

STUCOR APP

ANNA UNIVERSITY, CHENNAI AFFILIATED INSTITUTIONS R - 2013
SYLLABUS B.E. MECHANICAL ENGINEERING
MG6863 ENGINEERING ECONOMICS

L T P C
3 0 0 3

OBJECTIVES:

To enable students to understand the fundamental economic concepts applicable to engineering and to learn the techniques of incorporating inflation factor in economic decision making.

UNIT I INTRODUCTION TO ECONOMICS **8**

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

UNIT II VALUE ENGINEERING **10**

Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications – Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT III CASH FLOW **9**

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

UNIT IV REPLACEMENT AND MAINTENANCE ANALYSIS **9**

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

UNIT V DEPRECIATION **9**

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
2. Suma Damodaran, " Managerial economics", Oxford university press 2006.

REFERENCES:

1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 1984
4. Grant.E.L., Ireson.W.G., and Leavenworth, R.S, "Principles of Engineering Economy", Ronald Press, New York,1976.
5. Smith, G.W., "Engineering Economy", Iowa State Press, Iowa, 1973.
6. Truett & Truett, " Managerial economics- Analysis, problems & cases " Wiley India 8thedition 2004.
7. Luke M Froeb / Brian T Mccann, " Managerial Economics – A problem solving approach" Thomson learning 2007.

3. TABLE OF CONTENTS

S.NO	TABLE OF CONTENTS	PAGE NO
a.	Aim and Objective of the subject	4
b.	Detailed Lesson Plan	5
c.	Unit I- Introduction To Economics-Part A	9
d.	Unit I- Introduction To Economics-Part B	11
e.	Unit II-Value Engineering-Part A	21
f.	Unit II- Value Engineering-Part B	24
g.	Unit III-Cash Flow-Part A	34
h.	Unit III- Cash Flow-Part B	36
i.	Unit IV- Replacement And Maintenance Analysis -Part A	48
j.	Unit IV- Replacement And Maintenance Analysis- Part B	50
k.	Unit V- Depreciation- Part A	63
l.	Unit V- Depreciation- Part B	66
m.	Question Bank	77

MG6863 ENGINEERING ECONOMICS**L T P C**
3 0 0 3**1. Aim and Objective of the Subject**

- To learn about the basics of economics related to engineering so as to take economically sound decisions.
- To understand the depth knowledge about the value Engineering and cash flow.
- To know the machinery replacement and maintenance analysis.
- To know the value of depreciation and the depreciation methods.

2. Need and importance for study of the subject:

- Students will get a sound knowledge about the economics and cost analysis in current scenerio.
- It will be very much helpful if they are interested in doing research.

3. Industrial Connectivity and latest developments:

- It gives the knowledge about the replacement of an product and machineries in an industries.
- Recent techniques have been used for depreciation analysis.

Apprise Education, Reprise Innovations

**SCAD GROUP OF INSTITUTIONS
DEPARTMENT OF MECHANICAL ENGINEERING
DETAILED LESSON PLAN**

Name of the subject & code MG6863 ENGINEERING ECONOMICS

Name of the Faculty member:

TEXT BOOK (T):

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delh2001.
2. Suma Damodaran, "Managerial economics", Oxford University press 2006.

REFERENCES (R):

1. Chan S.Park, Contemporary Engineering Economics., Prentice Hall of India, 2002.
2. Donald.G. Newman, Jerome.P.Lavelle, Engineering Economics and analysis. Engg. Press, Texas, 2002
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, Engineering Economy., Macmillan, New York, 1984
4. Grant.E.L, Ireson.W.G., and Leavenworth, R.S, .Principles of Engineering Economy., Ronald Press, New York, 1976.
5. Smith, G.W., Engineering Economy, Iowa State Press, Iowa, 1973.
6. Truett & Truett, " Managerial economics- Analysis, problems & cases " Wiley India 8th edition 2004.
7. Luke M Froeb / Brian T Mccann, " Managerail Economics – A problem solving approach" Thomson learning 2007.
8. Dr.S.Senthil " Engineering economics and cost analysis" –Lakshmi Publications, Cheenai.
- 9.Dr.R.Kesavan , Dr.C.Elanchezhian " Engineering Economics cost Analysis- Anuradha Publications Chennai.

T – Text book, R – Reference book

Sl.no	Unit No.	Topic/ Portions to be Covered	Hours Required/ Planned	Cumulative Hrs	Books Referred
1	UNIT -I	Introduction to Economics- Flow in an economy.	1	1	T1,R8&R9
2		Law of supply and demand	1	2	T1,R8&R9
3		Concept of Engineering Economics	1	3	T1,R8&R9
4		Engineering efficiency, Economic efficiency, Scope of engineering economics	1	4	T1,R8&R9
5		Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost,	1	5	T1,R8&R9

6		Break-even analysis- P/V ratio,	1	6	T1,R8&R9
7		Elementary economic Analysis. Material selection for product Design, selection for a product,	2	8	T1,R8&R9
8		Process planning	1	9	T1,R8&R9
9		Make or buy decision. - Value engineering	1	10	T1,R8&R9
10		Value engineering - Function, aims, Value engineering procedure.	2	12	T1,R8&R9
11		Interest formulae and their applications. Time value of money	1	13	T1,R8&R9
12		Single payment compound amount factor,	1	14	T1,R8&R9
13	UNIT - II	Single payment present worth factor,	1	15	T1,R8&R9
14		Equal payment series sinking fund factor	1	16	T1,R8&R9
15		Equal payment series payment Present worth factor	1	17	T1,R8&R9
16		Equal payment series capital recovery factor	1	18	T1,R8&R9
17		Uniform gradient series annual equivalent factor	1	19	T1,R8&R9
18		Effective interest rate, Examples in all the methods.	1	20	T1,R8&R9
19		UNIT - III	Methods of comparison of alternatives.	1	21
20	Present worth method (Revenue dominated cash flow diagram).		1	22	T1,R8&R9

21		Future worth method (Revenue dominated cash flow diagram)	1	23	T1,R8&R9
22		Future worth method (cost dominated cash flow diagram)	1	24	T1,R8&R9
23		Annual equivalent method (Revenue dominated cash flow diagram).	2	26	T1,R8&R9
24		Annual equivalent method (cost dominated cash flow diagram).	2	28	T1,R8&R9
25		Rate of return method	2	30	T1,R8&R9
26		Examples in all the methods.	2	32	T1,R8&R9
27	UNIT - IV	Replacement and Maintenance analysis. Types of maintenance.	1	33	T1,R8&R9
28		Types of replacement problem.	1	34	T1,R8&R9
29		Determination of economic life of an asset,	1	35	T1,R8&R9
30		Determination of economic life of an asset.(problem)	1	36	T1,R8&R9
31		Replacement of an asset with a new asset.	1	37	T1,R8&R9
32		Replacement of an asset with a new asset. (problem)	1	38	T1,R8&R9
33		Challenger and defender.	1	39	T1,R8&R9
34		Types of maintenance capital recovery with return and Concept of challenger and defender.	1	40	T1,R8&R9
35		Simple probabilistic model for items which fail Completely.	1	41	T1,R8&R9

36	UNIT - V	Depreciation- Introduction,	1	42	T1,R8&R9
37		Causes of Depreciation	1	43	T1,R8&R9
38		Straight line method of depreciation,	1	44	T1,R8&R9
39		declining balance method of depreciation	1	45	T1,R8&R9
40		Sum of the years digits method of depreciation, sinking fund method of depreciation	2	47	T1,R8&R9
41		Annuity method of Depreciation,	1	48	T1,R8&R9
42		Service output method of depreciation	1	49	T1,R8&R9
43		Evaluation of public alternatives- introduction, Examples	2	51	T1,R8&R9
44		Inflation adjusted decisions - procedure to adjust inflation.	2	53	T1,R8&R9
45		Examples on comparison of alternatives and determination of economic life of asset.	2	55	T1,R8&R9

MG6863 ENGINEERING ECONOMICS

UNIT I INTRODUCTION TO ECONOMICS

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

PART – A

- 1. Define Engineering Economics. (Apr/May 2015) (May/June 2009)**

 - Engineering economics defined as how limited resources used to satisfy unlimited human wants
 - In other words, it can be defined as a set of principles, concepts, techniques and methods by which alternatives with in a project can be compared and evaluated for the best monetary return.
 - Engineering economics deals with the methods that enable one to take economic decisions towards minimizing costs and/or maximizing benefits to business organizations.

- 2. Define marginal costing. (Apr/May 2015)**

Marginal costing is defined by the ICWA as, “the ascertainment by differentiating between fixed costs, of marginal costs and of the effect on profit of changes in volume or type of output”.

- 3. How does Marshall explains the Law of the Demand? (Nov/Dec 2014) (Nov/Dec 2009)**

It states that other things being equal demand when price falls and contracts when price rises.

- 4. What is BEP? (Apr/May 2014) (Nov/Dec 2013)**

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

- 5. Differentiate ‘technical efficiency’ and ‘economical efficiency’.(Nov/Dec 2013) (Nov/Dec-2012) (May/June 2012) (Apr/May 2010)**

 1. Technical efficiency:

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

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

The technical efficiency of a diesel engine is as follows:

$$\text{Technical efficiency (\%)} = \frac{\text{Heat equivalent of mechanical energy produced}}{\text{Heat equivalent of fuel used}} \times 100$$
 2. Economic efficiency is the ratio of output to input of a business system.

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

6. Define opportunity cost. (Apr/May 2013)

Opportunity cost defined as the potential benefit that is given up as you seek an alternative course of action. In other words, the expected return or benefit forgone in rejecting one course of action for another.

7. What is sunk cost? (May/June 2012)

A cost which was incurred or sunk in the past and is not relevant to the particular decision making is a sunk cost or sunk loss. It may be variable or fixed or both.

8. Define P/V ratio. (Apr/May 2013)

Profit-Volume ratio expressed as a percentage indicates the relative profitability of different products.

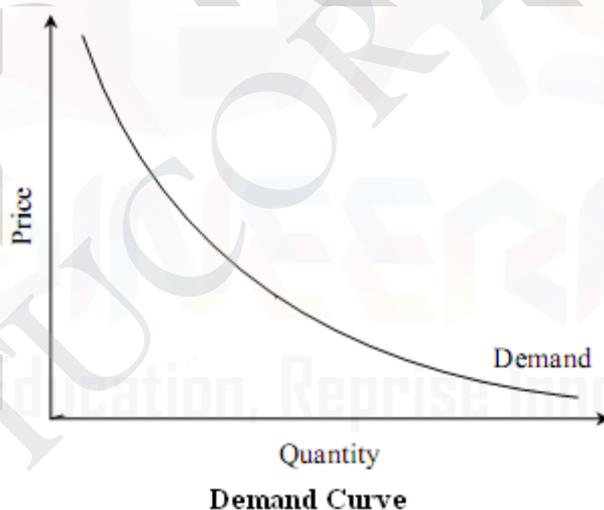
9. What are the elements of cost? (May/June 2009)

The elements of cost are:

- ✓ Materials cost
 - Labor cost
 - Expenses

10. What is elasticity of demand? (Apr/May 2008)

Elasticity of demand may be defined as the degree of responsiveness of quantity demanded to a Change in price.



