from fossil fuel us and space for roads and buildings.

Ecological footprint standards use global hectares as a measurement unit. This makes ecological footprint globally comparable just as financial assessments. At a global scale, it is used to estimate how rapidly we are depleting natural capital. The world average ecological footprint in 2013 was 2.8 global hectares per person. The average per country ranges from over 10 to under 1 global hectares per person. There is also a high variation within countries, based on individual lifestyle and economic possibilities.

The formula of the ecological footprint is,

$$EF = \left(\frac{P}{YN}\right) \times YF \times EQF$$

where,

EF = ecological footprint

P = amount of a product harvested or waste emitted

YN = national average yield for P

YF = yield factors for the country and land use type

EQF = equivalence factor for the country and land use type

The ecological footprint, in its most basic from, is calculated using the following equation:

$$EF = \frac{D}{Y}$$

where,

D = annual demand of a product

Y = annual yield of the same product which is expressed in global hectares

For example;

- A person who walks or takes public transportation has a smaller footprint than someone who travels 50 km by a smart car.
- A family of 6 living in 120 m² area has a smaller footprint than a family of two living in 250 m² area.

7.4 OVERCOMING ECOLOGICAL LIMITS

If sustainable development is considered possible as per the holistic approach which takes account of the interactive relation between the human system and the ecosystem, overcoming ecological limit is possible. Technology and human values can also play a significant role in creating space for economic development by relaxing the ecological constraints. Also, delinking economic growth and the environment through dematerialization of development, decarbonization of energy, development of the renewable as alternative energy sources, recycling of wastes etc, taking an organic view of technology and resource development also help on overcoming ecological limit.

The role of institutions in shaping the character and implementation of sustainable development by realizing the potential of such delinking of economic growth and the natural environment is important for overcoming ecological limit. Also, to overcome ecological limit, the integration of the concerned ecological factors into primarily economic models of development should be done. Future, the framework and the methodological approach to neoclassical economics should be a mended to appropriate modification required for addressing such issues.

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BOARD EXAM SOLVED PROBLEMS

1. **Define ecological footprint. Explain the concept of sustainable development.** **[15/S, 18/S]**

Ans: Refer topic 7.3 and 7.2.

2. **Write short notes on ecological limit and ecological footprint.** **[16/S]**

Ans: Refer topic 7.1.2 and 7.3.

3. **Write short notes on ecological limit and sustainable development.** **[18/F, 17/F]**

Ans: Refer topic 7.1.2 and 7.2.

4. **Define ecological footprint.** **[17/S]**

Ans: Refer topic 7.3.

Chapter 8

DEPRECIATION AND CORPORATE INCOME TAXES

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8.1.1 DEPRECIATION AND ITS CAUSES

"Depreciation can be defined as a gradual decrease in utility of fixed assets with use and time" -Chan S. Park.

"Depreciation is the gradual and permanent decrease in the value of an capital assets from any cause". -R.N. Carter.

Depreciation is a process of allocation not of valuation.

8.1.1.1 Causes of Depreciation

a) Physical depreciation

Physical depreciation can be defined as the reduction in an asset's capacity to perform its intended service due to physical impairment. It can occur in any fixed assets in the form of:

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i) Wear and Tear: The continuous use of an asset makes it old and decrease in working capacity and hence the value of asset depreciates.
ii) Accidental causes due to natural disaster or by manmade disaster.
iii) Deterioration from interaction with the environment, including such agents as corrosion, rotting and other chemical change.

b) Functional depreciation

Functional depreciation occurs as a result of changes in the organization or in technology that decreases or eliminates the need for an asset. It is due to

i) Obsolescence: An existing asset may loss its usefulness due to an improvement in technology, new invention, change in style etc. It is also called technological depreciation.
ii) Effusion of time: With the passage of time, the value of some asset diminishes even if they are not used in the business.
iii) Fall in market value: The value of an asset may decrease due to fall in market price of the assets.

8.1.2 ASSET DEPRECIATION OR ECONOMIC DEPRECIATION

Economic depreciation is a measure of the decrease in value of an asset over time. Economic depreciation is different deterioration and technological obsolescence.

Asset depreciation categories

Physical depreciation | Functional depreciation

Economic depreciation = Purchase price – Current market value
= Purchase price – Salvage value
= Initial cost – Salvage value

8.1.3 ACCOUNTING DEPRECIATION

Accounting depreciation is the systematic allocation of asset's value into book value in proportion of its total depreciable cost. Basically accounting depreciation is used to estimate after tax cash flow of any project. It provides information to make financial statement *i.e.*, profit and loss account of any organization.

8.2 DEPRECIATION METHOD

There are several methods of depreciation. Some important methods of depreciation are:

a) Straight line method
b) Declining balance method
c) Double rate declining balance method
d) Sinking fund method
e) Sum of the year method
f) Service output method
g) Straight line plus average interest method
h) Modified accelerated cost recovery system (MACRs)

a) Straight Line Method

It is also known as fixed installment method. In this method, the equal or fixed amount of depreciation is charged every year throughout the life of the asset so that the book value of asset may be reduced to zero.

$$\text{Annual depreciation} = \frac{\text{Original cost} - \text{Salvage value}}{\text{Life of the asset}}$$

$$= \frac{\text{Total depreciatin value}}{\text{Life of asset}} = \frac{I - S}{N}$$

If rate (R) is given,

$$\text{Annual depreciation} = \text{Total depreciable value} \times \frac{\text{Rate (\%)}}{100}$$

$$\therefore \text{Rate of depreciation} = \frac{\text{Amont of anual depreciation}}{\text{Total depreciable value}} \times 100$$

$$= \frac{1}{N} \times 100 \ (\because N = \text{life at asset})$$

and, total depreciable value = Initial cost + all other expenses – salvage value

Also, we can use the following formula to calculate depreciation by straight line method.

$$d_K = \frac{B - S}{N}$$

$$D_K = K\frac{(B - S)}{N}$$

$$BV_K = B - D_K$$

where,

d_K = Annual depreciation in the year K
B = Original cost
S = Salvage value
N = Life of the asset
D_K = Cumulative depreciation through year K
BV_K = Book value of the end of year K.

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b) Declining Balance Method or Diminishing Balance Method:

The declining balance method, also known as the reducing balance method, is an accelerated depreciation method that records larger depreciation expenses during the earlier years of an asset's useful life and smaller ones in later years. Usually, this method is suitable for the assets having long life and are subject to addition and extension from time to time, such as building plant, equipment etc. We cannot reduce book value of asset to zero under this method.

$$\text{Percentage rate, } R = 1 - \sqrt[N]{\frac{S}{B}}$$

where,

R = rate of depreciation

N = estimated life of asset

S = salvage value

B = original cost

If salvage value (S) = 0, this formula cannot be applied.

Formula to calculate depreciation of Matheson method:

$d_K = B(1 - R)^{K-1} \cdot (R)$

$D_K = B[1 - (1 - R)^K]$

$BV_K = B(1 - R)^K$

c) Double rate Declining Balance Method

The double declining balance depreciation method is a form of accelerated depreciation that doubles the regulator declining balance approach. It is also known as the 200% declining balance method of depreciation.

$$\text{Depreciation rate, } R = \frac{100}{N} \times 2$$

As N increases, depreciation expenses decreases resulting in a situation in which depreciation is highest in the first year and then decreases over the assets depreciable life.

d) Sum of the Year (SOYD) Method

According to this method, per year depreciation charge is calculated from the ratio of the sum of the years digit for the total useful life and remaining useful life at the beginning of the particular year.

SOYD depreciation

$$= \frac{\text{Remaining useful life at the begining of particular year} \times (I - S)}{\text{SOYD for the total useful life}}$$

This methods gives larger depreciation amount during the beginning years of assets and smaller depreciation amount as assets getting old.

e) Straight Line Plus Average Interest Method

It is also called as declining balance with switchover to straight line method. According to this method, the switchover occurs in the year when larger or equal depreciation amount is obtained from the straight line method in comparison to declining balance method.

f) Sinking Fund Method

The sinking fund method is a depreciation method that provides fund for the replacement of an asset at the end of its useful life. Under depreciation fund method or sinking fund method, a fund is created with the amount of annual depreciation. This method ensures that the full capital invested in a project is recovered at the end of the project's life. According to this, the book value of asset decreases at increasing rate with respect to the life of the asset.

Let, i = compound interest rate

A = annual equivalent amount

To find fixed annual equivalent amount, A;

$A = (I - S)\ (A/F, i\%, N)$

To find net depreciation charges in the year K;

$d_K = (I - S)\ (A/F, i\%, N) \times (F/P, i\%, K - 1)$

To find book value at the end of year K;

$BV_K = I - (I - S)\ (A/F, i\%, N) \times (F/A, i\%, K)$

g) Service Output Method

This method assumes that the total depreciation that has taken place is directly proportional to the quantity of output of the properly upto that time. This method has the advantage of making the unit cost of depreciation constant and giving low depreciation expenses during periods of low production. This method is also known as unit of production method.

$$\text{Depreciation} = \frac{\text{Units of production used} \times (I - S)}{\text{Total working hours or production unit}}$$

This method is similar to straight line method except that life of the asset is estimated in terms of number of operations or number of machine hours. Such a method is useful where a company has many fixed assets with varying usage.

h) Modified Accelerated Cost Recovery System (MACRS)

The MACRS is a depreciation system which allows the capitalized cost basis of assets to be recovered over a specified life of the asset by annual dedications for valued deprecation and went into effect in 1986.

Only by declining balance method and straight line method of computing depreciation are allowed depreciation; the main system is called the general depreciation system (GDS) and the second system is called the

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For the first accounting year, the asset may be purchased at different time periods. In such cases, base amount is determined as follows:

Purchase from 1st Shrawan to 30th Poush = 100% of value.

Purchase from 1st Magh to 31st Chzaitra = $\frac{2}{3}$ of value.

Purchase from 1st Baisakh to 31st Asadh = $\frac{1}{3}$ of value.

8.2.4 PERSONAL TAX

Personal tax is a direct tax and it is generally imposed by the central authority and collected through the local authorities. It is mostly levied on income and property in Nepal.

a) Income Tax

An income tax is a tax imposed in individuals or entities (tax payers) that varies with respective income or profits (taxable income). Income tax is computed as the product of a tax rate times taxable income. Taxation rates may vary by type or characteristics of the tax payer. The tax rate may increase as taxable income increases (referred to as the graduated or progressive rates).

Income tax rates Nepal according to 2075/76 budget:

For individual or single.

Particulars	Taxable amount	Tax rate
First tax slab (yearly income upto 3,50,000)	3,50,000	1%
Next (yearly income upto 4,50,000)	1,00,000	10%
Next (yearly income upto 6,50,000)	2,00,000	20%
Next (yearly income upto 10,00,000)	13,50,000	30%
Yearly income 20,00,000 and above	-	36%

For couple (married)

Particulars	Taxable amount	Tax rate
First tax slab (yearly income upto 4,00,000)	4,00,000	1%
Next (yearly income upto 5,00,000)	1,00,000	10%
Next (yearly income upto 70,00,000)	2,00,000	20%
Next (yearly income upto 20,00,000)	13,00,000	30%
Yearly income 20,00,000 and above	-	36%

Personal income tax is imposed by progressive way.

b) Property tax

Property tax is an annual tax on real property. Taxes are compulsory levied on the ownership of building, weapons, land, vehicles and so on. It

is common throughout the world and has often been the subject of political issues. Collected property taxes are used by the governing body of the jurisdiction in which is property is located. Property tax rates and the types of properties taxed vary by jurisdiction.

In Nepal, there are two types of property tax:

- House and land tax
- Unified property tax

8.3.5 CORPORATE TAX

A corporate tax also called corporation tax or company tax imposed by a jurisdiction on the income or capital of corporations or analogous legal entities. Many countries impose such taxes at the national level and a similar tax may be imposed at state or local levels. Nepal government has followed book profit as the tax base for the purpose of corporate income tax.

A corporate tax is a levy placed on the profit of a firm to raise taxes. After operating earnings are calculated by dedicating expenses, including the cost of goods sold (COGS) and depreciation from revenues, enacted tax rates are applies to generate a legal obligation the business owes the government. Rules surrounding corporate taxation vary greatly around the world and must be voted upon and approved by the government to be enacted.

Corporation are permitted to reduce taxable income by certain necessary and ordinary business expenditures. All current expenses required for the operation of the business are fully tax deductible. A corporation can deduct employee salaries, health benefits, tuition reimbursement and bonuses. In addition, a corporation can reduce its taxable income by insurance premium, travel expenses, bad debts, interest payments, sales taxes, fuel taxes and excise taxes.

8.3.6 VAT (Value Added Tax)

A value added tax (VAT) is a consumption tax placed on a product whenever value is added at each stage of the supply chain, from production to the point of sale. The amount of VAT that the user pays is the cost of the product less any of the costs of materials used in the product less any of the costs of materials used in the product that have already been taxed. It is a scientific tax system which was first introduced in 1954 A.D. in France. Now, this tax system in over 158 countries. In Nepal, VAT has come into consideration to replace of old indirect taxes. It was introduced on 16th November, 1997.

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There are two rates of VAT: Normal VAT rate is 13% whereas some goods or services are subjected to VAT at 0%. In addition some goods or services are exempt from VAT, Suppliers of taxable goods and services are required to register under the VAT act and collect this tax. It however, not necessary for them to register if they deal with only tax exempt goods and services. Similarly, small vendors falling in below the register for VAT. Government offices should purchase taxable goods and service having price more than Rs. 5,000 from the VAT registered trader compulsory.

Objectives of VAT

- To increase in government revenue
- To reduce tax evasion practice
- To avoid cascading effect
- To make the tax system more transparent
- To make flexible tax system
- To increase in exports
- To abolish several other taxes like turnover tax, surcharge etc.
- Avoids double taxation.

Features of VAT

- VAT avoid cascading effect existed in sales tax and contains catch-up effect
- VAT is based on self assessment system and provides the facility of tax credit and tax refund.
- Wider scope
- Indirect tax levied on goods and services.
- Expert promotional due to zero VAT on expert of goods and services.

Advantages of VAT

- VAT is a natural tax so it can be imposed on all types of business.
- As the VAT is collected in small installments so the consumers has minimum burden.
- Due to catch-up effect of VAT, it minimizes avoidance.
- Compared to other tax, VAT is easy to manage.
- Huge amount of revenue is generated on a low tax rate through VAT.
- Improves economic efficiency.
- Widening of tax base and reduction in rates of tax.
- Removes the cascading of taxes.

Disadvantages of VAT

- Tax evasion is possible through fake invoices.
- Increased compliance cost as records of all purchases and sales requires to be maintained.

- VAT encourages cash transactions to avoid VAT.
- VAT strength inflation.
- It is one kind of regressive tax. (The poor pay more in comparison than the rich).
- Relatively complex to understand.

8.4 GENERAL PROCEDURE FOR MAKING AFTER TAX ECONOMIC analysis

After tax economic analysis refers to the profitability measurement of any project including all income taxes. In another word, it is the analysis of after tax cash flow estimates and profitability analysis of the project.

General procedure for ATCF estimation

i) Find gross income before depreciation expenses also known as BTCF
ii) Calculate depreciation expenses for each year
iii) Find taxable income (deduct depreciation from BTCF)
iv) Find taxes for each period.
v) Deduct tax amount from BTCF to get ATCF for each year.
vi) Find NPW or NFW considering time value of money and make economic analysis.

End of year	BTCF	Depreciation	Total taxable income	Tax amount	ATCF
K	$R_K - E_K$	d_K	$R_K - E_K - d_K$	$t(R_K - E_K - d_K)$	$(1 - t)(R_K - E_K) + td_K$

where,

R_K = revenues from the project during ~~project~~ period K.
E_K = expenses from the project during ~~project~~ K.
d_K = depreciation amount of the project during ~~project~~ K.
t = Income tax rate.
T_K = Income tax amount during period K.

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BOARD EXAM Solved problems

1. Write short notes on VAT. [11/F, 12/S, 13/S, 13/F, 14/S, 14/F, 15/F, 16/F]

Ans: Refer topic 8.3.6.

2. Write short notes on personal tax and corporate tax. [11/F, 13/F, 18/S, 14/S, 14/F]

Ans: Refer topic 8.3.5 and 8.3.4.

3. Write short notes on taxation structures in Nepal. [13/S]

Ans: Nepal's tax structure is composed of three categories of revenues. These are direct taxes, indirect taxes and non-taxes. Direct tax include income tax, property tax, house rent tax, loan tax, corporate tax, interest tax etc. and indirect tax includes VAT, custom duties, excise duties; tax is a compulsory contribution or payment to government by the people and institute without any expectation of direct benefit.

a) Direct tax

Direct tax is levied on individual persons or corporations and the tax burden ultimately lies on the tax payer. These taxes are also known as personal tax. A tax is paid to be direct when impact and incidence of a tax are on one and some person. The tax rates are determined by parliament through government budget in Nepal.

b) Indirect tax

Indirect tax is imposed on commodities and allows the tax burden to shift. The consumers are the ultimate payers of the tax through it is imposed on the producer and sellers. These taxes are also known as impersonal taxes. Indirect tax is a major sources of tax revenue in Nepal. Indirect taxes promotes inflation. It is of regressive in nature.

4. Write short notes on types of depreciation. [14/S]

Ans: Refer topic 8.1.2 and 8.1.3.

5. Write short notes on direct and indirect tax. [15/S]

Ans:

S.N.	Direct tax	Indirect tax
i)	A tax is said to be direct when impact and incident of tax are on one and same person.	If impact of tax is on one person and incidence on the another, then that tax is called indirect tax.
ii)	Direct tax is imposed on the individual organization and burden of tax cannot be shifted to others.	Indirect tax is imposed on commodities and allows the tax burden to shift.
iii)	Direct taxes are lesser burden than indirect taxes to people as direct taxes are based on income earning ability of people.	Indirect taxes are borne by the consumer of commodities and service irrespective of financial ability as the MRP includes all taxes.
iv)	Tax evasion is possible.	Tax evasion is hardly possible because it is included in the price of goods and services.
v)	Direct tax helps in reducing inflation.	Indirect taxes promotes inflation.
vi)	Its nature is progressive.	Its nature is regressive.
vii)	It is levied on persons, company, firm.	It is levied on consumers of goods and services.
viii)	It includes income tax, wealth tax, property tax, corporate tax, import and export duties.	It includes VAT, service tax, exercise duty, custom duty, security transaction tax etc.

Merits of direct tax are:

- equality
- elastic
- progressive
- civic consciousness
- certainty
- economy
- anti-inflationary

Demerits of direct tax are

- lack of inspiration
- arbitary
- possibility of evasion
- unpopular
- inconvenient

Merits of indirect tax are:

- convenient
- difficulty of evasion
- wider scope
- promote social welfare

Demerits of indirect tax are

- inequality
- unproductive
- uncertainty
- inflation

6. Write short notes on causes of depreciation. [15/F, 18/S, 14/F]

Ans: Refer topic 8.1.1.1.

7. What is value added tax? Explain briefly the effectiveness of VAT in Nepal. [12/F]

Ans: A value added tax (VAT) is a consumption tax placed on a project whenever value is added at each stage of the supply chain, from production to the point of sale. Also, VAT is a consumption tax

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levied on products at every point of sale where value has been added, starting from raw materials and going all the way to final retail purchase.

For example; If a product cost Rs. 1,000 and there is a 13% VAT, the consumer pays Rs. 1,130 to merchant. The merchant keeps Rs. 1,000 and remits Rs. 130 to the government.

Effectiveness of VAT in Nepal:

VAT implementation is seen extremely challenging in Nepal. Resistance from the business community, ignorance of general people, lack of full support and commitments from the politicians and government officials forced the authority responsible for implementing VAT to make compromises on various aspects of VAT which has weekend the process of its implementation right from the beginning. The attitude of businessman and tax administration also appears hostile to the effective implementation of VAT in Nepal. The culture of doing business without maintaining proper books of accounts or maintaining multiple sets of books of accounts have of accounts have made implementation of VAT difficult. Due to traction, the auditing system, one of the most important aspects of VAT operation, is not effective.

The existing large amount of unauthorized trade with India has been posing a great threat for proper implementation of VAT. The illegal import is helping to black market channel resulting in a large scale tax evasion; the scope for illegal trade and tax evasion has not been decreased even after the implementation of VAT because tax administration is not strong and efficient enough to check this situation. No billing, lack of invoicing, incorrect value in billings is the main problems observed in invoicing system, leading weak VAT implementation. There is a high level of corruption and tax evasion by the means of illegal alliance between tax payer and tax administration. One of the best feature of VAT is the catch up effect which makes tax evasion impossible but this effect is not achieved because of illegal trade, undervalued transactions without invoices and lack of administrative capabilities to catch and destroy the illegal channels.

8. Define depreciation. [12/F]

Ans: Refer topic 8.1.1.

9. Define tax. [14/S]

Ans: A tax is a mandatory financial charge or some other type of levy imposed upon a taxpayer by a government in order to fund various

public expenditures. A failure to pay, along with evasion of or resistance to taxation is punishable by law. Taxes are imposed upon all those people who are able to pay or earn who owns property, who does consume or expenses. It is not any fee or fine or price under taken by the government.

10. A machine costing of Rs. 1,00,000 is estimated to have life of 10 years. The salvage value of the machine at the end of life is Rs. 20000. Find deprecation charge and book value of each year and tabulate it. Use straight line method and sum of years digit (SOYD) method. [16/F, 12/F]

Solution:

Original cost = Rs. 1,00,000

Salvage value = Rs. 20,000

Estimated life = 10 year

We know

i) **Straight line method:**

$$\therefore \text{Annual depreciation} = \frac{\text{Original cost} - \text{Salvage value}}{\text{Estimted life}}$$

$$= \frac{1,00,000 - 20,000}{10}$$

= Rs. 8,000 per year.

$$\therefore \text{Rate of depreciation} = \frac{\text{Annual depreciation}}{\text{Total depreciation value}} \times 100$$

$$= \frac{8,000}{(1,00,000 - 20,000)} \times 100$$

= 10% per year

[∴ Total depreciable value = original cost + all other expenses – salvages value]

Year	Depreciation (Rs.)	Book Value (Rs.)
1	8,000	1,00,000 – 8,000 = 92,000
2	8,000	92,000 – 8,000 = 84,000
3	8,000	84,000 – 8,000 = 76,000
4	8,000	76,000 – 8,000 = 68,000
5	8,000	68,000 – 8,000 = 60,000
6	8,000	60,000 – 8,000 = 52,000
7	8,000	52,000 – 8,000 = 44,000
8	8,000	44,000 – 8,000 = 36,000
9	8,000	36,000 – 8,000 = 28,000
10	8,000	28,000 – 8,000 = 20,000

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ii) Sum of years digit (SOYD) method

I = Rs. 100000

S = Rs. 20000

N = 10 years

Total depreciable value = I - S

= Rs. (1,00,000 - 20,000)

= Rs. 80,000

Sum of the year digit $= N\frac{(N+1)}{2} = 10\frac{(10+1)}{2} = 55$

Proportion of the year = 10 : 9 : 8 : 7 : 6 : 5 : 4 : 3 : 2 : 1

Depreciation charges and book value

SOYD depreciation $= \frac{\text{Remaining useful life}}{\text{Total useful life}} \times (I - S)$

Book value = I - accumulated depreciation

Year	Depreciation (Rs.)	Book Value (Rs.)
1	$\frac{10}{55} \times 80,000 = 14,545.45$	85,454.55
2	$\frac{9}{55} \times 80,000 = 13,090.90$	72,363.65
3	$\frac{8}{55} \times 80,000 = 11,636.36$	60,727.29
4	$\frac{7}{55} \times 80,000 = 10,181.81$	50,545.48
5	$\frac{6}{55} \times 80,000 = 8,727.27$	41,818.21
6	$\frac{5}{55} \times 80,000 = 7,272.72$	34,545.49
7	$\frac{4}{55} \times 80,000 = 5,818.18$	28,727.31
8	$\frac{3}{55} \times 80,000 = 4,363.63$	24,363.68
9	$\frac{2}{55} \times 80,000 = 2,909.09$	21,454.59
10	$\frac{1}{55} \times 80,000 = 1,454.54$	20,000
Total	Rs. 80,000	

Hence, depreciable value = Rs. 80,000

Book value = Rs. 20,000

11. A company has purchased equipment whose first cost is Rs. 10,000 with an estimated life of 5 years. The estimated salvage of the equipment at the end of its life time is Rs. 2,000. Determine the depreciation charge and book value at 3 and 4 years using the straight line and sum of years digit (SOYD) method of depreciation.

[18/S]

Solution:

Original cost B = Rs. 10,000

Estimate life, N = 5 years 2,000

i) **Straight line method**

Annual depreciation $= \frac{B - S}{N} = \frac{10,000 - 2,000}{5}$ = Rs. 1,600 per year.

Cumulative depreciation throughout the 3rd year:

$D_3 = 3\frac{(10,000 - 2,000)}{5}$ = Rs. 4,800

∴ Book value at the 3rd year,

BV_3 = Rs. (10,000 - 4,800) = Rs. 5,200

∴ Cumulative depreciation throughout the 4th year:

$D_4 = 4\frac{(10,000 - 2,000)}{5}$ = Rs. 6,400

∴ Book value at the 4th year,

BV_4 = Rs. (10,000 - 6,400) = Rs. 3,600

ii) **SOYD method:**

N = 5 years

Sum of the year digit = 5 + 4 + 3 + 2 + 1 = 15

or, $N\frac{(N+1)}{2} = 5\frac{(5+1)}{2} = 15$

Proportion of year = 5 : 4 : 3 : 2 : 1

Depreciation charges:

Year	Depreciation (Rs.)	Book Value (Rs.)
1	$\frac{5}{15} \times (10,000 - 2,000) = 2,666.67$	7,333.33
2	$\frac{4}{15} \times 8,000 = 2,133.33$	5,200
3	$\frac{3}{15} \times 8,000 = 1,600$	3,600
4	$\frac{2}{15} \times 8,000 = 1,066.66$	2,533.34
5	$\frac{1}{15} \times 8,000 = 533.34$	2,000
Total	Rs. 8,000	

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∴ Depreciation charge at 3rd year = Rs. 16,000

∴ Depreciation charge at 4th year = Rs. 1,066.67

∴ Book value at 3rd year = Rs. 3,600

∴ Book value at 4th year = Rs. 2,533.34

12. A company has purchased an equipment whose first cost is Rs. 100,000 with an estimated life of 8 years. The estimated salvage value of the equipment at the end of its lifetime is Rs. 20,000. Determine the depreciation using: [17/S, 13/S, 13/F]

i) Double declining methods of deprecation

ii) SOYD method

Solution:

Original cost, B = Rs. 1,00,000

Salvage value, S = Rs. 20,000

Estimated life, N = 8 years

i) Double declining method or 200% declining method

Double declining rate

$$R = \frac{1}{N} \times 100 \times 2$$

$$= \frac{1}{8} \times 100 \times 2$$

$$\therefore \quad R = 25\%$$

Depreciation value and book value:

Year (K)	Depreciation (Rs.)	Annual depreciation @ 25%
1	1,00,000	0.25 × 1,00,000 = 25,000
2	1,00,000 – 25,000 = 75,000	0.25 × 75,000 = 18,750
3	75,000 – 18750 = 56,250	0.25 × 56,250 = 14,062.5
4	56,250 – 14,062.5 = 42,187.5	0.25 × 42,187.5 = 10,546.8
5	42,187.5 – 10,546.8 = 31,640.7	0.25 × 31,640.7 = 7,910.2
6	31,640.7 – 7,910.2 = 27730.5	0.25 × 23,730.5 = 5,932.6
7	27,730.5 – 5,932.6 = 17798	0.25 × 17,798 = 4,449.5
8	17,798 – 449.5 = 13348.5	0.25 × 3,337.12
Total	Rs. 89990	

ii) SOYD method:

$$SOYD = N\frac{(N+1)}{2} = 8\frac{(8+1)}{2} = 36$$

$$\text{SOYD depreciation} = \frac{\text{Remaining useful life}}{\text{Total useful life}} \times (B - S)$$

Depreciation charge and book value:

Year	SOYD Depreciation	Book Value
1	$\frac{8}{36} \times 80,000 = 17,777.78$	82,222.22
2	$\frac{7}{36} \times 80,000 = 15,555.56$	66,666.66
3	$\frac{6}{36} \times 80,000 = 13,333.33$	53,333.33
4	$\frac{5}{36} \times 80,000 = 11,111.11$	42,222.22
5	$\frac{4}{36} \times 80,000 = 8,888.89$	33,333.33
6	$\frac{3}{36} \times 80,000 = 6,666.66$	26,666.67
7	$\frac{2}{36} \times 80,000 = 4,444.44$	22,222.23
8	$\frac{1}{36} \times 80,000 = 2,222.23$	20,000
Total	Rs. 80,000	

Hence, total depreciable amount is Rs. 80,000 and book value is Rs. 20,000 at the end of 8th year.