PART – B**1. (i) Explain the scope of Engineering Economics. (8) (Apr/May 2015)**

- ✓ Engineering economics plays a very important role in all engineering decisions. It is concerned with the monetary consequences (or) financial analysis of the projects, products and processes that engineering design. Engineering economics helps an engineer to assess and compare the overall cost of available alternatives for engineering projects or plants or machine, etc. According to the analysis, an engineer can take a decision from the alternative in most economical one as the best.
- ✓ Engineering economic concepts are used in the important fields like increasing production, improving productivity, reducing human efforts, increasing wealth by maximizing profits, controlling and reducing cost.
- ✓ Engineering economics provides a number of tools and techniques to solve engineering problems related to product mix, output level, pricing the product, investment, quantum of advertisement, etc.
- ✓ Engineering economics helps to understand the market conditions, general economic environment in which the firm is working.
- ✓ Engineering economics provide basis for resource allocation problem.
- ✓ Engineering economics deals with the identification of economic choice, and is concerned with the decision making of engineering problems of economic nature.

(ii) State and explain the factors influencing process design. (8) (Nov/Dec 2014)

The following factors should be considered while designing a manufacturing process.

Volume of output:

The quantity and rate of production affects the methods of production. Generally, more advanced methods of manufacturer can be used when output is large. The number of identical units to be produced exercises important influence on manufacturing design. In multi product Organizations, standardization of component parts and product are very important in process designing.

Volume Vs variety:

It could be considered as continues. One extreme end of this continue shows very high variety (and hence very low product variety but very high volumes. Variety requires skilled technicians, general purpose machines & complex production planning and control. High volume requires automation, mass production machines and simple production planning and control.

Quality of the product:

Product quality determines the quality of component parts and materials which in turn determines the methods and equipment to be used. Therefore, drawing, specifications, bills of materials, part lists, etc., should be read by the process engineer to determine process design.

Types of equipments:

The process engineer should attempt to design manufacturing processes that are adaptable to and will balance the productive load of existing equipment that may be used in the manufacture of the product.

Environment effect:

Process selection responds to environmental changes, especially changes in technology. A process may have to be replaced as it might have obsolete. Even the technology involved in organizing the operations function tells up on the process selected

Forms of transformation process:

Process selection also refers to the selection of sub processes, and the sub-process of these sub processes also. When the output contains of a product there are assemblies and sub assemblies and this break-up continues till the elementary level of components become incapable of being broken down further. These components and sub-components can either be made by the organization or purchased from outside. For example, if an organization assembles certain products like transistor, radios, etc., it has to outline in detail the assembly process. Here, the point to be noted in that there is no ideal process for an ideal product- there is room for improvement in both the process used and the output generated.

Produce-to-stock Vs Produce-to-Order:

One important consideration affecting selection of the process is that of making production either for storage and selling or receiving an order first from the customers, and then starting the production process. Standardization and variety reduction lead to batch production which forms the inventory from which stock to sell are drawn, is replenished by further batch production once it reaches a minimum pre-determined level. The system employed here is anticipated of demand. There is to waiting time involved for the customer. Such products are inventory able. The risk is much more in the case of perishables and short shelf-life products Produce-to-order is customaries producing where the manufacturing process follows the respect of customers in this process. Non inventory services are always produces to order, ensuring that the waiting time for the customer is as short as possible

Output characteristics Vs Process Selection:

The selection of process form project type, intermittent type, continuous type or continuous-process type depends upon the characteristics of the output.

2. Explain in detail the different elements of cost.**(16) (Apr/May 2014)****Elements of Costs:**

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

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

Direct material costs are those costs of materials that are used to produce the product. Direct labor cost is the amount of wages paid to the direct labor involved in the production activities.

Direct expenses are those expenses that vary in relation to the production volume, other than the direct material costs and direct labor costs.

Overhead cost is the aggregate of indirect material costs, indirect labor costs and indirect expenses. Administration overhead includes all the costs that are incurred in administering the business.

Selling overhead is the total expense that is incurred in the promotional activities and the expenses relating to sales force. Distribution overhead is the total cost of shipping the items from the factory site to the customer sites.

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

- (a) Direct material costs + Direct labor costs + Direct expenses = Prime cost
- (b) Prime cost + Factory overhead = Factory cost
- (c) Factory cost + Office and administrative overhead = Costs of production
- (d) Cost of production + Opening finished stock – Closing finished stock = Cost of goods sold
- (e) Cost of goods sold + Selling and distribution overhead = Cost of sales
- (f) Cost of sales + Profit = Sales
- (g) Sales/Quantity sold = Selling price per unit

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

Other Costs/Revenues

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

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

Marginal Cost

Marginal cost of a product is the cost of producing an additional unit of that product. Let the cost of producing 20 units of a product be Rs. 10,000, and the cost of producing 21 units of the same product be Rs. 10,045. Then the marginal cost of producing the 21st unit is Rs. 45.

2. Marginal Revenue

Marginal revenue of a product is the incremental revenue of selling an additional unit of that product. Let, the revenue of selling 20 units of a product be Rs. 15,000 and the revenue of selling 21 units of the same product be Rs. 15,085. Then, the marginal revenue of selling the 21st unit is Rs. 85.

3. Sunk Cost

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

Opportunity Cost

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

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

3. (i) Define break-even point. Draw a break-even chart and explain its components. (8)(Nov/Dec 2012)

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

Let

s = selling price per unit

v = variable cost per unit

FC = fixed cost per period

Q = volume of production

The total sales revenue (S) of the firm is given by the following formula:

$$S = s Q$$

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

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

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

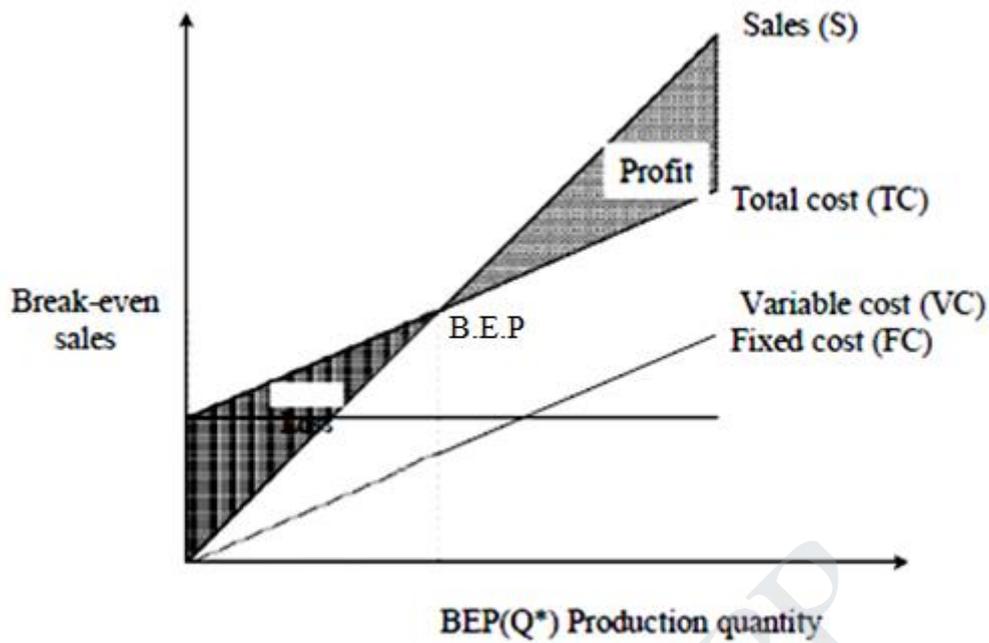


Fig. Break-even chart.

(ii) Discuss the factors which influence supply and demand. (8)(Nov/Dec 2012)

Laws of supply:

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

- If the cost of inputs increases, then naturally, the cost of the product will go up. In such a situation, at the prevailing price of the product the profit margin per unit will be less.
- The producers will then reduce the production quantity, which in turn will affect the supply of the product.
- For instance, if the prices of fertilizers and cost of labor are increased significantly, in agriculture, the profit margin per bag of paddy will be reduced.
- So, the farmers will reduce the area of cultivation, and hence the quantity of supply of paddy will be reduced at the prevailing prices of the paddy.
- If there is advancement in technology used in the manufacture of the product in the long run; there will be a reduction in the production cost per unit.
- This will enable the manufacturer to have a greater profit margin per unit at the prevailing price of the product. Hence, the producer will be tempted to supply more quantity to the market.

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

Factors influencing supply

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

- Cost of the inputs
- Technology
- Weather
- Prices of related goods

Law of demand:

states that other things being equal demand when price falls and contracts when price rises.

- **Market demand** is the total quantity demanded by all the purchasers together.
- **Elasticity of Demand** - Elasticity of demand may be defined as the degree of responsiveness of quantity demanded to a Change in price.
- An interesting aspect of the economy is that the demand and supply of a product are interdependent and they are sensitive with respect to the price of that product. .
- From Fig. it is clear that when there is a decrease in the price of a product, the demand for the product increases and its supply decreases.
- Also, the product is more in demand and hence the demand of the product increases.
- At the same time, lowering of the price of the product makes the producers restrain from releasing more quantities of the product in the market.
- Hence, the supply of the product is decreased. The point of intersection of the supply curve and the demand curve is known as the equilibrium point.
- At the price corresponding to this point, the quantity of supply is equal to the quantity of demand. Hence, this point is called the equilibrium point.

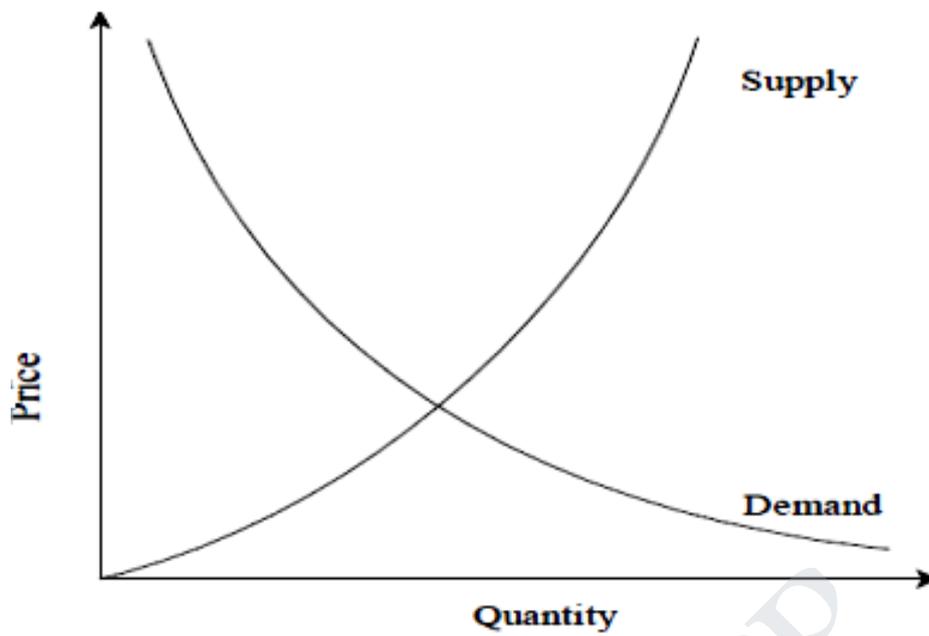


Fig. Demand and supply curve.

Factors influencing demand

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

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

Apprise Education. Reprise Innovations

4.(i) Suguna associates has the following details.

$$\text{Fixed Cost} = \text{Rs. } 20,00,000.$$

$$\text{Variable cost per Unit} = \text{Rs. } 100.$$

$$\text{Selling Price Per Unit} = \text{Rs. } 200.$$

Find out :

- (1) The break-even point in quantity.
- (2) The break-even point in Sales [Rupees].

Solution :

$$\text{Fixed cost (Fc)} = \text{Rs. } 20,00,000$$

$$\text{Variable cost Per Unit (V)} = \text{Rs. } 100$$

$$\text{Selling Price Per Unit (S)} = \text{Rs. } 200.$$

$$\begin{aligned} \text{(1) Break-even quantity :-} & \frac{Fc}{S-V} \\ & = \frac{20,00,000}{200-100} \Rightarrow \frac{20,00,000}{100} \\ & = 20,000 \text{ Units.} \end{aligned}$$

$$\begin{aligned} \text{(2) Break-even Sales :-} & \frac{Fc}{S-V} \times S \\ & = \frac{20,00,000}{200-100} \times 200 \\ & = \text{Rs. } 40,00,000 \end{aligned}$$

Result :

- (1) Break-even quantity \Rightarrow 20,000 Units.
- (2) Break-even Sales \Rightarrow Rs. 40,00,000.

(ii) In the design of a jet engine part, the designer has a choice of specifying either an aluminium alloy casting or a steel casting. Either material will provide equal service. but the aluminium alloy casting will weigh 1.2 kg as compared with 1.35 kg for the steel casting. The aluminium can be cast Rs. 80/kg. & the steel for Rs. 35/kg. The cost of machining per unit is Rs. 150. for aluminium & Rs. 170 for steel. Every kg of excess weight is associated with a penalty of Rs. 1300 due to increased fuel consumption. Which material should be specified and what is the economic advantage of selection per unit?

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

Weight of aluminium casting / Unit = 1.2 kg.

Cost of making aluminium casting = Rs. 80 / kg.

Cost of m/cing aluminium casting Per Unit = Rs. 150.

Total cost of jet engine part made of aluminium / Unit =

$$= \frac{\text{Cost of making al. casting}}{\text{Unit}} + \frac{\text{Cost of m/cing al. casting}}{\text{Unit}}$$

$$= 80 \times 1.2 + 150 \Rightarrow 96 + 150 \Rightarrow \text{Rs. } 246.$$

(b) Cost of jet engine part made of steel / Unit :

wt. of steel casting / Unit = 1.35 kg.

Cost of making steel casting = Rs. 35 / kg.

Cost of m/cing steel casting Per Unit = Rs. 170.

Penalty of excess wt. of steel casting = Rs. 1300 / kg.

$$\left. \begin{array}{l} \text{Total cost of} \\ \text{jet engine part made of} \\ \text{steel / Unit} \end{array} \right\} = \frac{\text{Cost of making}}{\text{Unit}} + \frac{\text{Cost of m/cing}}{\text{Unit}} + \frac{\text{Penalty of excess}}{\text{wt. of steel casting}}$$

$$= 35 \times 1.35 + 170 + 1300 (1.35 - 1.2)$$

$$\Rightarrow \text{Rs } 412.25.$$

Result: The total cost/unit of jet engine part made of al. is less than that engine made of steel. Hence Al is suggested for making engine part. The economic Adv. of using Al over steel is $\Rightarrow 412.25 - 246 \Rightarrow \text{Rs } 166.25$

5. Krishna Company Ltd. Have the following details:

$$\text{Fixed cost} = \text{Rs. } 40,00,000.$$

$$\text{Variable cost Per Unit} = \text{Rs. } 300.$$

$$\text{Selling Price Per Unit} = \text{Rs. } 500.$$

Find.: (i) The break even sales quantity.

(ii) The break even sales.

(iii) If the actual Production quantity is 1,20,000 find the following
(1) Contribution.
(2) Margin of safety by all methods.

Solution

$$(i) \text{ The break even quantity} = \frac{FC}{S-V} \Rightarrow \frac{40,00,000}{500-300} \\ \Rightarrow 20,000 \text{ Units.}$$

$$(ii) \text{ Break-even Sales} = \frac{FC}{S-V} \times S \\ = \frac{40,00,000}{500-300} \times 500 \\ \Rightarrow \text{Rs. } 10,000,000.$$

$$(1) \text{ Contribution} = \text{Sales} - \text{Variable cost.} \\ = (S \times Q) - (V \times Q) \\ = (500 \times 1,20,000) - (300 \times 1,20,000) \\ \Rightarrow \text{Rs. } 24,000,000.$$

$$(2) \text{ Margin of Safety} = \text{Sales} - \text{Break-even Sales.} \\ = (500 \times 1,20,000) - 10,000,000. \\ \Rightarrow \text{Rs. } 50,000,000.$$

$$\text{M.S. as percent of Sales} = \frac{50,000,000}{(500 \times 1,20,000)} \times 100 \Rightarrow 83.3\%.$$

UNIT II VALUE ENGINEERING

Make or buy decision, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

PART – A

1. Mention any two criteria for buy decision. (Apr/May 2015)

The following are the criteria for buy:

- Requires high investments on facilities which are already available at suppliers plant.
- The company does not have facilities to make it and there are more profitable opportunities for investing company's capital.
- Existing facilities of the company can be used more economically to make other parts.
- The skill of personnel employed by the company is not readily adaptable to make the part.
- Patent or other legal barriers prevent the company for making the part.
- Demand for the part is either temporary or seasonal.

2. Define effective interest rate. (Apr/May 2015)

Let i be the nominal interest rate compounded annually. But, in practice, the compounding may occur less than a year. For example, compounding maybe monthly, quarterly, or semi-annually. Compounding monthly means that the interest is computed at the end of every month. There are 12 interest periods in a year if the interest is compounded monthly. Under such situations, the formula to compute the effective interest rate, which is compounded annually, is Effective interest rate,

$$R = (1 + i/C)^C - 1$$

where,

i = the nominal interest rate

C = the number of interest periods in a year.

3. What is the Time value of Money? (Nov/Dec 2014)

The economic value of a sum depends on when it is received. Because money has earning power over time (it can be put to work, earning more money for its owner), a rupee received today has a greater value than a rupee received at some future time.

4. What is Value Engineering? (Nov/Dec 2014)

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

5. Mention the criteria for make decision. (Nov/Dec 2013)

The following are the criteria for make:

- The finished product can be made cheaper by the firm than by outside suppliers.
- The finished product is being manufactured only by a limited number of outside firms which are unable to meet the demand.

- The part has an importance for the firm and requires extremely close quality control.
- The part can be manufactured with the firm's existing facilities and similar to other items in which the company has manufacturing experience.

6. What would be the future value of Rs.100 invested in a fixed deposit for 5years with an interest rate of 15% compounded annually? (Apr/May 2010)

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

Compound Amounts
 (amount of deposit = Rs. 100.00)

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

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

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

where

- P = principal amount invested at time 0,
- F = future amount,
- i = interest rate compounded annually,
- n = period of deposit.

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

7. Explain the concept of Discounting. (Nov/Dec 2009)

Finding the present worth of a future sum is simply the reverse of compounding and is known as discounting process.

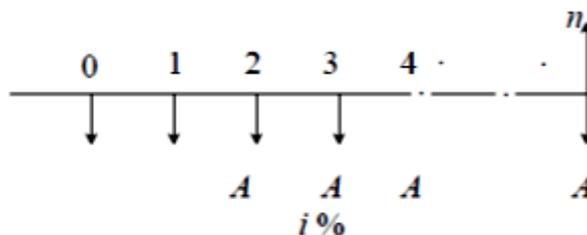
The formula to obtain present worth is

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

$(P/F, i, N)$ is the factor notation for single payment present worth factor. The interest rate i and the P/F factor are also referred to as the discount rate and discounting factor, respectively.

8. What is Sinking Fund Factor? (Nov/Dec 2008)

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



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

n = No. of interest periods

i = rate of interest

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

The formula to get F is

Where

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

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

9. What is simple interest?

(Apr/May 2014)

In simple interest, the interest earned in each period is calculated, based on the principle amount. In this case, calculation of interest on interest is not applicable.

10. List few factors that need to be considered in making a “make or buy” decision.

(May/June 2012)

1. Quantitative factors:
 - Opportunity costs
 - Incremental costs
 - Idle facilities
2. Qualitative factors:
 - Product quality
 - Patents
 - Skills and materials
 - Long term considerations
3. Other factors:
 - Number of outside suppliers
 - Reliability of outside sources
 - Seasonal or temporary demand
 - The size of investment

PART - B

(8)(Apr/May 2015)

1.(i) A Person is Planning for his retired life. He has 10 more years of service. He would like to deposit Rs. 8500 at the end of the first year and thereafter he wishes to deposit the amount with an annual decrease of Rs. 500 for the next 9 years with an Interest rate of 15%. Find the total amount at the end of the 10th year series.

Solution:

$$A_1 = \text{Rs. } 8,500.$$

$$G_1 = - \text{Rs. } 500$$

$$i = 15\%$$

$$n = 10 \text{ Years.}$$

$$A = ? \quad \& \quad F = ?$$

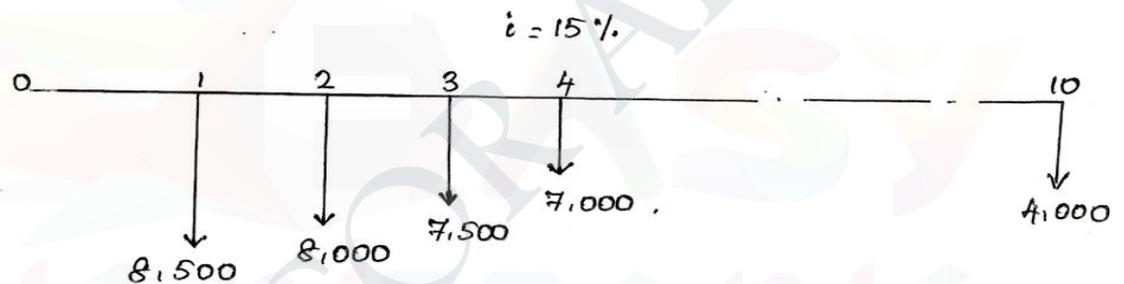


Fig. Cash flow diagram of Uniform Gradient series annual equivalent amount.

$$A = A_1 - G_1 \frac{(1+i)^n - in - 1}{i(1+i)^n - i} = A_1 - G_1 (A/G, i, n)$$

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

$$= 8,500 - 500 \times 3.3832 \Rightarrow \text{Rs. } 6808.40.$$

This is equivalent to paying an equivalent amount of Rs. 6808.40 at the end of every year for the next 10 years.

The future worth sum of this revised series at the end of the 10th year is obtained: $F = A (F/A, i, n)$

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

$$= 6808.40 (20.304) \Rightarrow 1,38,237.75$$

Result:

At the end of the 10th year, the Compound amount of all his payment is = Rs. 1,38,237.75.

(8)(Apr/May 2015)

(ii) A Person wishes to have a future sum of Rs. 1,00,000 for his son's education after 10 Years from now. What is the single payment that he should deposit now so that he gets the desired amount after 10 years? The bank gives 15% Interest rate compounded annually.

Solution:

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

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

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

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

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

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

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

Result:

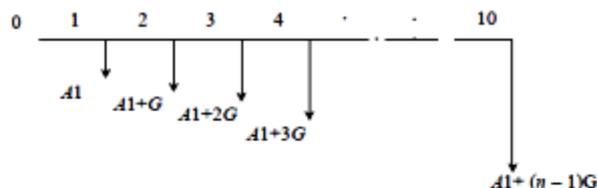
The person has to invest Rs. 24,720 now so that he will get a sum of Rs. 1,00,000 after 10 years at 15% interest rate compounded annually.

2. (i) What is uniform gradient conversion? Illustrate with an example. (8)(Apr/May 2008)

Uniform Gradient series annual equivalent:

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

The corresponding cash flow diagram is shown in Fig



Cash flow diagram of uniform gradient series annual equivalent amount.