13. A machine is costing of Rs. 5,00,000 with estimated salvage value of Rs. 50,000 at the end of 5th year. Find deprecation amount by, [15/F]

i) Straight line method for each year

ii) Declining balance methods for each year

Solution:

B = Rs. 5,00,000

S = Rs. 5,000

N = 5 years

i) Straight line method:

$$\text{Annual depreciation} = \frac{B - S}{N}$$

$$= \frac{5,00,000 - 50,000}{5}$$

= Rs. 90,000 per year

$$\text{Depreciation rate} = \frac{90,000}{(5,00,000 - 50,000)} \times 1,000$$

= 20% per year

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∴ Depreciation charge at 3rd year = Rs. 16,000

∴ Depreciation charge at 4th year = Rs. 1,066.67

∴ Book value at 3rd year = Rs. 3,600

∴ Book value at 4th year = Rs. 2,533.34

12. A company has purchased an equipment whose first cost is Rs. 100,000 with an estimated life of 8 years. The estimated salvage value of the equipment at the end of its lifetime is Rs. 20,000. Determine the depreciation using: [17/S, 13/S, 13/F]

i) Double declining methods of deprecation

ii) SOYD method

Solution:

Original cost, B = Rs. 1,00,000

Salvage value, S = Rs. 20,000

Estimated life, N = 8 years

i) Double declining method or 200% declining method

Double declining rate

$$R = \frac{1}{N} \times 100 \times 2$$

$$= \frac{1}{8} \times 100 \times 2$$

$$\therefore \quad R = 25\%$$

Depreciation value and book value:

Year (K)	Depreciation (Rs.)	Annual depreciation @ 25%
1	1,00,000	0.25 × 1,00,000 = 25,000
2	1,00,000 – 25,000 = 75,000	0.25 × 75,000 = 18,750
3	75,000 – 18750 = 56,250	0.25 × 56,250 = 14,062.5
4	56,250 – 14,062.5 = 42,187.5	0.25 × 42,187.5 = 10,546.8
5	42,187.5 – 10,546.8 = 31,640.7	0.25 × 31,640.7 = 7,910.2
6	31,640.7 – 7,910.2 = 27730.5	0.25 × 23,730.5 = 5,932.6
7	27,730.5 – 5,932.6 = 17798	0.25 × 17,798 = 4,449.5
8	17,798 – 449.5 = 13348.5	0.25 × 3,337.12
Total	Rs. 89990	

ii) SOYD method:

$$SOYD = N\frac{(N+1)}{2} = 8\frac{(8+1)}{2} = 36$$

$$SOYD \text{ depreciation} = \frac{\text{Remaining useful life}}{\text{Total useful life}} \times (B - S)$$

Depreciation charge and book value:

Year	SOYD Depreciation	Book Value
1	$\frac{8}{36} \times 80,000 = 17,777.78$	82,222.22
2	$\frac{7}{36} \times 80,000 = 15,555.56$	66,666.66
3	$\frac{6}{36} \times 80,000 = 13,333.33$	53,333.33
4	$\frac{5}{36} \times 80,000 = 11,111.11$	42,222.22
5	$\frac{4}{36} \times 80,000 = 8,888.89$	33,333.33
6	$\frac{3}{36} \times 80,000 = 6,666.66$	26,666.67
7	$\frac{2}{36} \times 80,000 = 4,444.44$	22,222.23
8	$\frac{1}{36} \times 80,000 = 2,222.23$	20,000
Total	Rs. 80,000	

Hence, total depreciable amount is Rs. 80,000 and book value is Rs. 20,000 at the end of 8th year.

13. A machine is costing of Rs. 5,00,000 with estimated salvage value of Rs. 50,000 at the end of 5th year. Find deprecation amount by,

i) Straight line method for each year

ii) Declining balance methods for each year [15/F]

Solution:

B = Rs. 5,00,000

S = Rs. 5,000

N = 5 years

i) Straight line method:

$$\text{Annual depreciation} = \frac{B - S}{N}$$

$$= \frac{5,00,000 - 50,000}{5}$$

= Rs. 90,000 per year

$$\text{Depreciation rate} = \frac{90,000}{(5,00,000 - 50,000)} \times 1,000$$

= 20% per year

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Year	Depreciation	Book Value
1	90,000	5,00,000 – 90,000 = 4,10,000
2	90,000	4,10,000 – 90,000 = 3,20,000
3	90,000	3,20,000 – 90,000 = 2,30,000
4	90,000	2,30,000 – 90,000 = 1,40,000
5	90,000	1,40,000 – 90,000 = 5,00,00

ii) Declining balance method:

Rate of deprecation $= 1 - \sqrt[N]{\frac{S}{B}} = 1 - \sqrt[5]{\frac{50,000}{5,00,000}} = 1 - 0.6309 = 37\%$

Year	Book value	35% declining balance method
1	500000	0.37 × 5,00,000 = 1,85,000
2	315000	0.37 × 2,15,000 = 1,16,550
3	198450	0.37 × 1,98,450 = 73,426.5
4	125023.5	0.37 × 1,25,023.5 = 46,258.7
5	78764.8	0.37 × 78,764.8 = 29,142.97

Depreciated amount at the end of 5th year is Rs. 4,50,378 and book value is Rs. 78,764.8.

14. Consider the following accounting information for a computer system: [15/S]

Cost basis of the assets, I = Rs. 10,000

Useful life, N = 5 years

Estimated salvage life, S = 0

Use double declining balance method to compute annual depreciation allowances and resulting book values.

Solution:

I = Rs. 10,000

N = 5 years

S = Rs. 0

Using double declining balance depreciation method,

$$\text{Rate} = \frac{1}{N} \times 100 \times 2 = \frac{1}{5} \times 100 \times 2 = 40\%$$

Year	Book value (Rs.)	Depreciation amount (Rs.)
1	10000	0.40 × 10,000 = 4000
2	10,000 – 4,000 = 6000	0.40 × 6,000 = 2400
3	6,000 – 2400 = 3600	0.40 × 3600 = 1440
4	3600 – 1440 = 2160	0.40 × 2160 = 864
5	2160 – 864 = 1296	0.40 × 1296 = 518.4
	Total	Rs. 9222.4

Total depreciated amount at the end of 5th year is Rs. 9,222.40.

15. Consider following accounting information for a computer system.

Cost basis of the asset = Rs. 40,000

Useful life = 5 years

Estimated salvage value = Rs. 2,500

Compute annual depreciation and resulting book value using double declining balance method. [14/S]

Solution:

I = Rs. 40,000

N = 5 year

S = Rs. 2,500

$$\text{Rate of depreciation} = \frac{1}{N} \times 100 \times 2$$

$$= \frac{1}{5} \times 100 \times 2$$

$$= 40\%$$

Year	Book value (Rs.)	Depreciation amount @ 40%
1	40,000	0.40 × 40,000 = 16,000
2	24,000	0.40 × 24,000 = 9,600
3	14,400	0.40 × 14,400 = 5,760
4	8,640	0.40 × 8,640 = 3,456
5	5,184	0.40 × 5,184 = 2,073.6
	Total	Rs. 36,889.60

Book value = Rs. 5,184

Total depreciation amount = Rs. 36,889.60

16. If a machine costing is Rs 400,000 is estimated 10 years useful life and Rs. 50,000 salvage value. Find depreciation amount for each year by using declining balance and sinking fund methods. 14/F

Solution:

Machine cost, B = Rs. 4,00,000

Salvage value, S = Rs. 50,000

Estimated life, N = 10 years

Let, MARR = 10% per year

i) Declining balance method:

$$\text{Rate of depreciation} = 1 - \sqrt[N]{\frac{S}{B}}$$

$$= 1 - \sqrt[10]{\frac{50,000}{4,00,000}}$$

$$= 1 - 0.812$$

$$= 19\%$$

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Year	Book value	19% declining balancing depreciation
1	4,00,000	76,000
2	3,24,000	61,560
3	2,62,440	49,863.60
4	2,12,576.40	40,389.51
5	1,72,186.88	32,715.50
6	1,39,471.37	26,499.56
7	1,12,971.80	21,464.643
8	91,506.35	17,386.207
9	74,120.14	14,082.82
10	60,037.32	11,407
	Total	Rs. 3,51,368.84

Hence, depreciation amount is Rs. 3,51,368.84 at the end of 10th year.

ii) Sinking fund method:

Sinking fund depreciation

$$= (I - S)\,(A/F, i\%, N)$$
$$= (4,00,000 - 50,000)\,(A/F, 10\%, 10)$$
$$= 35,00,000 \times 0.0627$$
$$= \text{Rs. } 21,945 \text{ per year}$$

Year	Depreciation with MARR = 10%	Cumulative depreciation	Book value (I-cumulative depreciation)
1	21,945	21,945	3,78,055
2	21,945 × 1.1 = 24139.5	46,084.5	3,53,915.5
3	24,139.5 × 1.1 = 26553.45	72,637.95	3,27,362.05
4	26,553.45 × 1.1 = 29208.8	1,01,846.8	2,98,153.26
5	29,208.8 × 1.1 = 32129.68	1,33,976.48	2,66,023.52
6	32,129.68 × 1.1 = 35342.7	1,69,319.18	2,30,680.82
7	35,342.7 × 1.1 = 37776.97	2,07,096.15	192.903.8
8	37,776.97 × 1.1 = 41,554.66	2,48,650.82	1,51,349.1
9	41,554.66 × 1.1 = 45,710.12	2,94,360.95	1,05,639.05
10	45,710.12 × 1.1 = 50,281.13	3,44,642.08	55,358

Hence, depreciation amount is Rs. 3,44,642.08 at the end of 10th year.

17. From the following information find annual depreciation and the book value of each year by straight line, declining balance, SOYD and sinking fund method. 16/S

Initial cost = Rs. 7,000

MARR = 10%

Useful life = 5 year

Salvage value = Rs. 2,000

Solution:

B = Rs. 7,000

S = Rs. 2,000

N = 5 year

MARR = 10%

i) Straight line method

$$\text{Depreciation for each year} = \frac{I - S}{N}$$
$$= \frac{7,000 - 2,000}{5}$$
$$= \text{Rs. } 1,000 \text{ per year.}$$

Year	Depreciation	Book value
1	1,000	7,000 – 1,000 = 6,000
2	1,000	6,000 – 1,000 = 5,000
3	1,000	5,000 – 1,000 = 4,000
4	1,000	4,000 – 1,000 = 3,000
5	1,000	3,000 – 1,000 = 2,000
Total	Rs. 5,000	

Total depreciated value = Rs. 5,000

Total book value = Rs. 2,000

ii) Declining balance method:

Rate of depreciation,

$$R = 1 - \sqrt[N]{\frac{S}{I}}$$
$$= 1 - \sqrt[5]{\frac{2,000}{7,000}} = 1 - 0.7784$$
$$= 22.17\% \text{ per year}$$

Year	Book value	Depreciation amount
1	7,000	0.2217 × 7,000 = 1,551.9
2	7,000 – 1,551.9 = 5,448.1	0.2217 × 5,448.1 = 1,207.85
3	5,448.1 – 1,207.85 = 4,240.25	0.2217 × 4,240.25 = 940.06
4	4,240.25 – 940.06 = 3,300.18	0.2217 × 3,300.18 = 731.65
5	3,300.18 – 731.65 = 2,568.53	0.2217 × 2,568.53 = 569.45
Total		Rs. 5,000

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iii) Sinking fund method

Sinking fund depreciation = (I – S) (A/F, i%, N)

= (7,000 – 2,000) (A/F, 10%, 5)

= 5,000 × 0.1638

= Rs. 819 per year

Year	Depreciation amount	Cumulative depreciation	Book value
1	819	819	6,181
2	1.1 × 819 = 901	1,720	5,280
3	1.1 × 901 = 991	2,712	4,289
4	1.1 × 991 = 1090	3,802	3,199
5	1.1 × 1090 = 1199	5,000	2,000
Total		Rs. 5,000	

iv) SOYD method:

$$\text{SOYD} = N\frac{(N+1)}{2}$$

$$= 5\frac{(5+1)}{2} = 15$$

$$\text{Depreciation} = \frac{\text{Remaining useful life}}{\text{Total useful life}} \times (B - S)$$

Year	Depreciation amount	Book value
1	$\frac{5}{15} \times 5{,}000 = 1{,}666.67$	5,333.34
2.	$\frac{4}{15} \times 5{,}000 = 1{,}333.34$	4,000.01
3.	$\frac{3}{15} \times 5{,}000 = 1{,}000$	3,000.01
4.	$\frac{2}{15} \times 5{,}000 = 666.66$	2,333.33
5	$\frac{1}{15} \times 5{,}000 = 333.33$	2,000
Total	Rs. 5,000	

18. A machine costs Rs. 12,00,000 now and its useful life is 5 years. Its salvage value is expected to be Rs. 5,00,000. Calculate depreciation in each year and corresponding salvage value using sinking fund method and double declining balance method. [18/F]

Solution:

Machine initial costs, B = Rs. 12,00,000

Estimated life, N = 5 years

Salvage value, S = Rs. 5,00,000

i) **Double declining balance method:**

Declining balance rate (R) $= \frac{1}{N} \times 100 \times 2 = \frac{1}{5} \times 100 \times 2 = 40\%$

Year	Book value	Annual depreciation @ 40%
1	12,00,000	4,80,000
2	12,00,000 – 4,80,000 = 7,20,000	2,88,000
3	7,20,000 –2,88,000 = 4,32,000	172,800
4	4,32,000 – 1,72,800 = 2,59,200	1,03,680
5	2,59,200 – 1,03,680 = 1,55,520	62,208

Salvage value is Rs. 5,00,000.