The formula to compute A under this situation is

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

here
 Where

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

(ii) What are the different approaches for make or buy decisions? (8)(Apr/May 2014)

Approaches for Make or Buy Decision

Types of analysis followed in make or buy decision are as follows:

1. Simple cost analysis
2. Economic analysis
3. Break-even analysis

1. Simple Cost Analysis:

The concept is illustrated using an example problem.

EXAMPLE

A company has extra capacity that can be used to produce a sophisticated fixture which it has been buying for Rs. 900 each. If the company makes the fixtures, it will incur materials cost of Rs. 300 per unit, labor costs of Rs. 250 per unit, and variable overhead costs of Rs. 100 per unit. The annual fixed cost associated with the unused capacity is Rs. 10,00,000. Demand over the next year is estimated at 5,000 units. Would it be profitable for the company to make the fixtures?

Solution

We assume that the unused capacity has alternative use.

Cost to make

Variable cost/unit = Material + labor + overheads
 = Rs. 300 + Rs. 250 + Rs. 100
 = Rs. 650

Total variable cost = (5,000 units) (Rs. 650/unit) = Rs. 32,50,000

Add fixed cost associated with unused capacity + Rs. 10,00,000

Total cost = Rs. 42,50,000

Cost to buy

Purchase cost = (5,000 units) (Rs. 900/unit) = Rs. 45,00,000
 Add fixed cost associated with unused capacity + Rs. 10,00,000
 Total cost = Rs. 55,00,000

The cost of making fixtures is less than the cost of buying fixtures from outside. Therefore, the organization should make the fixtures.

2. Economic Analysis:

The following inventory models are considered to illustrate this concept:

- Purchase model
- Manufacturing model

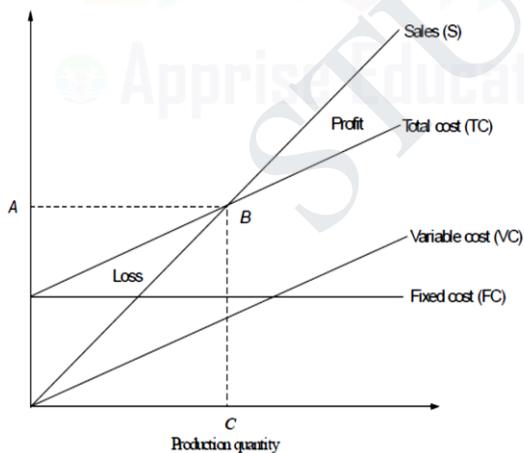
The formulae for EOQ and total cost (TC) for each model are given in the following table:

Purchase model	Manufacturing model
$Q1 = \sqrt{\frac{2C_2D}{C_c}}$	$Q2 = \sqrt{\frac{2CD}{C_c(1-r/k)}}$
$TC = D P + \frac{DC_2}{Q1} + \frac{Q1 \times C_c}{2}$	$TC = D P + \frac{DC_2}{Q2} + C_c(k-r) \frac{Q2}{2 \times k}$

- Where D = demand/year
- P = purchase price/unit
- C_c = carrying cost/unit/year
- C_o = ordering cost/order or set-up cost/set-up
- k = production rate (No. of units/year)
- r = demand/year
- $Q1$ = economic order size
- $Q2$ = economic production size
- TC = total cost per year

3. Break-even Analysis:

The break-even analysis chart is shown in Fig.



TC = total cost
 FC = fixed cost
 $TC = FC + \text{variable cost}$
 B = the intersection of TC and sales (no loss or no gain situation)
 A = break-even sales
 C = break-even quantity/break-even point (BEP)

The formula for the break-even point (BEP) is

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

3.(i) A Company has to replace a present facility after 15 years at an outlay of Rs. 5,00,000. It plans to deposit an equal amount at the end of every year for the next 15 years at an Interest rate of 18% compounded annually. Find the equivalent amount that must be deposited at the end of every year for the next 15 years. Use equal Payment Series Sinking fund formula.

Solution:

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

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

$$i = 18\%.$$

$$A = ?$$

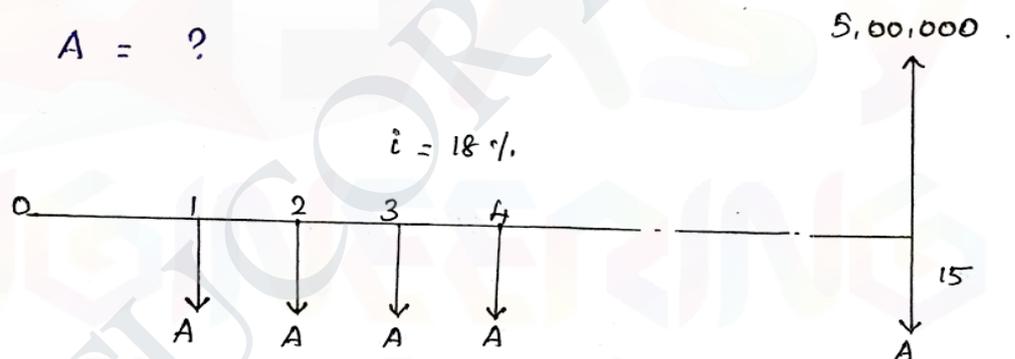


Fig. Cashflow diagram of equal-payment series sinking fund.

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

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

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

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

Result:

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

(ii) A Person deposits a sum of Rs. 20,000 at the Interest rate of 18%, Compounded for annually 10 Years. Find the maturity value after 10 Years. Use single-payment Compound amount formula.

Solution:

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

$$i = 18\% \text{ (Compounded annually.)}$$

$$n = 10 \text{ Years.}$$

Formula:

Single Payment compound amount =

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

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

$$= 20,000 \times 5.234$$

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

Result:

The maturity value of Rs. 20,000 Invested now at 18%. Compounded Yearly is equal to Rs. 1,04,680 after 10 Years.

1. The Management of a Company finds that while the cost of making a Component Part is Rs. 10, the same is available in the market at Rs. 9, with an assurance of Continuous Supply. Give a Suggestion whether to make or buy this part. Give also Your views in case the Supplier reduces the Price from Rs. 9 to Rs. 8. The Cost Information is as follows:

Particulars.	Rs.
Material	3.50
Direct labour	4.00
Other variable expenses	1.00
Fixed expenses	1.50
Total	10.00.

Solution

Material cost = Rs. 3.50.
 Direct labour = Rs. 4.00.
 Other variable cost = Rs. 1.00.
 Fixed expenses = Rs. 1.50.

Cost to make:

$$\begin{aligned} \text{Total Variable Cost} &= (\text{Material Cost}) + (\text{Labour Cost}) + (\text{Other Variable Cost}) \\ &= 3.50 + 4.00 + 1.00 \\ &= \text{Rs. } 8.50. \end{aligned}$$

$$\begin{aligned} \text{Total Variable Cost} &= \text{Rs. } 8.50. \\ \text{Add fixed expenses} &= \text{Rs. } 1.50 \\ \hline &= \text{Rs. } 10.00 \end{aligned}$$

Cost to buy:

$$\begin{aligned} \text{Purchase cost} &= \text{Rs. } 9.00. \\ \text{Add fixed expenses} &= \text{Rs. } 1.50 \\ \hline &\text{Rs. } 10.50 \end{aligned}$$

In case of the supplier reduces the Price from
 Rs. 9 to Rs. 8

$$\begin{aligned} \text{Purchase cost} &= \text{Rs. } 8.00 \\ \text{Add fixed expenses} &= \text{Rs. } 1.50 \\ \hline &\text{Rs. } 9.50 \end{aligned}$$

Result:

- * The cost of making the component part is less than the cost of buying. So, the company should make the part.
- * If the supplier reduces the price from Rs. 9.00 to Rs. 8.00, the cost of buying is less than cost of making. So, the company should buy the component part.

5(i) A Person is Planning for his retired life. He has 10 more years of service. He would like to deposit 20% of his salary, which is Rs. 4000 at the end of the first year, and thereafter he wishes to deposit the amount with an annual increase of Rs. 500 for the next 9 years with an Interest rate of 15%. Find the total amount at the end of the 10th year of the above service.

Solution:
 $A_1 = \text{Rs. } 4,000.$
 $G = \text{Rs. } 500.$
 $i = 15\%.$
 $n = 10 \text{ Years}$

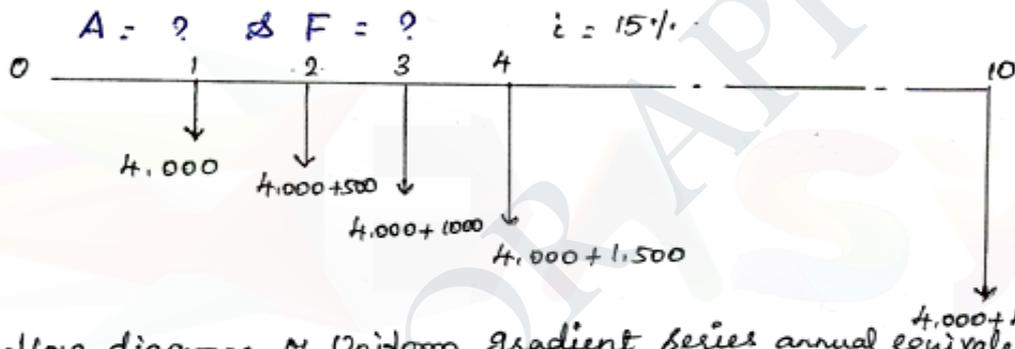


Fig. Cash flow diagram of Uniform gradient series annual equivalent amount

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

$$= 4,000 + 500 (A/G, i, n).$$

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

$$= 4,000 + 500 \times 3.3832 \Rightarrow \text{Rs. } 5691.60.$$

This is equivalent to paying an equivalent amount of Rs. 5691.60 at the end of every year for the next 10 years. The future worth sum of this revised series at the end of the 10th year is obtained as follows:

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

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

$$= 5,691.60 \times 20.304 \Rightarrow \text{Rs. } 1,15,562.25$$

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

5. (ii) Discuss the advantages and application areas of value engineering.**(6)(Nov/Dec 2012)**

Value engineering:

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

Applications:

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

Advantages:

- ➤ Value engineering improves your ability to manage project, solve problems, innovative and communicate.
- It helps to generate new ideas.
- It creates quality consciousness and cost consciousness among the employer
- It helps to save money and increase the profits.

Apprise Education, Reprise Innovations

UNIT III CASH FLOW

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

PART – A

1. What is the concept of ‘future worth method of comparison’? (Apr/May 2015)

- In the future worth method of comparison of alternatives, the future worth of various alternatives will be computed.
- Then, the alternative with the maximum future worth of net revenue or with the minimum future worth of net cost will be selected as the best alternative for implementation.

2. What is the idea of ‘rate of return method of comparison’? (Apr/May 2015)

Rate of return is the break-even interest rate, i , which equates the present worth of a project’s cash outflows to the present worth its cash inflow

3. List out the quantitative and qualitative factors to be considered in ‘Make or Buy Decision’ (Nov/Dec 2014)

Quantitative factors:

- Opportunity costs
- Incremental costs
- Idle facilities

Qualitative factors:

- Product quality
- Patents
- Skills and materials
- Long term considerations

4. Mention the various Rate of return methods. (Nov/Dec 2008)

- ✓ Internal rate of return(IRR)
- Average rate of return(ARR)
- Net present value method (NPV)
- Pay-back period (PBP)

5. What is the basic concept of ‘annual equivalent method of comparison’? (Nov/Dec 2013)

- In the annual equivalent method of comparison, first the annual equivalent cost or the revenue of each alternative will be computed.
- Then the alternative with the maximum annual equivalent revenue in the case of revenue-based comparison or with the minimum annual equivalent cost in the case of cost- based comparison will be selected as the best alternative.