Total depreciation at the end of 5th year = Rs. 11,06,688.

ii) **Sinking fund method**

Let MARR = 10%

Sinking fund depreciation = (I – S) (A/F, i%, N)

= (12,00,000 – 5,00,000) (A/F, 10%, 5)

= 7,00,000 × 0.1638

= Rs. 1,14,660 per year

Year	Depreciation amount with i = 10%	Cumulative depreciation	Book value
1	1,14,660	1,14,660	1,14,660
2	1,14,660 × 1.1 = 1,23,126	2,40,786	9,59,214
3	1,23,126 × 1.1. = 1,38,738.6	3,79,524.6	8,20,475.4
4	1,38,738.6 × 1.1 = 1,52,612.46	5,32,137.06	6,67,862.94
5	1,52,612.46 × 1.1 = 1,67,873.30	7,00,000	5,00,000

19. A construction equipment has initial cost and annual saving per year are of Rs. 40,000 and Rs. 20,000 respectively. With annual operating and maintenance cost of Rs. 7,000. If will depreciate by MACRS method and will have no savage value. The useful life of equipment is 5 years. Estimate before and after tax cash flow. The company pays income tax @ 40%. [17/F]

Solution:

Tax rate = 40%

N = 5 years

I = Rs. 40,000

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S = Rs. 0

R = Rs. 10,000 per year

E = Rs. 7,000 per year

We know,

$$BTCF_K = R_K - E_K$$

$$ATCF_K = BTCF_K - T_K$$

$$= R_K - E_K - t(R_K - E_K + d_K)$$

$$= (1 - t)(R_K - E_K) + td_K$$

tax राशि

Year	BTCF = Revenue – Cost ($R_K - E_K$)	Depreciation amount with MACRS (d_K)	Net taxable income = BTCF – d_K	Tax amount @ 40%	ATCF = BTCF – Tax paid
0	-40000	-	-	-	-40000
1.	$\frac{1}{2}$(20,000 – 7,000) = 6,500	20@ of 4,000 = 8,000	6500 – 8,000 = -1500	No tax	6,500
2.	20,000 – 7,000 = 1,300	32% of 40,000 = 12,800	200	0.40 × 200 = 80	1,300 – 80 = 12,920
3.	13,000	19.2% of 40,000 = 7,680	5,320	0.40 × 5,320 = 2128	10,872
4	13,000	11.52% of 40,000 = 4,608.0	8,392	0.40 × 8,392 = 3,356	9,643.20
5	13,000	11.52% of 4,000 = 4608.0	8,392	0.40 × 8,392 = 3,356	9,643.20
6.	$\frac{1}{2}$(20,000 – 7,000) = 6,500	5.76% of 40,000 = 2304	4,196	0.40 × 4,196 = 1,678	4,822

NOTE

When $R_K > E_K + d_K \Rightarrow$ Tax liability

When $R_K < E_K + d_K \Rightarrow$ No tax liability

MACRS % calculation is as follows for 5 year class.

Straight line rate = $\frac{1}{N}$ × book value → 100% at 1st year

Declining balance rate = $\frac{R}{N} = \frac{200\%}{5} = 40\%$

[∵ For 5 years life, R = 200% according to IRS guide line]

$$= \frac{40}{1,000} \times \text{book value}$$

$$= 0.4 \times \text{book value}$$ → 1st year में 100%

Year	MACRS % calculation	Selected MACRS
1.	$\frac{1}{2}$ year DB = $\frac{1}{2} \times 0.40 \times 100\% = 20\%$ $\frac{1}{2}$ year SL = $\frac{1}{2} \times \frac{1}{5} \times 100\% = 10\%$	20%
2.	DB = 0.40 × (100 – 20)% = 32% SL = $\frac{1}{4.5}$ × (100 – 20)% = 17.78%	32%
3.	DB = 0.40 × (100 – 20 – 32)% = 19.2% SL = $\frac{1}{3.5}$ (100 – 52)% = 13.7%	19.20%
4.	DB = 0.40 × (100 – 52 – 19.20)% = 11.52% SL = $\frac{1}{2.5}$ (100 – 71.20)% = 11.52%	11.52%
5.	DB = 0.40 × 17.28% = 6.9% SL = $\frac{1}{1.5}$ × 17.28% = 11.52%	11.52%
6.	DB = $\frac{1}{2}$ × 0.40 × 5.76% = 1.15% $\frac{1}{2}$ year SL = $\frac{1}{2} \times \frac{1}{0.5} \times 5.76\% = 5.76\%$	5.76%
	Total	100%

20. **We are considering the purchase of bike at a cost of Rs. 1,10,000 with an estimated salvage value of Rs. 2,000 and a project useful life of 5 years. Interest is 10% determine declining balance with conversion to straight line depreciation.** **[11/F]**

Solution:

I = Rs. 1,10,000

S = Rs. 2,000

N = 5 years

$$\text{Depreciation rate} = \frac{1}{I}\left(\frac{I - S}{N}\right) \times 100\%$$

$$= \left(\frac{1,10,000 - 2,000}{1,10,000 \times 5}\right) \times 100\%$$

$$= 19.636\%$$

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Switchover from 19.63% declining balance to straight line method:

Year	Beginning of year book value	19.63% declining balance method	Switching decision	Straight line method	Depreciation amount select
1.	1,10,000	21,600	=	21,600	21,600(switch)
2.	88,400	17,358.22	<	21,600	21,600
3.	69,041.78	13,557.25	<	21,600	21,600
4.	55,484.53	10,895.10	<	21,600	21,600
5.	44,589.43	8,755.71	<	21,600	21,600
Total		Rs. 74,186.28			Rs. 1,08,000

NOTE

$$\text{Straight line method value} = \left(\frac{\text{Being of year value}}{\text{No. of remaining year}}\right)$$

But if switchover occurs, then the straight line method value remains constant.

Here in above equation

$$\text{SL method value} = \left(\frac{\text{Being of year value} - \text{Salvage value}}{\text{No. of remaining year}}\right)$$

For 2nd year

$$\text{SL method value} = \left(\frac{88{,}400 - 2{,}000}{4}\right) = 21600$$

$$\text{SL method value for 3rd year} \left(\frac{69{,}041.78 - 2{,}000}{3}\right) = 22347.26$$

But value is 21600 due to switchover in 1st year.

Similarly,

$$\text{SL method for 4th year} = \left(\frac{55{,}484.53 - 2{,}000}{2}\right) = 26{,}742.265$$

But value is 21,600 due to switchover.

Hence, after occurring switchover, the value of SL method for remaining year is also same as that of the switchover occurring years value.

ADDITIONAL PROBLEMS

1. **Compute the annual depreciation allowances and the resulting book value using declining method with switchover to straight line method. *i.e.*, straight line plus average interest method.**

Cost of asset = Rs. 30,000

Estimated life = 5 years

Salvage value = 0

Solution:

I = Rs. 30,000

N = 5 years

S = Rs. 0

$$\text{Rate of depreciation} = \left(\frac{I - S}{I \times N}\right) \times 100$$

$$= \left(\frac{30{,}000 - 0}{30{,}000 \times 5}\right) = 20\%$$

$\frac{24000 - 0}{4} = 6000$

$\frac{19200}{3} = 6400$

$\frac{15360}{2} = 7680$

Year	BOY book value	20% declining balance method	Switching decision	Straight line method	Depreciation amount select
1.	30,000	6,000	=	6,000	6,000
2.	24,000	4,800	<	6,000	6,000
3.	19,200	3,840	<	6,000	6,000
4.	15,360	3,072	<	6,000	6,000
5.	12,288	2,457.60	<	6,000	6,000
Total		Rs. 20,169.60			Rs. 30,000

2. **Consider the following information for machine operation system.**

Initial cost = Rs. 40,000

Useful life = 10 years

Salvage value = Rs. 0

Depreciation rate = 20% per year

Compute the annual depreciation amount and book values by using straight line plus average interest method.

Solution:

B = Rs. 4,000

N = 10 years

R = 20%

S = 0

Switch from 20% declining balancing to straight line method.

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Year	BOY book value	20% declining balance method	Switching decision	Straight line method	Depreciation amount select
1	4,000	800	>	$\frac{4000}{10}$ = 400	800
2	3,200	640	>	$\frac{3200}{9}$ = 355.56	640
3.	2,560	512	>	$\frac{2560}{8}$ 320	512
4.	2,048	409.6	>	292.57	409.6
5.	1,638.4	327.68	>	273.07	327.68
6.	1,310.72	262.14	=	262.14	262.14(switch)
7.	1,048.58	209.72	<	262.14	262.14
8.	786.44	167.77	<	262.14	262.14
9.	524.30	134.22	<	262.14	262.14
10.	262.16	107.37	<	262.14	262.14
Total		Rs. 3,570.50			Rs. 4,000

3. Machine is purchased at Rs. 4,000 and its scarp value is Rs. 10,480 and its useful life is 6 years. Find:

i) Rate of depreciation under diminishing balance method.

ii) Amount of deprecation for 6 years .

Solution:

B = Rs. 4000

S = Rs. 10,480

N = 6 years

We know,

i) Rate of depreciation, $(R) = 1 - \sqrt[N]{\frac{S}{B}} = 1 - \sqrt[6]{\frac{10,480}{40,000}} = 20\%$

ii) Amount of depreciation for 6 years.

Year	Book value	Annual depreciation
1.	40,000	8,000
2.	32,000	6,400
3.	25,600	5,120
4.	20,480	4,096
5.	16,384	3,276.80
6.	13,107.2	2,621.44
Total		Rs. 29,514.24

Depreciated amount for 6 years = Rs. 29,514.44

4. A laptop costing of Rs. 40,000 is estimated to have life of 10 years and salvages value is 0. Find

i) Depreciation amount for the 7th year.

ii) Accumulated depreciation throughout 7th year.

iii) Book value at the end of 7th year.

Solution:

B = Rs. 40,000

S = Rs. 0

N = 10 years

i) Depreciation amount of the 7th year:

$$D_7 = \frac{B - S}{N} = \frac{40,000 - 0}{10} = \text{Rs. } 4,000$$

ii) Accumulated depreciation throughout 7th year:

$D_7 = 7 \times D_6 = 7 \times 4,000 = 28,000$

iii) Book value at the end of 7th year:

$BV_7 = B - D_6 = 40,000 - 28,000 = \text{Rs: } 12,000$

5. Suppose an equipment purchased for Rs. 10,00,000. It is expected to generate income of Rs. 350,000 per year during 5 years and corporate income tax rate is 25% per year. Under the recovery periods, depreciation are as follows:

Year	1	2	3	4	5
Depreciation	1,00,000	20,00,00	2,00,000	2,00,000	1,00,000

Estimate before and after tax flow.

Solution:

EOY	BTCF	d_K	Taxable income	Income tax @25%	ATCF
0	-1,00,000	-	-	-	-1,00,000
1.	3,50,000	1,00,000	2,50,000	62,500	2,87,500
2.	3,50,000	2,00,000	1,50,000	37,500	3,12,500
3.	3,50,000	2,00,000	1,50,000	37,500	3,12,500
4.	3,50,000	2,00,000	1,50,000	37,500	3,12,500
5.	3,50,000	1,00,000	1,50,000	62,500	2,87,500

6. What are the factors affecting to the amount of depreciation?

Solution:

Factors affecting to the amount of depreciation are:

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i) **Cost of assets:**
The cost of asset include the purchase price less any trade discount plus all the costs essential to bring the asset to a usable condition. It is taken as a main basis for determining the depreciation rate and amount.

ii) **Estimated scrap value:**
Scrap value refers to the value estimated to be realize after the expiry of the useful working life of the asset. This is also known as salvage or residual value. It should be determined for correct ascertainment of depreciation.

iii) **Estimated useful life:**
An asset cannot work forever. Every asset has a certain useful life of an asset is generally to be taken in terms of asset's expected use. The service life may be measured in terms of time, unit of output, working hours etc.

iv) **Legal provision:**
The amount of depreciation depends upon the statutory and legal provisions prescribing the admissible rate of depreciation on fixed assets. All the statutory and legal provisions must be carefully evaluated.

Chapter 9

ENTERPRISE FINANCING AND CAPITAL INVESTMENT

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9.1 METHODS OF FINANCING

The two broad choices a firm has for financing an investment project are equity financing and debt financing.

9.1.1 EQUITY FINANCING

It is first type of financing. Equity financing is the process of raising capital through the sales of share in an enterprise. Equity financing essentially refers to the sale of an ownership to raise funds for business purposes. It has two forms/models:

i) The uses of retained earning into company development.

ii) Issuing share to outside/creating new owners.

If a company does not have sufficient cash on hand to make an investment and does not wish to borrow in order to fund the investment, financing can be arranged by selling common stock to raise the required funds. To do this, the company has to decide how much money to raise, the type of securities to issue (common stocks or preferred stock) and the basis for pricing the issue. Once the company has decided to issue common stock, it must estimate flotation costs the expenses it will incur in connection with the issue, such as investment banker's fees, lawyer's fee, accountant's costs and cost of printing and engraving. Generally investment bankers will buy the issue from the company at a discount below the price at which the stock is to be offered to the public. If the company is already public owned, the offering price will commonly be based on the existing market price of the stock.

If the company is going public for the first time, no established price will exist, so investment bankers have to estimate the expected market price at which the stocks will sell after the stock issue.

9.1.2 DEBT FINANCING

The second major type of financing a company can select is debt financing, which includes both short term borrowing from financial institutions and the sale of long term bonds, where in money is borrowed from investors for a fixed period. Hence, a debt financing occurs when a firm raises money for working capital or capital expenditures by selling debt instruments to individuals and for institutional investors. In return for lending credits and receive a promise that the principal and interest on the debt will be repaid.