6. What is cost Dominated Cash Flow Diagram? (May/June 2013)

- The cost outflow will be assigned with positive sign and profit, revenuesalvage value all inflows etc.,
- Will be assigned with negative sign is called cost dominated cash flow.

7. Define IRR and MARR.**(Apr/May 2010)**

Internal rate of return (IRR):

It is the rate of return at which total present value of future cash inflow is equal to initial investment. The rate of future cash inflow is equal to initial investment. The rate of return is generally found by trial and error method.

Minimum Attractive Rate of Return (MARR):

It represents the required or minimum interval rate of return for a project. The MARR is a minimum return the company will accept on the money it invests.

8. What is Present worth method of comparing alternatives? (Nov/Dec 2009)**(Nov/Dec 2009)**

- The present worth measures the surplus in an investments project at time zero (0).
- The present worth of all cash inflows is computed the present worth of all cash outflows associated with an investment of project is called present worth method.

9. What are the advantages of Rate of Return method? (May/June 2009)**(May/June 2009)**

- It is easy to understand and operate.
- It uses the entire earning of an investment proposal, unlike the payback period method.
- It gives a clear picture of the profitability of a project.

10. What is revenue dominated cash flow?**(Apr/May 2008)**

The profit/revenue, salvage value of all inflows to an organization will be assigned with positive sign and the cost outflows will be assigned with negative sign is called revenue dominated cash flow.

PART - B

(16)(Apr/May 2015)

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

Bid	Engineer's estimates		
	Initial Cost (Rs).	Service life (Years)	Annual operations & Maintenance Cost (Rs).
Alpha Elevator Inc.	4,50,000	15	27,000
Beta Elevator Inc.	5,40,000	15	28,500.

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

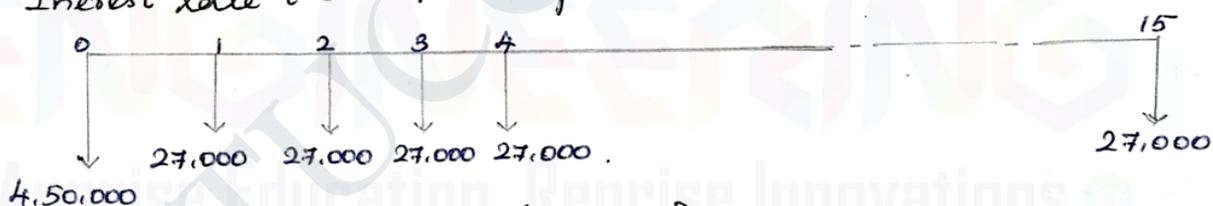
Solution Bid 1 : Alpha Elevator Inc.

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

Annual operation & Maintenance cost, $A = \text{Rs. } 27,000$.

Life = 15 years.

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



(Cash flow diagram).

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

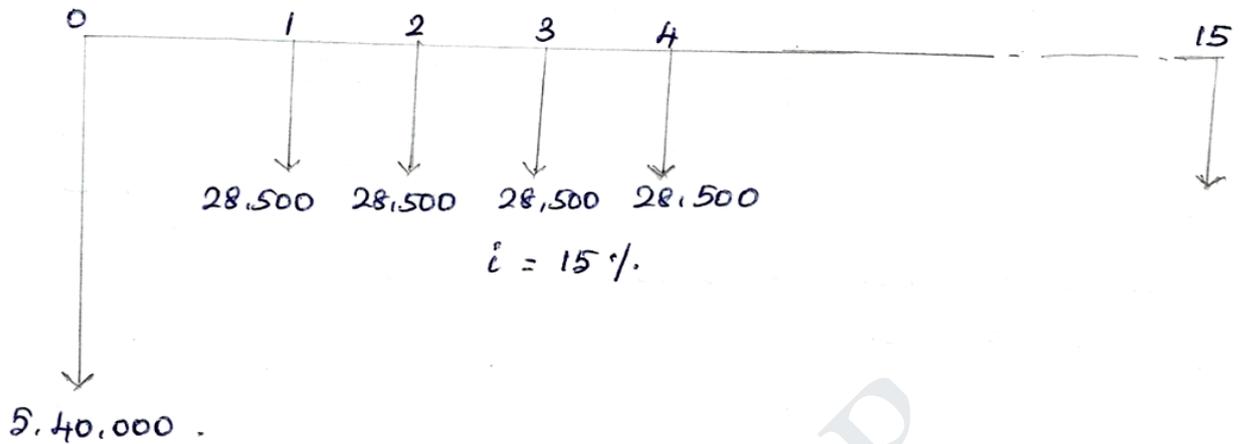
$$\begin{aligned}
 PW(15\%) &= 4,50,000 + 27,000 (P/A, 15\%, 15) \\
 &= 4,50,000 + 27,000 \times 5.8474 \\
 &= 4,50,000 + 1,57,879.80 \\
 &= \text{Rs. } 6,07,879.80
 \end{aligned}$$

Bid 2 : Beta Elevator Inc.

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

Annual operation & Maintenance cost, $A = \text{Rs. } 28,500$.

Life = 15 years.
 Interest rate, $i = 15\%$, Compounded annually.



(Cash flow diagram for bid 2)

The Present worth of the above cash flow diagram is,

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

Result :

The total Present worth Cost of bid 1 is less than of bid 2. Hence, bid 1 is to be Selected for Implementation That is, the elevator from ALPHA Elevator Inc. is to be Purchased and Installed in the new building.

2. Write about the revenue dominated cash flow diagram and cost dominated cash flow diagram. (16)(Apr/May 2014)

Revenue-Dominated Cash Flow Diagram:

A generalized revenue-dominated cash flow diagram to demonstrate the annual equivalent method of comparison is presented in Fig.

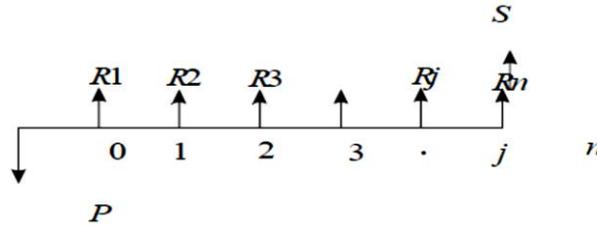


Fig. Revenue-dominated cash flow diagram.

In Fig. P represents an initial investment, R_j the net revenue at the end of the j th year, and S the salvage value at the end of the n th year.

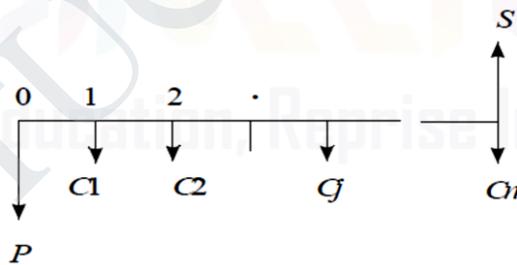
The first step is to find the net present worth of the cash flow diagram using the following expression for a given interest rate, i :

$$PW(i) = -P + R_1/(1+i)^1 + R_2/(1+i)^2 + \dots + R_j/(1+i)^j + \dots + R_n/(1+i)^n + S/(1+i)^n$$

In the above formula, the expenditure is assigned with a negative sign and the revenues are assigned with a positive sign.

Cost-Dominated Cash Flow Diagram:

A generalized cost-dominated cash flow diagram to demonstrate the annual equivalent method of comparison is illustrated in Fig.



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

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

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

3. Alpha Industry is Planning to expand its Production operation. It has Identified three different technologies for meeting the goal. The Initial outlay and annual Revenues with respect to each of the technologies are summarized in Table. Suggest the best technology which is to be Implemented based on the Present worth method of Comparison assuming 20% Interest Rate Compounded annually.

	Initial outlay (Rs).	Annual Revenue (Rs).	Life (Years)
Technology 1	12,00,000	4,00,000	10
Technology 2	20,00,000	6,00,000	10
Technology 3	18,00,000	5,00,000	10

Solution: In all the technologies, the Initial outlay is assigned a negative sign and the annual revenues are assigned a positive sign.

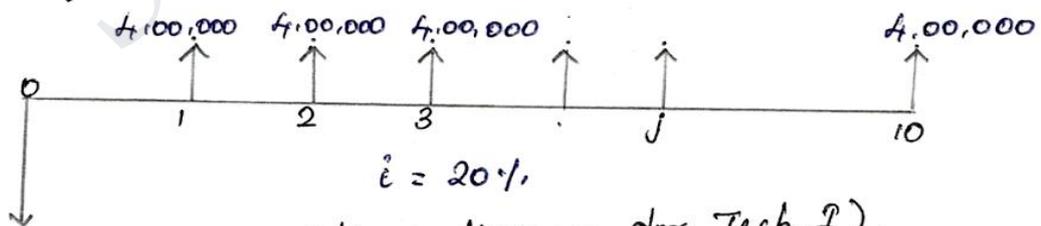
Technology 1:

Initial outlay, $P = \text{Rs. } 12,00,000$

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

Interest rate, $i = 20\%$, Compounded annually.

Life of this technology, $n = 10$ Years.



(Cash flow diagram for Tech. I).

The Present worth expression for this technology is

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

$$\begin{aligned}
 &= -12,00,000 + 4,00,000 \times (4.1925) \\
 &= -12,00,000 + 16,77,000 \\
 &= \text{Rs. } 4,77,000.
 \end{aligned}$$

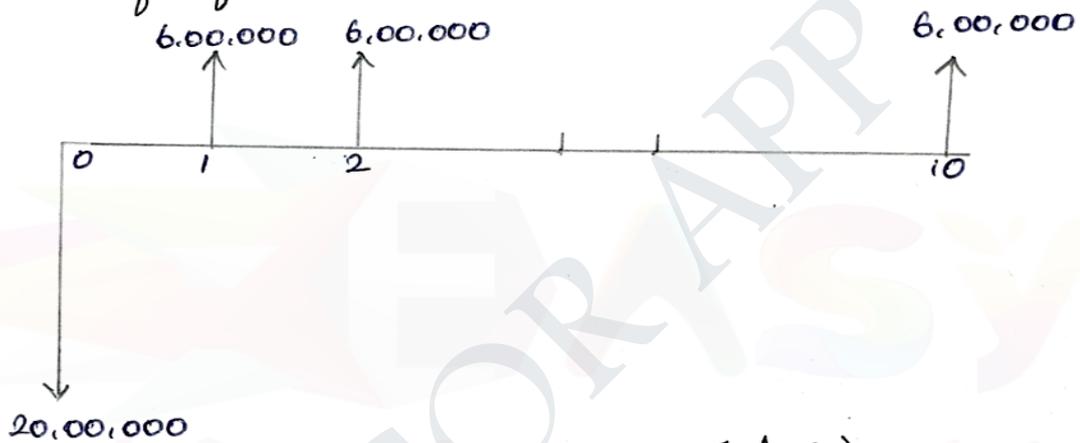
Technology 2 :

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

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

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

Life of this technology, $n = 10$ years.



(Cash flow diagram for Tech. 2).