Difference between debt financing and equity financing:

S.N.	Debt financing	Equity financing
i)	Must be repaid or refinanced.	Can usually be kept permanently.
ii)	Debts provides are conservator.	Equity providers are aggressive.
iii)	Does not grant ownership of the firm.	Grants ownership of the firm.
iv)	Interest payments are tax deductible.	Dividend payments are not tax deductible
v)	Collateral assets must usually be available.	No collateral required.
vi)	Requires regular interest payments.	No payments requirement.
vii)	Debts has little or no impact on control of the company.	Equity requires shared control of the company and may impose restrictions.
viii)	Debts holders cannot share any upside or profits.	Shareholders can share any upside or profits.
ix)	Debts has a maturity dare	Stock has no maturity date.

9.1.3 CAPITAL STRUCTURE

The ratio of total debts to total capital, generally called the debts ratio or capital structure represents the percentage of the total capital provided by borrowed funds.

i.e., $\text{Capital structure} = \dfrac{\text{Total debt}}{\text{Total capital}}$

For example; A debt ratio of 0.30 indicates that 30% of the capital is borrowed and 70% funds are provided by equity.

This types of financing is called mixed financing

Also, $\text{debt ratio} = \dfrac{\text{Debt}}{\text{Total assets}} = \dfrac{\text{Debt}}{\text{Debts + Equity}}$

A firm usually establishes a target capital structure or target debt ratio, after considering the effects of various financing methods. This target may change over time as business conditions vary, but a firm's management always strives to achieve the target whenever individual financing decisions are considered.

On the one hand, the actual debt ratio is below the target level, any new capital will probably be raised by issuing debt. On the other hand, if the debt ratio is current above the target, expansion capital will be raised by issuing stocks.

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9.2 COST OF CAPITAL

Cost of capital is the required return necessary to make a capital budgeting such as new factory, worthwhile. Cost of capital includes the cost of debt and the cost of equity and is used by companies internally to judge whether a capital project is worth the expenditure of resources and by investor who use it to determine whether an investment is worth the risk compared to the return.

"The cost of capital is the minimum required rate of earnings or the cutoff rate of expenditure" Solomon Ezra.

9.2.1 COST OF EQUITY

Cost of equity is the minimum rate of return a firm must offer shareholders to compensate for waiting for their returns and for bearing some risk.

∴ Cost of equity

$$= \frac{\text{Next year's Dividend per share}}{\text{Current market stock value}} + \text{Growth rate of dividends}$$

Cost of equity calculation is based on sources of capital:

i) Cost of retained earnings:

$$k_r = \frac{D_1}{P_0} + g$$

where,

D_1 = first year dividend or $D_0(1 + g)$

P_0 = present cost of stocks

g = grow rate of stock

ii) Issuing new common stock:

$$k_p = \frac{D_1}{P_0(1 - f_c)} + g$$

where,

f_c = flotation cost

iii) Cost of preferred stock:

$$k_p = \frac{D^*}{P^*(1 - f_c)}$$

where,

D^* = fixed annual dividend

P^* = issuing price.

iv) Cost of equity:

Weight average cost of equity,

i.e., $\frac{C_r}{C_e}k_r + \frac{C_c}{C_e}k_e + \frac{C_p}{C_e}k_p$

where,

C_r = amount of equity financed from retained earnings.

C_p = amount of equity financed from preferred stock.

C_c = amount of equity financed from issuing new common stock.

$C_e = C_r + C_p + C_c$

Another method of determining cost of equity is,

$$i_e = r_f + \beta[r_m - r_f]$$

where,

i_e = cost of equity

r_f = risk free rate

β = firms beta risk

r_m = market rate of return

If $\beta > 1$; stock is more volatile than the market.

If $\beta < 1$; stock is more volatile than the market.

9.2.2 COST OF DEBT

Cost of debt is the effective rate that a company pays on its current debt. The two types of debt financing are term loans and bonds. Because the interest payments on both are tax deductible, the effective cost of debt will be reduced. To determine the after tax cost of debt (id), we use formula,

$$id = \left(\frac{C_s}{C_d}\right)k_s(1 - t_m) + \left(\frac{C_b}{C_d}\right)k_b(1 - t_m)$$

where,

id = cost of debt

C_s = amount of short term loan

C_d = amount of bond financing

$C_d = C_s + C_b$ = total amount of debt

k_s = before tax interest rate short term loan

k_b = before tax interest rate on bond

t_m = firm's marginal tax rate

9.2.3 CALCULATING THE COST OF CAPITAL

We can determine tax weighted average cost of capital (simply stated as the cost of capital) by reflecting the cost of raising funds from different sources.

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$$\text{Cost of capital, } k = \frac{id \cdot C_d}{V} + \frac{ie \cdot Ce_d}{V}$$

where,

C_d = total debt capital

$C_d = C_s + C_b$

C_e = total equity capital = $C_r + C_p + C_c$

ie = avarage equity interest rate per period

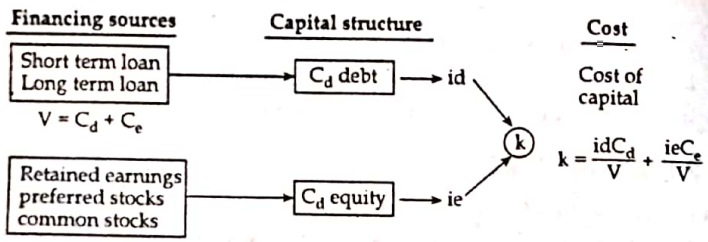
id = after tax average borrowing interest rate per period.

k = tax adjustment weighted average cost of capital.

$V = C_d + C_e$

Marginal cost of capital

It is define as the cost of obtaining another dollar of new capital and the marginal cost rises as more and more capital is raised during a given period.



9.3 PROJECT FUNDING MECHANISM

In life cycle of project, various nature of cost will be incurred and such cost is funded by mainly three mechanism:

- Government budget
- Private investment
- Public private partnership

9.3.1 GOVERNMENT BUDGET

A government budget is an annual financial statement presenting the revenues and spending for a financial year that is often passed by the legislature. The budget is also known as the annual financing statement of the country. Most of the development and public utility projects like road, water supply, electricity, gas, hospitals etc are established and run by government funding through budget. The funding made by the local and central government agencies to produce and delivery various public utilities include in this heading.

9.3.2 PRIVATE INVESTMENT

Private investment includes domestic and foreign private organization or people having financial and technical capabilities. All private companies and business projects are established and run by the private investment. Generally, private sector choose low risk and high return low investment as well as short run projects. Government also emphasized globalization and liberalization policies tom encourage private sectors for the development works. Its main objective is to maximize the profit rather than doing social welfare.

9.3.3 PUBLIC PRIVATE PARTNERSHIP (PPP)

Public private partnership is a contractual agreement between a public agency (federal, state or local) and a private sector entity. Through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of general public. In addition to the sharing of resources, each party shares in the potential risks and rewards in the delivery of the services and/ or facility.

Public = Government institutions like ministries, department, VDC, municipalities etc.

Private = Local and international body that may include financial and technical expertise relevant to the project.

Partnership = Formal agreement in which two or more parties cooperate to manage and operate a business or to provide services.

In PPP, government as well as private sector both are active on commercial functions of the projects and work for their mutual benefits. In PPP, government remains actively throughout the life of project and private sectors is responsible for the more commercial functions. Like the project design, construction, finance and operations. PPP is widely accepted project funding mechanism (development approach) throughout the world. Through PPP, government can reduce cost and risk and private sectors can generate business opportunities ad general people can receive better and more accessible services.

Success factors of PPP models

- Political will
- Security and privacy
- Legal framework
- Project address a real need
- Transparent selection procedures
- Clear definition of the scopes, roles, risk and obligations
- Consultation with stakeholders.

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Benefits from PPP

- Cost effectiveness
- Project acceleration
- Better public sector risk
- Reduce public sectors risk
- Improve service delivery
- Increase investment in public infrastructure.

9.4 FIRR, EIRR AND RETURN ON EQUITY

9.4.1 FINANCIAL INTERNAL RATE OF RETURN (FIRR)

The FIRR is an indicator to measure the financial return on investment of an income project and is used to make the investment decision. Some mega projects may generate different financial inflows and outflows for different stakeholders and their internal rate of return for that investment project may be different. FIRR can be calculated by various stakeholders based on their investment (cash inflow and outflow) projects. This can be

- FIRR for project entity (for total investment)
- FIRR for stockholder (for share/equity capital)
- FIRR for lenders/banks (for debt capital)
- FIRR for government
- FIRR for lender and contractor

FIRR is obtained by equating the present value of investment costs (cash outflows) and present value of net incomes (cash inflows).

$$\sum_{n=0}^{m} \frac{In}{(1+r)^n} = \sum_{n=0}^{m} \frac{Bn}{(1+r)^n}$$

where,

In = investment expenditure for the entire project life period from year o to m.

Bn = annual net incomes for the entire project life period from year o to m.

Solving above equation, we can obtain the value of r which is called FIRR.

Decision rule:

If FIRR > MARR; accept the project.

If FIRR < MARR; reject the project.

If FIRR = MARR; remain indifferent.

9.4.2 ECONOMIC INTERNAL RATE OF RETURN (EIRR)

Economic internal rate of return is calculated as the rate of discount for which the present value of the net benefit stream becomes zero or at which the present value of the benefit stream is equal to the present value

of the cost stream. The EIRR determines the discount rate where the present value of benefits is just equal to the present value of costs.

If there is no project boundary and externalities and price and policy distribution is zero, then, FIRR can be used as proxy for EIRR.

EIRR = FIRR + Profitability associated with consumers due to market price distortion + Profitability associate with externalities expressed in market price + Profitability associated with environment distraction.

For a project to be acceptable, the EIRR should be greater than the economic cost of capital.

9.4.3 RETURN ON EQUITY (ROE)

Return on equity (ROE) is a measure of financial performance calculated by dividing net income by shareholder's equity. Because shareholder's equity is equal of a company's assets minus its debt, ROE could be though as the return on the net assets. ROE is expressed as a percentage and can be calculated for any company if net income and equity are both positive number *i.e.*,

$$ROE = \frac{\text{Net income} - \text{Preferred diidends}}{\text{Shareholder's equity or common equity}} \times 100$$

$$= \frac{\text{Net income}}{\text{Shareholder's equity}} \times 100$$

ROE is sometimes called "return of net worth". ROE is more than a measure of profit; it is a measure of efficiency. A rising ROE suggest that a company is increasing its ability to generate profit without needing as much capital. It also indicates how well a company's management is deploying the shareholder's capital. Falling ROE is usually a problem. Many investors choose to calculate the ROE at the beginning and end of period to see the change in return ratio.

$$\text{Return on equity} = \text{Return of assets} \times \text{Leverage}$$

$$= \frac{\text{Net income}}{\text{Total assets}} \times \frac{\text{Total assets}}{\text{Average equity}}$$

$$\therefore \quad \text{Return on equity} = \frac{\text{Net income}}{\text{Average equity}}$$

Hence, ROE is a profitability ratio from the investors point of view not the company point of view.

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Benefits from PPP

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$$ROE = \frac{\text{Net income} - \text{Preferred diidends}}{\text{Shareholder's equity or common equity}} \times 100$$

$$= \frac{\text{Net income}}{\text{Shareholder's equity}} \times 100$$

ROE is sometimes called "return of net worth". ROE is more than a measure of profit; it is a measure of efficiency. A rising ROE suggest that a company is increasing its ability to generate profit without needing as much capital. It also indicates how well a company's management is deploying the shareholder's capital. Falling ROE is usually a problem. Many investors choose to calculate the ROE at the beginning and end of period to see the change in return ratio.

$$\text{Return on equity} = \text{Return of assets} \times \text{Leverage}$$

$$= \frac{\text{Net income}}{\text{Total assets}} \times \frac{\text{Total assets}}{\text{Average equity}}$$

$$\therefore \quad \text{Return on equity} = \frac{\text{Net income}}{\text{Average equity}}$$

Hence, ROE is a profitability ratio from the investors point of view not the company point of view.

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BOARD EXAM SOLVED PROBLEMS

1. **What are the sources of project finance? Explain the advantages of debt financing. If interest on debt is 12%, dividend to share holders over 15%, calculate weighted average cost of capital if debt is 70% and equity is 30%, tax rate is 20%.** **[18/F]**

Ans: Source of project finance are:

i) Debt finance
ii) Equity finance
iii) Public finance
iv) Personal capital
v) Retained profits

Advantages of debt financing are

i) Utilization of resources:
When a business use debt finance its operation, they got no option than to fully utilize their resources because they will have to pay back the debt and interest to their creditor.

ii) Tax advantage:
Debt financing also offers tax advantage to business as interest is deductible for income tax purpose.

iv) No future lender claims:
Lenders has no direct claim on future earnings.

v) Non dilutive
Debt does not dilute the ownership of small business.

vi) Future impact forecasting
Interest and principal repayment are based on fixed percentage and can be forecast.

vii) Simple loan repayment:
Lenders are only entitled to loan repayment and interest on loan.

Solution:

Interest on debt = 12%
Tax rate, T_C = 20%
Dividend to shareholder ratio = 15%
Weighted average cost of capital = ?
Debt (D/V) = 70%
Equity (E/V) = 30%

We know,

Weighted average cost of capital, WACC

$$= \frac{E}{V} \times Re + \frac{D}{V} \times R_C \times (1 - T_C)$$

Also,

Cost of debt, Rs = 10%
Cost of equity, Re = 15% = dividend to shareholder ratio.

Hence,

$$\begin{aligned} WACC &= 0.30 \times 0.15 + 0.75 \times 0.75 \times 0.12 \times (1 - 0.20) \\ &= 0.045 + 0.06720 \\ &= 11.22\% \end{aligned}$$

Thus, weighted average cost to capital is 11.22%.

2. **Write short notes on capital structure.** **[17/S]**

Ans: Refer topic 9.1.3.

3. **What are the factors to be considered while determining the cost of debt? Calculate the after tax cost of debt while the interest rate = 10% and tax rate = 40%.** **[17/S]**

Ans: Factors to be considered while determining the cost of debt are:

- Interest risk
- Nominal interest rate
- Real interest rate
- Risk free interest rate
- Inflation
- Inflation premium
- Maturity premium

Solution:

Interest rate = 10%
Tax rate = 40%

$$\begin{aligned} \therefore \text{After tax cost of debt} &= \text{Interest rate} \times (100\% - \text{tax rate}) \\ &= 10\% \times (100\% - 40\%) \\ &= 10\% \times 60\% \\ &= 6\% \end{aligned}$$

Hence, after tax cost of debt is 6%.

4. **Define funding and financing with examples.** **[17/S]**

Ans: Funding is an amount of money provided by the organization or government on the basis of an agreement. It is usually free of charge.
For example; Fund for building roads provided by government.
Financing is an amount of capital or the sum of money provided to an organization with the expectation to reply, and organizations are liable to pay back the capital amount along with a certain percentage of interest.
For example; Capital provided by bank to open new company.

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5. **Write short notes on project funding mechanism.** **[17/F, 16/S]**

Ans: Refer topic 9.3, 9.3.1, 9.3.2, 9.3.3.

6. **What do you mean by equity financing and debt financing? Explain ways to project funding mechanism by giving example.** **[17/F]**

Ans: Refer topic 9.3, 9.1.1 and 9.1.2.

7. **Write short notes on method of financing.** **[16/F]**

Ans: Refer topic 9.1, 9.1.1, 9.1.2 and 9.1.3.

8. **Write short notes on stock and bond.** **[16/F, 14/F, 12/F, 11/S]**

S.N.	Stocks/Share	Bonds/debenture
i)	Stocks are the financial instrument that carries ownership interest, issued by the company in exchanged for cash.	Bounds are the debt instrument issued by the company to raise capital with a promise to pay back the money after some period along with interest.
ii)	Stocks represent ownership.	Bonds represent debt.
iii)	Stocks do not have a maturity date.	Bonds have a maturity date.
iv)	High risk	Comparative low risk.
v)	All corporations issue or after to sell stocks. That is what makes them corporation.	Corporations are not required to issue bonds.
vi)	Stockholder's can elect a board of directors, which controls the corporation.	Bondholder's usually have no voice in or over management of the corporation.
vii)	Return is dividend.	Return is interest.
viii)	No return guarantee.	Return guaranteed.
ix)	It is not convertible into bond.	It may be convertible to bond.
x)	Issue of shares at a premium or discount has to be made with the company.	There is no any restriction on the issue of bond at a premium or discount.

9. **Define debt and equity financing. What is difference between them? If Asian electric company presently pays a dividend of Rs. 12 per share and has a share price of Rs. 110. The expected growth was 8% forever then what is the required return on equity?** **[15/F]**

Ans: Refer topic 9.1.1 and 9.2.2.

Present share price including dividend = Rs. 110

Initial price of share before dividend = Rs. (110 – 12) = Rs. 98

Expected growth on share = 8%

$\therefore$ Required return on equity $= \dfrac{\text{Initial price} \times \text{Expected growth rate}}{100}$

$= \dfrac{98}{100} \times 8 = \text{Rs. } 7.84$

Hence, required return on equity = Rs. 7.84.

10. **Write short notes on FIRR and EIRR.**

Ans: Refer topic 9.4.1 and 9.4.2. **[15/S]**

S.N.	FIRR	EIRR
i)	FIRR is calculated by financial analysis.	EIRR is calculated by economic analysis.
ii)	FIRR is mainly carried out by private sector.	EIRR is carried out by public sector.
iii)	Tax and subsidies are incorporated in FIRR.	Tax and subsidies are ignored in EIRR.
iv)	Market price is used.	Shadow price is used.
v)	Direct costs of project and benefits are calculated by investors point of view.	Direct as well as indirect cost and benefits are calculated by social point of view.

11. **Explain cost of capital. Briefly explain the equity financing and debt financing.** **[15/S]**

Ans: Refer topic 9.1.1, 9.1.2 and 9.2.

12. **Write short notes on public private partnership. 14/S**

Ans: Refer topic 9.3.3.

13. **Bond issued by Everest Bank Ltd. has a coupon rate of 8%. Interest is paid quarterly and the bond mature in 5 years. The face value of the bond is Rs. 1,000. What is the present value of the bond if market interest rate is 7.5%?** **[13/F, 12/S]**

Solution:

Coupon rate = 8% compounded quarterly.

Effective coupon rate $= \left(1 + \dfrac{r}{m}\right)^m - 1.$

$= \left(1 + \dfrac{0.08}{4}\right)^4 - 1$

$= 8.240\%$

Yearly return amount = rate × face value

= 03.824 × 1,000

= Rs. 82.40

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Present value of bond:

$$B_o = \frac{82.4}{(1+0.075)^1} + \frac{82.4}{(1+0.075)^2} + \frac{82.4}{(1+0.075)^3} + \frac{82.4}{(1+0.075)^4} + \frac{82.4}{(1+0.075)^5} + \frac{1,000}{(1+0.075)^5}$$

$$= 76.65 + 71.3 + 66.3 + 61.7 + 57.4 + 696.6$$

$$= \text{Rs. } 1,030$$

∴ Present value of bond = Rs. 1030.

14. Difference between common stock and preferred stock. [13/F, 12/S]

S.N.	Common stock	Preferred stock
i)	Common stock refers to the ordinary stock representing part ownership and confers voting rights to the person holding it.	Preferred stock represents that part of company's capital that carry preferential right to be paid, when the company goes bankrupt or wound up.
ii)	Differential rights	Preferential rights.
iii)	Return on capital is not guaranteed.	Return on capital is guaranteed.
iv)	Cannot be redeemed.	Can be redeemed.
v)	It is not convertible.	It is convertible.
vi)	Payment to common stock holder are made at the end.	Preferred stockholders are paid before common stockholders.
vii)	It has voting right on general meeting.	It do not have any voting rights.
viii)	Growth potential is high.	Low growth potential.
ix)	Rate of dividend may vary over the years.	Rate of dividend is fixed.
x)	If there is no profit, common stockholders receive nothing.	Irrespective of making profit/ incurring losses, preferred stockholders receive the dividend.
xi)	Don't receive arrears in the next year.	Receives arrears in the next year.

Chapter 10

BASIC ACCOUNTING PROCEDURE

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10.1 ACCOUNTING

Accounting is a system of collecting, summarizing, analyzing, classifying and interpreting business information in financial and monetary terms. Accounting is the systematic and comprehensive recording of financial transactions pertaining to a business.

10.1.1 ASSETS

An asset is any resource owned by the business organization to generate economic benefit. Anything tangible or intangible that can be owned or controlled to produce value and that is held by a company to produce positive economic value is an asset.

For example; Cash in hand, stock, land, building, goodwill, loan.

Types of assets are:

a) Fixed assets

Fixed assets are of a fixed nature in the context that they are not readily convertible into cash. They require elaborate procedure and time for their sale and converted into cash.

For example; Land, building, plant and machinery equipment, furniture and fixtures, vehicles etc.

b) Current assets

Current asset is any asset which can reasonably be expected to be sold, consumed or exhausted through the normal operation of a business within the current fiscal year or operating cycle.

For example; Sundry debtors, accrued incomes, cash in hand, cash at bank, Bills receivable etc.

c) Fictitious assets

Fictitious assets are those assets which are neither tangible assets nor intangible assets but represent loss or expenses yet to be written off. They are taken as the assets on legal and technical grounds.

For example; Advertisement expenditure, deferred revenue expenditure, discount on shares and debentures, debit balance of profit and loss account etc.

d) Intangible assets

An intangible asset is an asset that is not physical in nature. It includes patent, copyrights, franchises, goodwill, trademarks and trade names. Intangible assets are categorized as limited life and indefinite life. While

intangible assets don't have the obvious physical value of a factory or equipment, they can prove valuable for a firm and be critical to its long term success or failure.

For example; Goodwill, brand recognition, patents, trademarks, customer lists etc.

10.1.2 LIABILITIES

Liabilities are debts payable in the future by the firm to its creditors. It denotes economic obligation to pay cash or to provide goods or services in the accounting records with a credit and decreased with a debt. A liability can be considered as a source of fund. Liabilities are aggregated on the balance sheet with two general classifications, which are current liabilities and long term liabilities.

a) Current liabilities

Current liabilities are a company's debts or obligations that are due within one year. Current assets are converted into cash to pay current liabilities.

For example; Account payable, notes payable, advance income, short term loan, Bank overdraft, sales tax payable etc.

b) Long term liabilities

Long term liabilities are financial obligations of a company that become due more than one year. It is also known as permanent liabilities.

For example; Deferred revenues, capital leases, long term loans, bounds payable, bank loan, pension liabilities etc.

10.1.3 FUNDAMENTAL EQUATION OF ACCOUNTING

The fundamental accounting equation also called the balanced sheet equation, represents the relationship between balanced sheet equation, represents the relationship between the assets, liabilities and owner's equity of a business or a person. It is the fundamental of the double entry book-keeping system. Assets denote resources, and capital and liabilities are source of financial. The value of resources and sources must be equal. It can be expressed as

Assets = Liabilities + Equity

A = L + E

Capital = Assets – Liabilities

Liabilities = Assets – Capital

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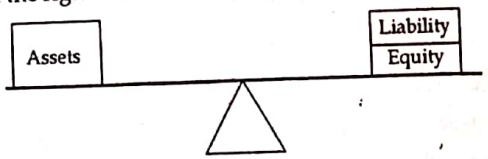
In a corporation, capital represents the shareholders equity. Since, every business transaction affects at least two of a company's account the accounting equation will be in balance, meaning the left side should always equal the right side.



10.2 FINANCIAL STATEMENTS

Financial statements are written records that convey the financial activities and conditions of a business or entity and consist of four major components. Relevant financial information is presented in a structured manner and in a form easy to understand. They are useful for the following reasons:

- To determine the ability of a business to generate cash and the source and uses of that cash.
- To determine whether a business has the capability to pay back its debt.
- To track financial results on a trend line to stop any looming profitability issues.
- To derive financial ratios from the statement that can indicate the condition of the business.
- To ascertain the results of various business operation such as debtors, profit, loss, payables, incomes etc.
- To promote effective decision making.

Basic financial statements are:

- Balance sheet
- Cash flow statement
- Income statement
- Statement of retained earnings

10.2.1 THE BALANCE SHEET

A balance sheet is a statement of the financial position of a business which states the assets, liabilities and owner's equity at a particular point of time. Balance sheet is the final step of final account. Balance sheet is not an account but a statement of assets, liabilities and capital of the business

enterprises at a given date. In balance sheet, total of all assets will always be equal to the total of all capital and liabilities.

i.e., Assets = Capital + Liabilities

a) Objective/Importance of Balance sheet:

i) It reveals the financial position. *i.e.*, state of affairs of a business.
ii) It ascertains composition of assets and liabilities.
iii) It tells about the balance of debtors and creditors.
iv) It tells about the liabilities and assets of the firm.
v) It tells about liquidity position of a firm.
vi) It depicts the debt paying capacity of the firm.

b) Characteristics of balance sheet:

i) Balance sheet is only a statement not an account.
ii) Balance sheet is prepared on a particular date but not for a particular period unlike trading and profit and loss account.
iii) Balance sheet shows the nature and value of assets and the nature and the amount of liabilities at a given date.
iv) The totals of liabilities and assets are always equal.
v) It shows the financial position of the business concern.
vi) It shows what the firm owes to others and also what others owe to the firm.

c) General format of balance sheet:

Assets		Liabilities
Current assets	=	Current liabilities
		Long term liabilities
Long term assets		Equity i) Owner contribution ii) Retained earnings

There are several balance sheet formats available and generally, it is categorized as classified, common size, comparative and vertical balance sheets. In account format, the balance sheets is divided into left and right sides like a T-account. The assets are listed on the left hand side whereas both liabilities and owner's equity are listed on the right hand side of the balance sheet. It all the elements of balance sheet are correctly listed, the total asset side must be equal to the total of liabilities and owner' equity side.

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..... Company

Balance Sheet

As on .....

Assets	Rs.	Liabilities and Capital	Rs.
Fixed assets:		Opening capital: × ×	
Land and building	× ×	Less: Drawing : × ×	
Plant and machinery	× ×	Add: Net profit : × ×	
Equipments	× ×	Less: Net loss : × ×	× ×
Furniture and fixtures	× ×	**Reserve and funds:**	
vehicles	× ×	General reserve	× ×
live stocks	× ×	Capital reserve	× ×
Goodwill	× ×	Specific reserve	× ×
Patent, trademark and		Sinking fund	× ×
copyright	× ×	Other reserve and funds	× ×
Investment:		**Secured loans:**	
Investment in share and		Debenture	× ×
debentures	× ×	Mortgaged loan	× ×
Investment in government		Bonds	× ×
securities	× ×	other secured loans and	
Current assets:		advance	× ×
Sundry debtors	× ×	**Unsecured loan:**	
Cash in hand	× ×	Fixed deposit	× ×
Cash at bank	× ×	Bank overdraft	× ×
Loss tools	× ×	Short term loan from bank	× ×
Stores and spare parts	× ×	**Current liabilities:**	
Closing stock	× ×	Bills payable	× ×
Loan and advance:		Advance receipts	× ×
Deposit with suppliers	× ×	Sundry creditors	× ×
Bills receivable	× ×	Accounts payable	× ×
Prepaid expenses	× ×	Outstanding payable	× ×
Advance paid(tax, rate etc)	× ×	Outstanding expenses	× ×
Miscellaneous expenses:		Other current liabilities	× ×
Preliminary expenses	× ×	**Provisions:**	
Advertisement suspense	× ×	Provision for taxation	× ×
unadjusted development		Provision for staff	× ×
expenses	× ×	Provided fund	× ×
		Pension fund	× ×
		Other provisions	× ×
	× ×		× ×

10.2.2 INCOME STATEMENT

The income statement is one of the financial statement used to assess a company's performance and financial position. The income statement summarizes the revenues and expenses generated by the company over the entire reporting period. The income statement is also called as profit and loss (P and L) statement. Statement of earnings, statement of income or statement of operations. The basic equation on which an income statement is based is:

Revenue - Expenses = Net income (Loss)

In case of trading business, it is prepared in two steps.

i) Trading account

ii) Profit and loss account

Importance of income statement

- To ascertain gross and net profit
- To keep control on indirect expenses
- Basis for managerial decision.
- Basis for preparing balance sheet.

10.2.2.1 TRADING ACCOUNT

The account which is prepared to determine the gross profit or gross loss of a business concern is called trading account. In equation, gross profit = sales - cost of goods sold. It should be noted that the result of the business determined through trading account is not true result. The true result is the net profit or the net loss which is determined through profit and loss account.