The Present worth expression for this technology is

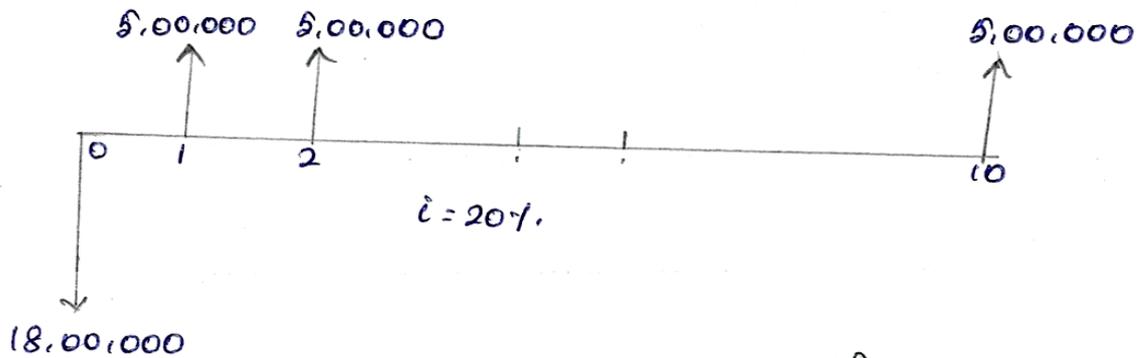
$$\begin{aligned}
 PW (20\%) &= -20,00,000 + 6,00,000 \times (P/A, 20\%, 10) \\
 &= -20,00,000 + 6,00,000 \times 4.1925 \\
 &= -20,00,000 + 25,15,500 \\
 &= \text{Rs. } 5,15,500.
 \end{aligned}$$

Technology 3 :

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

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

Interest Rate, $i = 20\%$, compounded annually.
Life of this Technology, $n = 10$ years.



(Cash flow diagram for Tech. 3)

The Present worth expression for this Tech.

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

Result:

From the above calculations, it is clear that the Present worth of technology 2 is the highest among all the technologies. Therefore, technology 2 is suggested for Implementation to expand the Production.

4. A company that manufactures amplified transducers is trying to decide between the machines shown below. Compare them on the basis of annual worth using an interest rate of 15% per year.

	Variable speed	Dual speed.
First cost, Rs.	4,50,000	2,40,000
Annual operating cost, Rs.	3,10,000	3,50,000
Overhaul in year 2 & 4 ; Rs.	-	60,000
Overhaul in years 5 Rs.	1,20,000	-
Salvage value, Rs.	1,00,000	80,000
Life, years	8	6

Solution: Variable Speed ; Alternative 1

First cost = Rs. 4,50,000

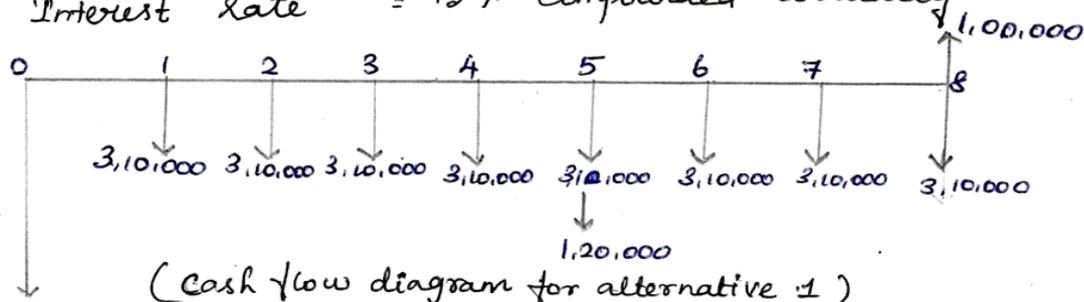
Annual operating cost = Rs. 3,10,000

Overhaul in Year 5 = Rs. 1,20,000

Salvage Value = Rs. 1,00,000

Life = 8 years.

Interest rate = 15% Compounded annually



$$\begin{aligned}
 PW, (15\%) &= 4,50,000 + 3,10,000 (P/A, 15\%, 1) + \\
 & 3,10,000 (P/A, 15\%, 2) \dots + 4,30,000 (P/A, 15\%, 6) \\
 & + \dots + 3,10,000 (P/A, 15\%, 8) - 1,00,000 \\
 & \quad \quad \quad (P/F, 15\%, 8) \\
 &= 4,50,000 + 3,10,000 (0,8696) + 3,10,000 \\
 & \quad \quad (1,6257) + 4,30,000 (3,3522) + 3,10,000 \\
 & \quad \quad (4,4873) - 1,00,000 (0,3269) \\
 &= 4,50,000 + 2,89,576 + 5,03,965 + \\
 & \quad \quad (4,41,446 + 13,91,063 - 32,690.
 \end{aligned}$$

$$PW, (15\%) = 40,43,360$$

$$AE, (15\%) = 40,43,360 (A/P, 15\%, 8)$$

$$= 40,43,360 \times 0,2229$$

$$= 9,01,264,94.$$

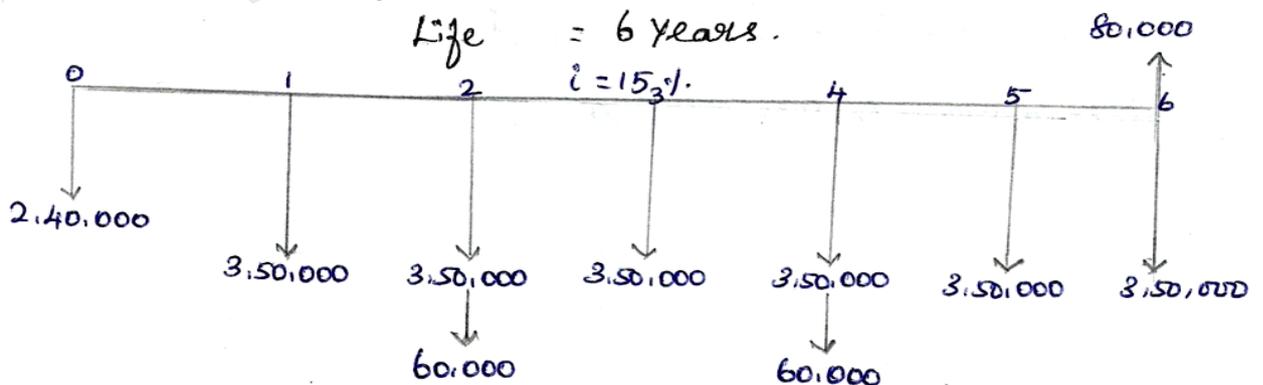
Dual Speed : Alternative 2.

First cost = Rs. 2,40,000

Annual operating cost = Rs. 3,50,000

overhaul in years 2 & 4 = Rs. 60,000

Salvage Value = Rs. 80,000



$$\begin{aligned}
 PW_2 (15\%) &= 2,40,000 + 3,50,000 (P/A, 15\%, 1) + \\
 & 4,10,000 (P/A, 15\%, 2) + 3,50,000 (P/A, 15\%, 3) \\
 & + 4,10,000 (P/A, 15\%, 4) + 3,50,000 \\
 & (P/F, 15\%, 6) - 80,000 (P/F, 15\%, 6) \\
 & = 2,40,000 + 3,50,000 (0.8696) + 4,10,000 \\
 & (1.6257) + 3,50,000 (2.2832) + 4,10,000 \\
 & (2.8550) + 3,50,000 (3.7845) - 80,000 (0.4323) \\
 & = 2,40,000 + 3,04,360 + 6,66,537 + 7,99,120 + \\
 & 11,70,550 + 13,24,575 - 34,584
 \end{aligned}$$

$$PW_2 (15\%) = 44,70,558.$$

$$\begin{aligned}
 AE_2 (15\%) &= 44,70,558 (A/P, 15\%, 6) \\
 &= 44,70,558 (0.2642) \\
 &= 11,81,121.42
 \end{aligned}$$

Result :

The annual equivalent cost of variable speed is less than that of dual speed. Therefore, the best alternative is variable speed.

(16)(Nov/Dec 2013)

5. A Company is planning to Purchase an advanced machine Centre. Three original Manufacturers have responded to its tender whose Particulars are tabulated as follows.

Manufacturer	Down Payment (Rs.)	Yearly equal Installment (Rs.)	No. of Installments.
1	5,00,000	2,00,000	15
2	4,00,000	3,00,000	15
3	6,00,000	1,50,000	15

Determine the best alternative based on the annual equivalent method by assuming $i = 20\%$, Compounded annually.

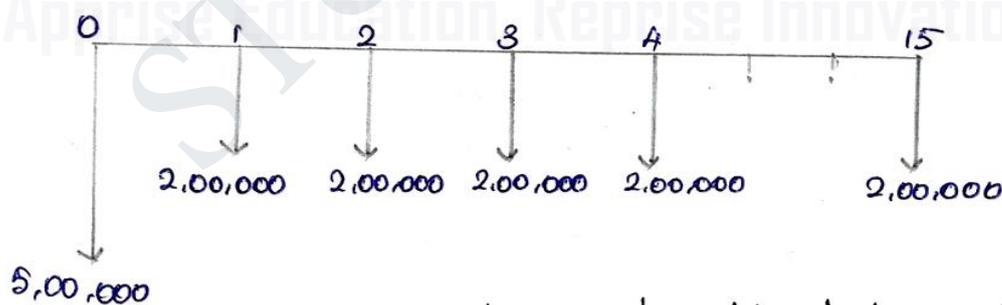
Solution: Alternative. 1 :

Down Payment, $P = \text{Rs. } 5,00,000$

Yearly equal Installment, $A = \text{Rs. } 2,00,000$

$n = 15$ Years.

$i = 20\%$, Compounded annually.



(Cash flow diagram for Manufacturer-1)

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

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

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

$$= 3,06,950.$$

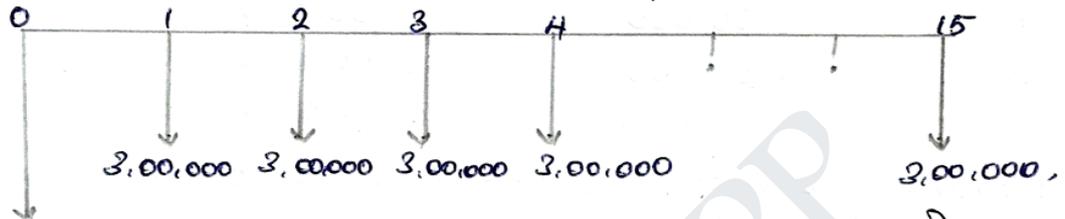
Alternative : 2 .

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

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

n = 15 years

i = 20% , compounded annually .



4,00,000 (Cash flow diagram for Manufacturer-2)

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

$$AE_2 (20\%) = 4,00,000 (A/P, 20\%, 15) + 3,00,000$$

$$= 4,00,000 (0.2139) + 3,00,000$$

$$= Rs. 3,85,560.$$

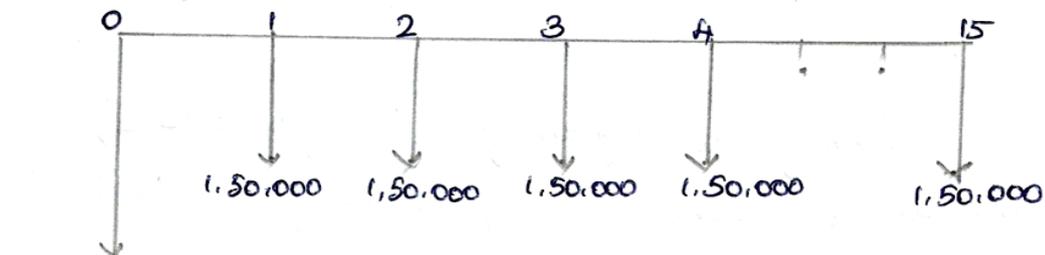
Alternative : 3

Down Payment , P = Rs. 6,00,000

Yearly equal Installment, A = Rs. 1,50,000

n = 15 years

i = 20% , compounded annually .



6,00,000 (Cash flow diagram for Manufacturer-3)

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

$$\begin{aligned} A E_3 (20\%) &= 6,00,000 (A/P, 20\%, 15) + 1,50,000 \\ &= 6,00,000 (0.2139) + 1,50,000 \\ &= \text{Rs. } 2,78,340. \end{aligned}$$

Result :

The annual equivalent cost of manufacturer 3 is less than that of Manufacturer 1 & Manufacturer 2. Therefore, the company should buy the advanced machine Centre from manufacturer. 3.



UNIT IV - REPLACEMENT AND MAINTENANCE ANALYSIS:

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

PART – A

1. **What is meant by preventive maintenance? (Apr/May 2015)**
Preventive maintenance (PM) is the periodical inspection and service activities which are aimed to detect potential failures and perform minor adjustments or repairs which will prevent major operating problems in future.

2. **What are the causes of breakdown (May/June 2009)**
 - ✓ Failure to replace worn out parts
 - Lack of lubrication
 - Indifference towards minor faults

3. **What are all the types of replacement problem? (Nov/Dec 2009)**
 - ✓ Replacement of asset that deteriorates with time (replacement due to gradual failure, or wear and tear of the components of the machines.) this can be future classified in to the following types.
 - (i) Determination of economic life of an asset
 - (ii) Replacement of an existing asset with a new asset.
 - ✓ Simple probabilistic model for assets which fail completely (replacement due to sudden failure).

4. **What is defender? (Apr/May 2014)**
If existing equipment is considered for replacement with new equipment, then the existing equipment is known as the *defender*.

5. **Explain Predictive maintenance. (May/June 2013)**
 - ✓ It is comparatively a newer maintenance technique.
 - ✓ Equipment conditions are measured periodically or on a continuous basis and this enable maintenance men to take a timely action such as equipment adjustments repair or overhaul.

6. **Distinguish between breakdown maintenance and preventive maintenance. (Nov/Dec 2012)**

Breakdown maintenance	Preventive maintenance
Breakdown maintenance is the repair which is generally done after the equipment has attained down state. It is often of an emergency nature which will have associated penalty in terms of expediting cost of maintenance and down time cost of equipment.	Preventive maintenance (PM) is the periodical inspection and service activities which are aimed to detect potential failures and perform minor adjustments or repairs which will prevent major operating problems in future.
The cost of preventive maintenance will be more when compared to the breakdown maintenance cost.	The cost of breakdown maintenance cost is less.

7. Explain annual equivalent total cost

Annual equivalent total cost of owning and operating an asset is a summation of the capital recovery cost (average first cost) and the annual equivalent operating cost of the asset.

8. Define Economic life of an asset. (May/June 2009)

The economic service life of an asset is defined to be the period of useful life that minimizes the annual equivalent cost of owning and operating the asset.

9. What is meant by capital recovery cost

Capital recovery cost computed from the first cost (initial investment/ purchase price) of the machine.

Generally, as an asset becomes older, its salvage value becomes smaller. As long as the salvage value is less than the initial cost, the capital recovery cost is a decreasing function of the life of the asset. In other words, the longer we keep an asset, the lower the capital recovery cost becomes.

10. What is future worth analysis? (Nov/Dec 2008)

- ✓ Net future worth measures the surplus at time period other than 0.
- Future worth analysis is particularly useful in an investment situation where we need to compute the equivalent worth of a project at the end of its investment period.



PART - B

(16)(Apr/May 2015)

1. The following table gives the operation cost : Maintenance Cost & Salvage value at the end of every year of a machine whose Purchase value is Rs. 20,000. Find the economic life of the machine assuming Interest rate $i = 15\%$.

End of Year (n)	Operation cost at the end of Year (Rs).	Maintenance cost at the end of Year (Rs).	Salvage value at the end of Year (Rs).
1	3000	300	9000
2	4000	400	8000
3	5000	500	7000
4	6000	600	6000
5	7000	700	5000
6	8000	800	4000
7	9000	900	3000
8	10000	1000	2000
9	11000	1100	1000
10	12000	1200	0

Solution:

First Cost = Rs. 20,000

Interest rate = 15%

Calculation to Determine Economic Life.

First cost = Rs. 20,000, Interest rate = 15%

End of Year (h)	operation cost at the end of Year	Maintenance cost at the end of Year	Sum of operation and maintenance costs at the end of Year	P/F, 15%, n	Present worth at beginning of Year of operation & maintenance cost	Cumulative sum of Column of Through Year designated	Salvage value at the end of Year	Present worth as of beginning of Year of salvage value	Total Present worth	A/P, 15%, n	Annual Equivalent total cost through Year given
A	B (Rs)	C (Rs)	D (Rs)	E	F (Rs)	G (Rs)	H (Rs)	I (Rs)	J (Rs)	K	L (Rs)
1	3,000	300	3,300	0.8696	2,869.68	2869.68	9000	7826.40	15,043.28	1.1500	17,299.77
2	4000	400	4400	0.7562	3,326.84	6,196.52	8000	6048.80	20,147.72	0.6157	12392.86
3	5000	500	5500	0.6575	3616.25	9,812.77	7000	4602.50	25,210.27	0.4380	11042.01
4	6000	600	6600	0.5718	3773.88	13,586.65	6000	3430.80	30,155.85	0.3503	10563.59
5	7000	700	7700	0.4972	3828.44	17,415.09	5000	2486.00	34,929.09	0.2983	10419.35
6	8000	800	8800	0.4323	3804.24	21,219.33	4000	1729.20	39,490.13	0.2642	10433.29
7	9000	900	9900	0.3759	3721.41	24,940.74	3000	1127.70	43,813.04	0.2404	10532.66

* Economic Life = 5 Years.

Total annual equivalent cost .

$$= \left[\begin{array}{l} \text{Cumulative} \\ \text{sum of present} \\ \text{worth as of} \\ \text{beginning of year} \\ \text{of operation} \\ \text{and Maintenance} \\ \text{Costs} \end{array} + \text{First cost} - \begin{array}{l} \text{Present} \\ \text{worth as} \\ \text{of beginning} \\ \text{of year 1} \\ \text{of salvage} \\ \text{value} \end{array} \right] \times (A/P, 15\%, n)$$

i.e.

$$\begin{aligned} \text{Column L} &= (\text{Column G} + 20,000 - \text{Column I}) \times \\ &\quad \text{Column K} \\ &= \text{Column J} \times \text{Column K.} \end{aligned}$$

In Column L, the annual equivalent total cost is minimum for $n=5$. Therefore the economic life of the machine is five years.

2. Two Years ago, a machine was purchased at a cost of Rs. 2,00,000 to be useful for eight years. Its salvage value at the end of its life is Rs. 25,000. The annual maintenance cost is Rs. 25,000. The market value of the present machine is Rs. 1,20,000. Now, a new machine to cater to the need of the present machine is available at Rs. 1,50,000 to be useful for six years. Its annual maintenance cost is Rs. 20,000. Using an interest rate of 12%, find whether it is worth replacing the present machine with the new machine.

Solution: Alternative 1 - Present machine.

Purchase Price = Rs. 2,00,000

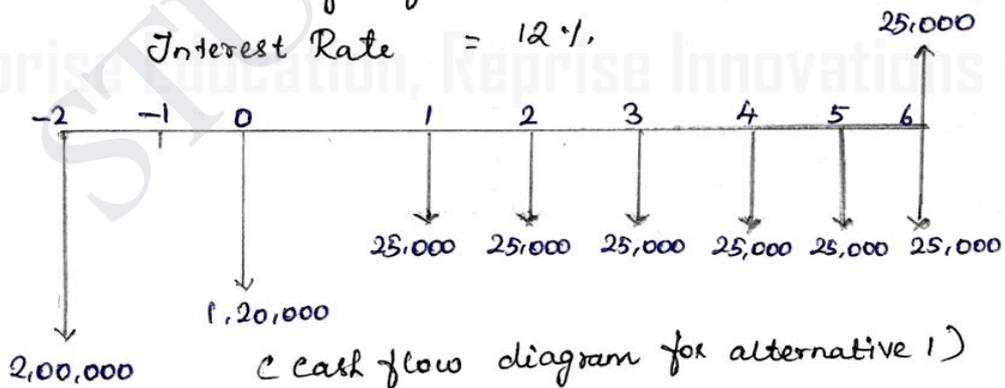
Present value (P) = Rs. 1,20,000

Salvage value (F) = Rs. 25,000

Annual maintenance cost (A) = Rs. 25,000

Remaining life = 6 years.

Interest Rate = 12%



annual maintenance cost for the preceding periods are not shown in fig.

The annual equivalent cost is compared as,

$$AEC(12\%) = (P - F) (A/P, 12\%, 6) + F \cdot i + A$$

$$= (1,20,000 - 25,000) (0.2432) + 25,000 \times 0.12 + 25,000$$

$$= \text{Rs. } 51,104.$$

Alternative 2 - New machine.

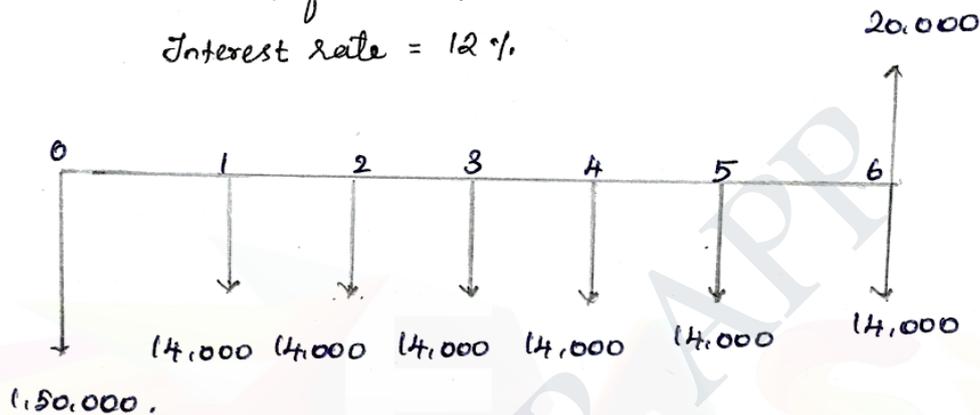
Purchase Price (P) = Rs. 1,50,000

Salvage Value (F) = Rs. 20,000

Annual maintenance cost (A) = Rs. 14,000

Life = 6 Years

Interest rate = 12%



The formula for the annual equivalent cost is

$$AEC(12\%) = (P-F) (A/P, 12\%, 6) + F \times i + A.$$

$$= (1,50,000 - 20,000) (0.2432) + 20,000 \times 0.12 + 14,000.$$

$$= \text{Rs. } 48,016$$

Since the annual equivalent cost of the new machine is less than that of the Present machine, it is suggested that the Present machine be replaced with the new machine.

3. A diesel engine was installed 10 years ago at a cost of Rs. 50,000. It has a present realizable market value of Rs. 15,000. If kept, it can be expected to last five years more, with operating and maintenance cost of Rs. 14,000 per year and to have a salvage value of Rs. 8,000 at the end of the fifth year. This engine can be replaced with an improved version costing Rs. 65,000 which has an expected life of 20 years. This improved version will have an estimated annual operating & maintenance cost of Rs. 9,000 and ultimate salvage value of Rs. 13,000. Using an interest rate of 15%, make an annual equivalent cost analysis to determine whether to keep (or) replace the old engine.

Solution: Alternative 1 - old diesel engine.

Purchase Price = Rs. 50,000.