1. Features of trading account are:

i) It is the first stage of final accounts of a trading concern.

ii) It is prepared on the last day of an accounting period.

iii) Only direct revenue and expenses are considered in it.

iv) Direct revenues are recorded on its credit side and direct expenses are recorded on its debit side.

v) All items of direct expenses and direct revenue concerning current year are taken into account but no item relating to past or next year is considered in it.

2. Importance of trading account are:

i) It provides information related to gross profit and loss and helps in defining the upper limits for the operating expenses of the business.

ii) It helps in computation of gross profit ratio. A decrees in the gross profit indicates increase in the purchased cost or decrease in selling price.

iii) To ascertain the performance of different years of business through the gross profit ratio which is calculated by dividing the gross profit by sales.

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3. Format of trading account

All the direct expenses are debited and all direct incomes are credited to trading account being a special nominal account. Trial balance is a list of all ledger accounts balance. So all the necessary information for preparation of a trading account is available from the trial balance. If the credit side of the trading account exceeds the debit side, the result is "gross profit" and it debit side exceeds the credit side, the result is "gross loss". The format of a trading accounting is shows below:

Trading account of .....
For the year ended .....

Dr. Cr.

Particulars	Rs.	Particulars	Rs.
To opening stock	× ×	By sales : × ×	
To purchase : × ×		Less: Sales return	
Less: Purchase return		or, return inward	
or, return outward		or, return from debtors: × ×	× ×
or, return to creditors : × ×	× ×		
To purchase expenses:		By closing stock	× ×
Carriage/Carriage inward	× ×	(By gross loss transferred	
Freight/Freight inward	× ×	to profit and loss account)	× ×
Freight on purchase	× ×		
Dock charges	× ×		
Coolie and cartage	× ×		
Import duty	× ×		
Custom duty on import	× ×		
Clearing charges	× ×		
Packing on purchase	× ×		
To factory/Manufacturing expenses:			
Wages/Salaries	× ×		
Factory rent	× ×		
Fuel and power	× ×		
Coal, gas, water	× ×		
Heating and lighting	× ×		
Store consumed	× ×		
Excise duty	× ×		
Royalties	× ×		
All other factory expenses	× ×		
To gross profit expenses	× ×		
To profit loss account	× ×		
	× ×		× ×

10.2.2.2 PROFIT AND LOSS ACCOUNT

Profit and loss account is prepared after the completion of trading account. The profit and loss account is a financial statement that summarizes the revenues, costs and expenses during a specified period usually a fiscal year. Gross profit or loss of a business is ascertained through trading account and net profit is determined by deducting all the indirect expense from the gross profit through profit and loss account. Thus, profit and loss account starts with the result provided by trading account.

1. Importance of profit and loss account are:

i) It provides information about net profit earned or net loss suffered by the business.

ii) It helps in preparing balance sheet after finding out net profit or net loss.

iii) It helps in controlling indirect expenses and in improving profitability.

iv) It follows in the estimation of profits for the coming years by comparing the profits of previous year.

v) It helps for the calculation of important financial ratios.

2. Format of profit and loss account

Profit and loss account is also prepared as the trading account. Profit and loss account keeps all indirect income in the credit side with gross profit and all indirect expenses including gross loss are kept on debt side. The format of profit and loss account is shown below:

Profit and Loss Account of ..... Company
For the year ended .....

Dr. Cr.

Particulars	Rs.	Particulars	Rs.
To gross loss	× ×	By gross profit	× ×
To office & administrative expenses:		By interest received	× ×
		By bad debt recovered	× ×
Salary and wages	× ×	By dividend received	× ×
Printing and stationary	× ×	By discount received	× ×
Rent and taxes	× ×	By commission received	× ×
Insurance and interest	× ×	By profit on sale of assets	× ×
Audit and license fee			

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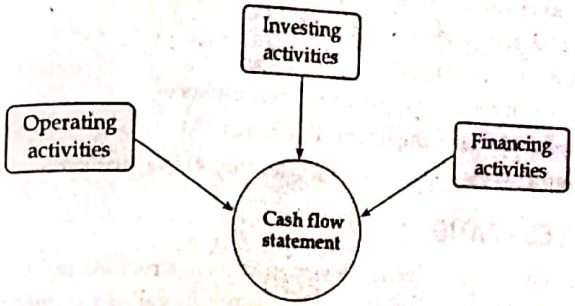
Lighting and heating	× ×	By appreciation on fixed assets	× ×
Bonus and other official expenses	× ×	By net loss transferred to balance sheet	× ×
Electricity and Telephone	× ×		
To selling and distribution expenses:	× ×		
Salesman salary and commission			
Packing & travelling expenses	× ×		
Advertising & publishing	× ×		
Free sample & ware house	× ×		
Carriage & freight outward	× ×		
Export duty and discount allowed	× ×		
Research and development expenses	× ×		
VAT and bad debts	× ×		
To other expenses and loses:	× ×		
Depreciation			
Repair & maintenance	× ×		
Abnormal loss on goods or machines	× ×		
To net profit transferred to balance sheet	× ×		
	× ×		
	× ×		× ×

It debit side exceeds credit side, the result shall be net loss. The net loss is then transferred to asset side of balance sheet. If credit side is more than debit side, the result will be net profit and it is then transferred to liabilities side of balance sheet.

10.2.3 CASH FLOW STATEMENT

A cash flow statement also known as statement of cash flows is a financial statement that shows how changes in balance sheet accounts and income affect cash and cash equivalents, and breaks the analysis down to operating, investing and financial activities. Cash flow is the statement of sources and uses of cash funds that shows where from cash came and

where cash was used during the given period. The difference between inflow and outflow of cash and cash equivalent is termed as net increase or decrease in cash and cash equivalent.



The cash flow statement reports cash flows during the period in 3 category.

- Operating activities
- Financing activities
- Investing activities

1. **Objectives of cash flow statement:**

i) To asset short term cash planning of the firm
ii) To evaluate the financial policies of the firm
iii) To know the liquidity position of the firm
iv) To know the company's operating, inverting and financing activities during accounting period.
v) To understand the reasons for variation in cash position of the firm.
vi) To help in planning of the repayment of loan replacement of fixed assets and other long term planning etc.
vii) To know the cash payment and cash receipt of the firm during the accounting period.
viii) To evaluate the financial policies of the firm.

It is an important financial tool for the management internally and for the investors of creditors externally and for the investors or creditors in assessing the company's ability to manage cash flows, to generate positive future cash flow, to pay dividend and interest etc.

10.3 RATIO ANALYSIS

Ratio is the mathematical relationship between two figure where one number is expressed in terms of another. Ratio analysis can evaluate the performance of any analysis of financial statement by the help of ratio between two accounting figures.

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Importance of ratio analysis:

- Helpful in decision making
- Helpful in future forecasting
- Helpful in corrective action
- Helpful in cost control
- Helpful in comparing inter-firm performance
- Helpful in measuring financial solvency
- Helpful in assessing operating efficiency of the business

10.3.1 DEBT RATIO

It is also known as solvency/leverage/capital structure ratio. The ratio between total liabilities and total assets, generally called the debt ratio tells us the proportion of the company's assets that it has financed with debt

$$\therefore \quad \text{Debt ratio} = \frac{\text{Total debt}}{\text{Total asset}}$$

Total debt includes both current liabilities and long term debt. If the debt ratio is unity, then the company has used debt to finance all of its assets. Debt ratio measures the ability of firm for paying the interest regularly and to repay the principal on agreed time.

10.3.2 CURRENT RATIO

The current ratio measures a company's ability to pay its short term obligations. Current ratio is the ratio of current assets to current liabilities which is calculated by dividing current assets by current liabilities.

$$\therefore \quad \text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

Companies with a seemingly current ratio may not be safer than a company with a relatively low current ratio. The current ratio is an indication of a firm's liquidity. A current ratio of less than 1 indicates that the company may have problems meeting its short term obligations. A ratio of 1 or higher shows that company has enough assets to cover liabilities.

10.3.3 QUICK RATIO/ACID-TEST RATIO/LIQUID RATIO

It measures the ability of firs to pay current liability immediately. Quick ratio is a type of liquidity ratio which measures the ability of a company to use its near cash or quick assets to extinguish or retire its current liabilities immediately.

$$\therefore \quad \text{Quick ratio} = \frac{\text{Quick assets}}{\text{Current liabilities}}$$

Higher the quick ratio, better the liquidity position.

10.3.4 INVENTORY TURNOVER RATIO

The inventory turnover ratio measures how many times the company sold and replaced its inventory over a specific period. It is also called stock turnover ratio. It is calculated by dividing the cost of goods sold by average inventory.

$$\therefore \quad \text{Inventory turnover ratio} = \frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

Cost of goods sold = Opening stock + Purchase + Direct expenses − Closing inventory

= Sales − Gross profit

$$\text{Average inventory} = \frac{\text{Opening stock} + \text{Closing stock}}{2}$$

Also,

$$\text{Inventory turnover ratio} = \frac{\text{Sales}}{\text{Averge inventory}} = \frac{\text{Sales}}{\text{Closing inventory}}$$

Hence, high inventory turnover indicates efficient inventory management. Low inventory turnover indicates stocks are kept for long time in store.

10.3.5 TOTAL ASSET TURNOVER(INVESTMENT TURNOVER RATIO)

The total assets turnover ratio measure how effectively the firm uses its total assets in generating its revenues. It is the ratio of sales to all the firm's assets.

$$\therefore \quad \text{Total assets turnover ratio} = \frac{\text{Net sales}}{\text{Total assets}}$$

Total assets = Fixed assets + investment + current assets, loan and advance − fictitious assets.

Net sales = Total sales − Sales return.

Higher the investment turnover ratio implies better utilization of total assets for making the sales and vice-versa.

10.3.6 PROFIT MARGIN ON SALES

Profit margin is the direct expression of gross profit in relation of sales.

$$\therefore \text{Gross profit margin} = \frac{\text{Gross profit amount}}{\text{Sales quantities}}$$

Higher ratio of net profit to net sales quantity is a indication of efficient management that reflects lower cost of goods sold and maximum profit.

$$\therefore \quad \text{Net profit margin} = \frac{\text{Net profit amount}}{\text{Sales quantities}}$$

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10.3.7 RETURN ON TOTAL ASSETS

It is also called profit to assets ratio. The ratio of net income to total assets measures the return on total assets after interest and taxes.

$$\therefore \quad \text{Return on total assets} = \frac{\text{Net profit}}{\text{Total asets}}$$

$$= \frac{\text{Net income + interest expense (1 - tax rate)}}{\text{average total asets}}$$

Higher ratio implies available resources are employed efficiently.

10.3.8 PRICE EARNING RATIO

The price earnings ratio is the ratio for valuing a company that measures its current share price relative to its per share earnings. It is also known as price multiple or the earning multiple. It shows that how much investors are ready to pay per rupee of reported profit.

$$\therefore \quad \text{Price sharing ratio} = \frac{\text{Initial market price per share}}{\text{Current earning per share}}$$

10.3.9 BOOK VALUE PER SHARE

Book value per share measures the amount that would be distributed to holders of each share of common stock if all assets were sold at their balance sheet carrying amounts and if all creditors were paid off. It is the ratio between common shareholder's equity and number of common shares outstanding.

$$\therefore \quad \text{Book value per share} = \frac{\text{Common shareholdr's equity}}{\text{Number of common shares outstanding}}$$

$$= \frac{\text{Total common stockholder's equity - Preferred stock}}{\text{Number of common shares}}$$

A relatively high book value per share in relation to stock price often occurs when a stock is undervalued. Book value per share indicated the book value of each share of stock.

BOARD EXAM SOLVED PROBLEMS

1. **What is financial ratios? Explain major financial ratios that can be applied in decision making process in business.** (18) (7)

[18/S, 17/F, 16/S, 15/F]

Ans: A financial ratio or accounting ratio is a relative magnitude of two selected numerical values taken from an enterprise's financial statements. Financial ratios are relationship determined from a company's financial information and used for comparison purpose. Refer topic 10.3, 10.3.1, 10.3.2, 10.3.3, 10.3.4, 10.3.5, 10.3.6, 10.3.7, 10.3.8 and 10.3.9.

2. **Difference between net profit and gross profit.** (10) **[18/F]**

S.N.	Gross profit	Net profit
i)	Gross profit is the difference between sales and cost of goods sold.	Net profit is the difference between gross profit and all other income less all indirect expenses and losses.
ii)	It is ascertained from the trading account.	It is ascertained from the profit and loss account.
iii)	It is transferred to profit and loss account.	It is transferred to capital account.
iv)	It does not include any income from other sources.	It may include income from other sources.

3. **Difference between general accounting and cost accounting.** (10)

[17/S, 16/F, 14/S, 11/F]

S.N.	General/Financial accounting	Cost accounting
i)	It provides information about the business in a general way. It tells about the profit and loss and financial position of the business to owners and other outside parties.	It provides information to management for proper planning, operation control and decision making.
ii)	These accounts are kept in such a way as to meet the requirements of companies act and income tax act.	These accounts are generally kept voluntarily to meet the requirements of management. But now companies act has made it obligatory to keep cost records in some manufacturing industries.

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iii)	It classifies, records and analyzes the transactions in a subjective manner *i.e.*, according to the nature of expenses.	It records the expenditure in an objective manner *i.e.*, according to the purpose for which the costs are incurred
iv)	Stocks are valued at cost or market price whichever is less.	Stocks are valued at cost.
v)	Financial accounts do not provide information on the relative efficiencies of various workers, plans and machinery.	Cost accounts provide valuable information on the relative efficiencies of various workers, plants and machinery.
vi)	The costs are reported in aggregate in financial accounts.	The costs are broken down on a unit basis in cost accounts.
vii)	It reports operating results and financial position usually at the end of the year.	It gives information through cost reports to management as and when desired.
viii)	Monetary information is only used *i.e.*, only monetary transactions are recorded.	Non monetary information like units is also used *i.e.*, it deals with monetary as well as non-monetary information.
ix)	It is the account of whole business and discloses the net profit or less of the business as a whole.	It is only a part of general account and disclose profit and loss of each product (job or service)
x)	It records in a subjective manner.	It records in a objective manner.

4. Define accounting. How do you formulate an accounting equation? [17/F, 15/5, 14/S]

Ans: Refer topic 10.1 and 10.1.3.

5. Explain the golden role of accounting. [16/F, 11/F,14/F]

Ans: Golden rules of accounting are the basic accounting rules on the basis of which accounting entries are recorded. It is the traditional approach for the rules of debit and credit. There are 3 types of account *i.e.*, real, personal and nominal account.

i) **Personal account**

Personal accounts are related to individuals, firms, companies etc. The person who receives a benefit is debited and who gives the benefit is credited. The rule for personal accounts is:

"Debit the receiver, and credit the giver"

ii) **Real account**

All assets of a firm, which are tangible or intangible fall under the category real account. The golden rule for real account is:

"Debit what comes in and credit what goes out"

iii) **Nominal account**

Accounts which are related to incomes, expenses, gains and losses of the business are called nominal account. The golden rule of debit and credit for nominal accounts is rule of debit and credit for real account is,

"All expenses and losses are debited and all incomes and gains are credited."

6. What are the significance of financial statements in business? Explain the financial statement with its type. [16/S]

Ans: Refer topic 10.2, 10.2.1, 10.2.2 and 10.2.3.

7. What is income statement and balance sheet? How are they related to each other? [15/S, 18/S]

Ans: Refer topic 10.2.2 and 10.2.1.

The relationship between balance sheet and income statement is that the profit of the business shown in the income statement belongs to the owners and this is shown by a movement in equity between the opening and closing balance sheets of the business. The income statement reports a company's financial performance while the balance sheet reports its financial health. One proceeds from the another. A company financial performance regulates its financial health. Performance and health are liked through the net income account on the income statement and the equity account on the balance sheet.

So, the relationship between balance sheet and income statement is that the profit for the period which comes from the income statement represents the movement on equity which is the difference between the opening and closing equity in the balance sheet of the business.

8. What are the elements used in debit and credit side of trading account and profit and loss account? [11/F]

Ans: Elements that are used in debit and credit side of

a) Trading account:

On debit side

i) opening stock
ii) purchase and purchase return
iii) purchase related expenses
iv) factory or manufacturing expenses.

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On credit side

i) sales and sales return

ii) closing stock

b) Profit and loss account

On debit side

i) financial expenses

ii) depreciation and repair and maintenance

iii) selling and distributing expenses

iv) office and administrative expenses

v) other expenses and losses

On credit side

i) indirect incomes

ii) other incomes and profits

9. Write the short notes on balance sheet. **[13/S, 17/F]**

Ans: Refer topic 10.2.1.

10. Difference between trading account and profit and loss account. What are the elements used in balance sheet? **[14/F]**

Ans: Elements used in balance sheet

The balance sheet consists of three major elements: assets, liabilities and owner's equity.

i.e., Assets = Liabilities + Owner's equity.

S.N.	Trading account	Profit and loss account
i)	Trading account is the part of profit and loss account.	Profit and loss account is the main account.
ii)	Gross loss or gross profit is ascertained from trading account.	Net profit or net loss is ascertained from profit and loss account.
iii)	Balance of trading account is transferred to profit and loss account.	Balance of profit and loss account is transferred to capital account.
iv)	It does not start with the balance of any account.	It always start with the balance of a trading account (gross profit or gross loss)
v)	All direct expenses are considered in it.	All expenses connected with sales and administration of business are recorded.
vi)	It is the first stage of final account.	It is the second stage of final account.

11. Prepare one sample of balance including the components of assets and liability. **[17/S, 13/F]**

Ans: Refer topic 10.2.1. (3)

12. Define asset and liability. **[13/F]**

Ans: Refer topic 10.1.1 and 10.1.2.

13. List out the major financial statements. Explain the main purpose of preparing the profit and loss account along with providing its appropriate format. **[12/S]**

Ans: Major financial statements are:

i) Balance sheet

ii) Income statement

iii) Cash flow statement

Main purpose of preparing the profit and loss account are:

Refer topic 10.2.2.2 (1)

General format:

Refer topic 10.2.2.2 (2)

14. Define the financial ratios and their importance for financing. **[17/S]**

Ans: Financial ratio is defined as the mathematical expression of the relationship between two accounting figures.

Importance of financial ratios are:

i) Helpful in assessing operating efficiency of the business.

ii) Helpful in measuring financial solvency.

iii) Helpful in decision making

iv) Helpful in corrective action

v) Helpful in cost control.

vi) Helpful in future forecasting

vii) Helpful in comparing inter-firm preference.

Ratios are used for efficiency and profitability measurement of any organization by the relationship between figures and evaluating financial performance. The popular by used ratios are:

i) Debt ratios

ii) Operating ratios

iii) Liquidity ratios

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15. The following is trail balance of Acharya Company. [15/F]

Particulars	Debit (Rs.)	Credit (Rs.)
Capitals		2,00,000
Plants and machinery	50,000	
Furniture and fitting	75,000	
Motor van	24,000	
Sundry debtors	40,000	
Cash at bank	7,000	
Wages	1,50,000	
Purchases and sales	2,13,000	4,00,000
Bills receivable and payable	35,000	15,000
Sundry creditors		20,000
Salaries	36,000	
Drawings	20,000	
Discount received		10,000
Bank loan		30,000
General reserve		20,000
Opening stock	40,000	
Bad debt	5,000	
Total	6,95,000	6,95,000

Value of closing stock = Rs. 52,000

Net Profit = Rs. 18,600

Required: Balance sheet.

Solution:

Profit and loss account

For the year ended 30th Chaitra 2074

Dr. **Cr.**

Particulars	Amount	Particulars	Amount
To opening stock	40,000	By gross profit	49,000
To purchases	2,13,000	By discount received	10,000
To wages	1,50,000	By sales	4,00,000
To gross profit	49,000	By closing stock	52,000
To salaries	36,000		
To bad debt	5,000		
To net profit	18,000		
Total	59,000		59,000

Balance sheet of Acharya Company

Assets	Amount	Capital and liabilities	Amount
Plant and machinery	50,000	Capital : 2,00,000	
Furniture and fitting	75,000	Add: Net profit : 18,000	
Motor van	24,000	Less: Drawing : 20,000	1,98,000
Bills receivable	35,000	General reserve	20,000
Sundry debtors	40,000	Bank loan	30,000
Closing stock	52,000	Bills receivable	15,000
Cash at bank	7,000	Sunday creditors	20,000
Total	2,83,000		2,83,000

16. **Prepare balance sheet of ABC Company from the following information as on 31st December 2014.** [14/S]

Capital	40,000	Building	3,00,000
Sundry debtors	15,000	Furniture	12,500
Cash in hand	4,000	Cash at bank	7,500
Bank overdraft	85,200	Bills receivable	4,500
Sundry creditors	3,500	Closing stock	3,500
Reserve funds	4,500	Net profit	20,500

Solution:

Balance sheet of ABC Company

as on 31st December 2014

Assets	Amount	Capital and liabilities	Amount
Building	30,000	Capital : 40,000	
Furniture	12,500	Add: Net profit : 20,500	60,500
Bills receivable	4,500	Bank overdraft	85,200
Closing stock	3,500	Sunday creditors	3,500
Sundry debtors	15,000	Reserve fund	4,500
Cash at bank	7,500		
Cash in hand	4,000		
Total	77,000		77,000

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17. From the following trial balance, prepare P/L account and balance sheet. [18/F]

Debit balance	Amount	Credit balance	Amount
Closing stock	30,000	Capital	2,50,000
Sundry debtors	50,000	Gross profit	1,22,000
Plant and machinery	2,25,000	Dividend received	1,250
Goodwill	14,500	Interest received	750
Land and building	1,35,000	Sundry creditors	39,000
Salaries and wages	27,500	Reserve fund	50,000
Rent	7,500	Bank loan	50,000
Selling expenses	12,500	Bank overdraft	23,500
Cash at bank	10,000		
Deposit with custom	7,500		
Advertisement	5,000		
Investment	12,000		
Total	5,36,500		5,36,500

Solution: **Profit and loss account of ..... Company**

For the year ended 2074/12/30

Dr. Cr.

Particulars	Amount	Particulars	Amount
To rent	7,500	By gross profit	1,22,000
To salaries and wages	27,500	By interest	750
To selling expenses	12,500	By dividend received	1,250
To advertisement	5,000		
To net profit	71,500		
Total	1,24,000		1,24,000

Balance sheet of ..... Company

as on 2074/12/30

Assets	Amount	Capital and liabilities	Amount
Closing stock	30,000	Capital : 2,50,000	
Cash at bank	10,000	Add: Net profit : 71,500	3,21,500
Sundry debtors	50,000	Bank loan	50,000
Plant and machinery	2,25,000	Bank over draft	23,500
Land and building	1,35,000	Sunday creditors	39,000
Goodwill	14,500	Reserve fund	50,000
Investment	12,000		
Deposit with custom	7,500		
Total	4,84,000		4,84,000

18. **What do you mean by profit and loss account and balance sheet?** [12/F]

Ans: Refer topic 10.2.2.2 and 10.2.1.

ADDITIONAL PROBLEMS

1. **Difference between trial balance and balance sheet.** (12)

S.N.	Trial balance	Balance sheet
i)	It shows the balance of all ledger account.	It shows the balances of personal and real accounts only.
ii)	It is prepared after the completion of the ledger account.	It is prepared after the completion of trading and P & L account.
iii)	It shows the opening stock.	It shows the closing stock.
iv)	Its objective is to check the arithmetical accuracy.	Its objective is to reveal the financial position of the business.
v)	The preparation of trial balance is not compulsory.	The preparation of balance sheet is must.
vi)	Trial balance can't be used as evidence in the court of law.	Balance sheet can be presented as documentary evidence in the court of law.
vii)	It contains all ledgers *i.e.*, capital, liabilities, incomes, gains, assets, expenses and losses.	It contains only assets, liabilities and capital including net profit and net loss.

2. **Difference between journal and ledger.** (12)

S.N.	Journal	Ledger
i)	Journal is a subsidiary book of account. It is the store house of recording transitions.	Ledger is the permanent and final book of accounts. It is termed as the means of classified transactions.
ii)	Journal helps in preparing ledger account correctly.	The objectives of ledger is to know income and expenditure of different heads.
iii)	Transactions are recorded in journal in chronological order of dates.	Ledger is prepared according to nature of accounts.
iv)	The total results of transitions cannot be known from journal.	Results of particular head of accounts can be known from ledger.
v)	It is a book of primary entry.	It is a book of final entry.
vi)	The process of recording of entries in these book is called journalizing.	The process of recording of entries in the ledger is called posting.
vii)	Journal is not balanced.	Every account is balanced.
viii)	The narration is given after every entry.	The narration is not given.

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3. Moon and Moon Company has just completed preparing its trial balance as of 30 June 2018. Prepared income statement and balance sheet.

Moon and Moon Company
Trial balance
As of 30 June 2018

Accounts	Debit (Rs.)	Credit (Rs.)
Cash	6,200	
Accounts receivable	10,400	
Prepaid rent	4,400	
Chemical inventory	9,400	
Accumulated depreciation		1,050
Accounts payable		1,180
Capital stock		5,000
Retained earnings		25,370
Treatment revenue		40,600
Wages and salary expenses	22,500	
Utility expense	1,240	
Advertising expenses	860	
Equipment	18,200	
Total	73,200	73,200

Solution:

Income statement of Moon and Moon Company
As of 30 June 2018

Dr. Cr.

Particulars	Amount	Particulars	Amount
To wages and salaries	22,500	By treatment revenue	40,600
To advertising expenses	860		
To utility expenses	1,240		
To net profit	16,000		
Total	40,600		40,600

Balance sheet of Moon and Moon Company
As of 30 June 2018

Assets	Amount	Capital and liabilities	Amount
Cash	6,200	Capital : 5,000	
Account receivable	10,400	Add: Net profit : 16,000	
Prepaid rent	4,400	Add: retain earning : 25,370	46,370
Chemical inventory	9,400	Accumulated depreciation	1,050
Equipment	18,200	Account payable	1,180
Total	48,600		48,600

0.25%

	SINGLE PAYMENT		EQUAL PAYMENT SERIES				GRADIENT SERIES		
N	Compound Amount Factor(F/P,i,N)	Present Worth Factor (P/F,i,N)	Compound Amount Factor(F/P,i,N)	Sinking Fund Factor (A/F,i,N)	Present Worth Factor (P/F,i,N)	Capital Recovery Factor(A/P,i,N)	Gradient Uniform Series(A/G,i,N)	Gradient Present Worth Factor(P/G,i,N)	N
1	1.0025	0.9975	1.0000	1.0000	0.9975	1.0025	0.0000	0.0000	1
2	1.0050	0.9950	2.0025	0.4994	1.9925	0.5019	0.4994	0.9950	2
3	1.0075	0.9925	3.0075	0.3325	2.9851	0.3350	0.9983	2.9801	3
4	1.0100	0.9901	4.0150	0.2491	3.9751	0.2516	1.4969	5.9503	4
5	1.0126	0.9876	5.0251	0.1990	4.9627	0.2015	1.9950	9.9007	5
6	1.0151	0.9851	6.0376	0.1656	5.9478	0.1681	2.4927	14.8263	6
7	1.0176	0.9827	7.0527	0.1418	6.9305	0.1443	2.9900	20.7223	7
8	1.0202	0.9802	8.0704	0.1239	7.9107	0.1264	3.4869	27.5839	8
9	1.0227	0.9778	9.0905	0.1100	8.8885	0.1125	3.9834	35.4061	9
10	1.0253	0.9753	10.1133	0.0989	9.8639	0.1014	4.4794	44.1842	10
11	1.0278	0.9729	11.1385	0.0898	10.8368	0.0923	4.9750	53.9133	11
12	1.0304	0.9705	12.1664	0.0822	11.8073	0.0847	5.4702	64.5886	12
13	1.0330	0.9681	13.1968	0.0758	12.7753	0.0783	5.9650	76.2053	13
14	1.0356	0.9656	14.2298	0.0703	13.7410	0.0728	6.4594	88.7587	14
15	1.0382	0.9632	15.2654	0.0655	14.7042	0.0680	6.9534	102.2441	15

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