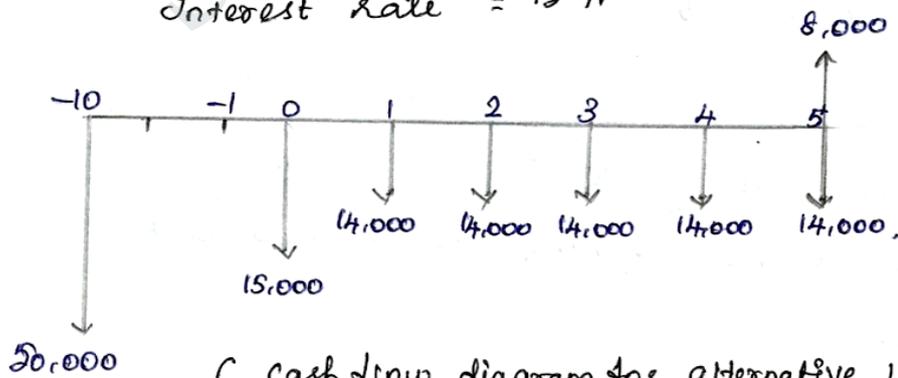
Present value (P) = Rs. 15,000.

Salvage Value (F) = Rs. 8,000.

Annual Operating & Maintenance Cost (A) = Rs. 14,000.

Remaining life (n) = 5 years.

Interest rate = 15%.



The formula for the annual equivalent cost is

$$AE (15\%) = (P - F) (A/P, 15\%, 5) + Fxi + A$$

$$= (15,000 - 8,000) (0.2983) + 8,000 \times 0.15 +$$

$$14,000.$$

$$= \text{Rs. } 17,288.10.$$

Alternative 2 - New machine.

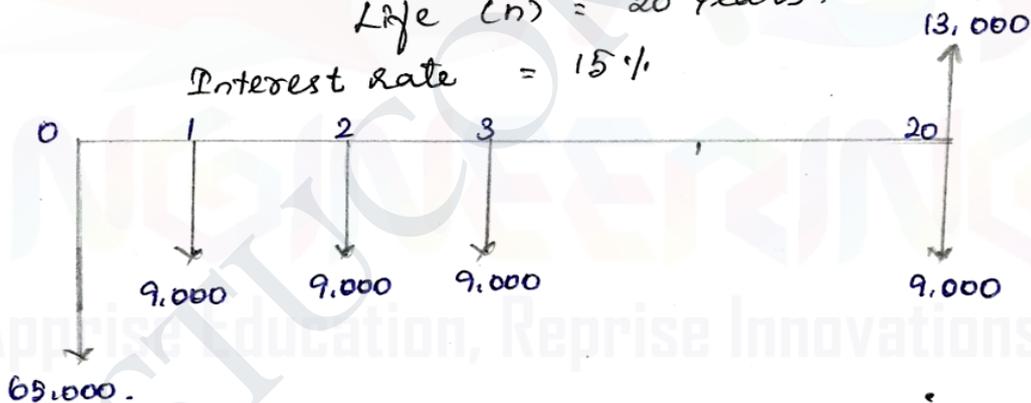
Present Value (P) = Rs. 65,000.

Salvage Value (F) = Rs. 13,000.

Annual operating & Maintenance Cost (A) } = Rs. 9,000.

Life (n) = 20 Years.

Interest rate = 15%



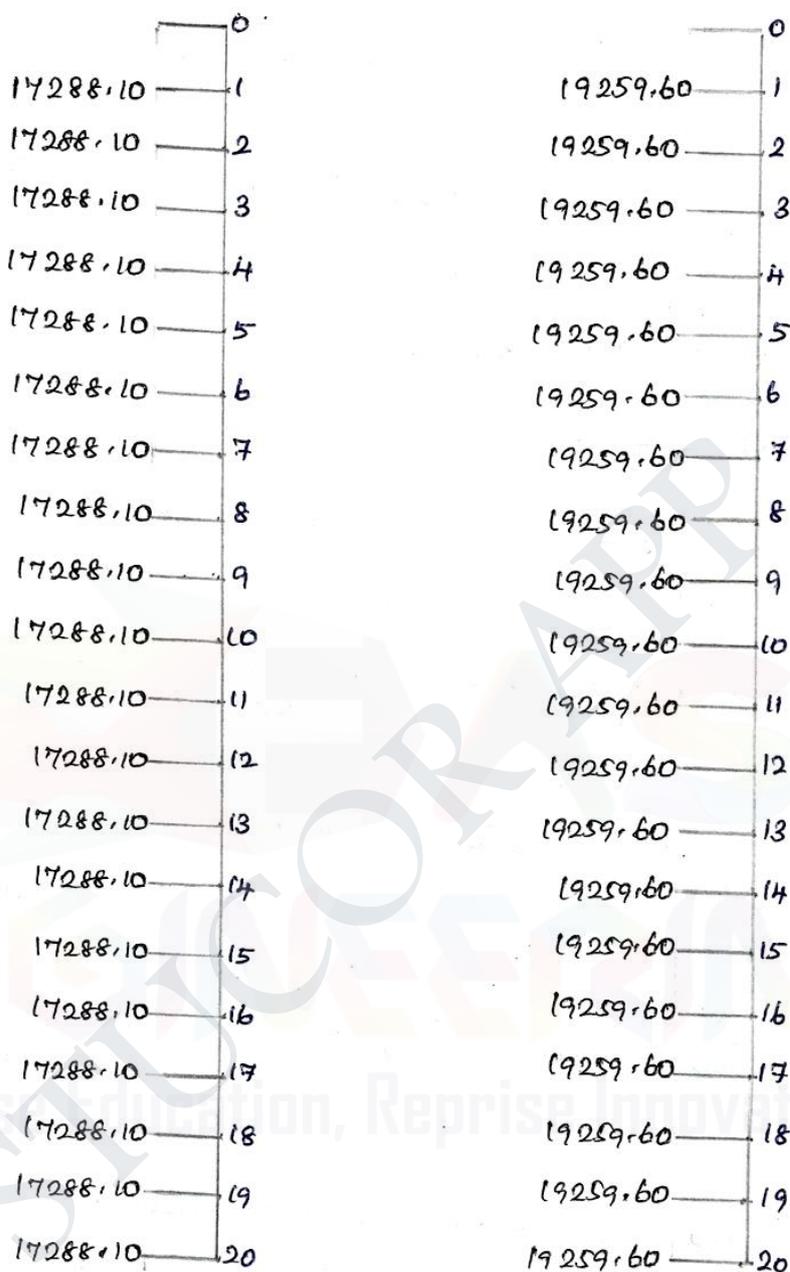
The formula for the annual equivalent cost is

$$AE (15\%) = (P - F) (A/P, 15\%, 20) + Fxi + A$$

$$= (65,000 - 13,000) (0.1598) + 13,000 \times 0.15 + 9,000.$$

$$= \text{Rs } 19,259.60.$$

For comparing the engines based on equal lives (20 Years), the annual equivalent for are given in Fig. Equal lives are nothing but the least common multiple of the lives of the alternatives.



Cash flow diagram of alternatives based on common lives.
 Since the annual equivalent cost of the old diesel engine is less than that of the new diesel engine, it is suggested to keep the old diesel engine. Here an important assumption is that the old engine will be replaced four times during the 20 years period of comparison.

4(ii) A firm is considering replacement of an equipment, whose first cost is Rs. 4,000, and the scrap value is negligible at the end of any year based on experience, it was found that the maintenance cost is zero during the first year & it increased by Rs. 200 every year thereafter. When should the equipment be replaced if $i=0\%$.

Solution: First cost = Rs. 4,000.
Maintenance cost is Rs 0 during the first year and it increased by Rs. 200 every year thereafter.

End of Year (n)	Maintenance Cost at end of year	Summation of maintenance costs	Average cost of maintenance through year given	Average first cost if replaced at year end given	Average total cost through year given
		ΣB	C/A	$4,000/A$	$D+E$
A	B (Rs)	C (Rs)	D (Rs)	E (Rs)	F (Rs)
1	0	0	0	4,000.00	4,000.00
2	200	200	100	2,000.00	2,100.00
3	400	600	200	1,333.33	1,533.33
4	600	1,200	300	1,000.00	1,300.00
5	800	2,000	400	800.00	1,200.00
6	1,000	3,000	500	666.67	1,166.67*
7	1,200	4,200	600	571.43	1,171.43

Column C summarizes the summation of maintenance costs for each replacement period. The value corresponding to any end of year in this column represents the total maintenance cost of using the equipment till the end of that particular year.

$$\text{Average total cost} = \frac{\text{First cost (FC)} + \text{Summation of maintenance Cost}}{\text{Replacement Period.}}$$

$$= \frac{Fc}{n} + \frac{\text{Column c}}{n}$$

$$= \text{Average first cost for the given period} + \text{Average maintenance cost for the given period.}$$

$$\text{Column F} = \text{Column E} + \text{Column D.}$$

The value corresponding to any end of year (n) in Column F represents the average total cost of using the equipment till the end of that particular year.

For this problem, the average total cost decreases till the end of year 6 and then it increases. Therefore, the optimal replacement period is six years.

i.e. Economic life of the equipment is six years.

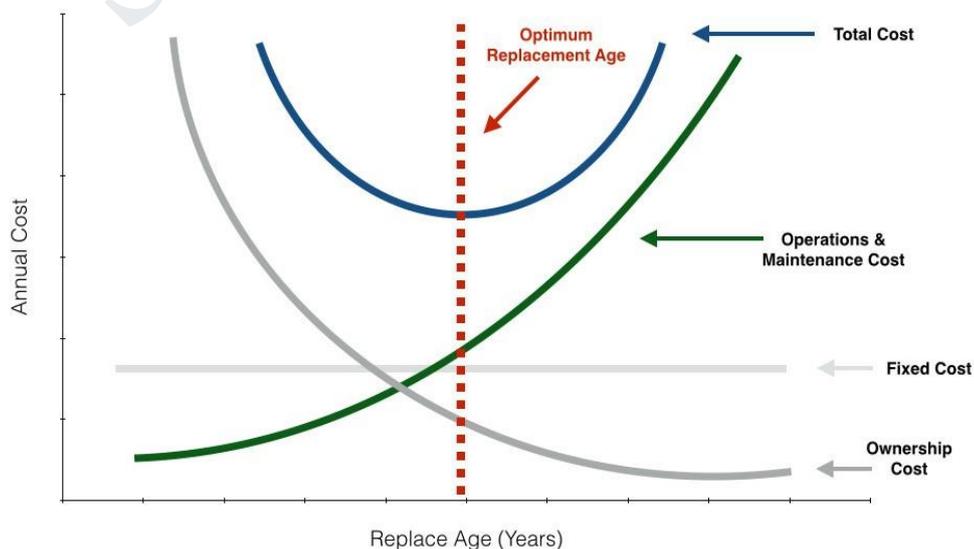
4. (ii) Write short notes on “economic life” of equipment. (6) (Nov/Dec 2013)

Determination of Economic Life of an Asset

Any asset will have the following cost components:

- Capital recovery cost (average first cost), computed from the first cost (purchase price) of the machine.
- Average operating and maintenance cost (O & M cost)
- Total cost which is the sum of capital recovery cost (average first cost) and average maintenance cost.

Economic Life of Assets



(16) (Nov/Dec 2012)

5. Electronic equipment contains 1,000 resistors. When any resistor fails, it is replaced. The cost of replacing a resistor individually is Rs. 10. If all the resistors are replaced at the same time, the cost per resistor is Rs. 4. The present surviving, $s(i)$ at the end of month i is tabulated as follows.

i	0	1	2	3	4	5	6
$s(i)$	100	96	89	68	37	13	0

Which is the optimum replacement plan?

Solution: Let p_i be the probability of failure during the month i , then,

$$p_1 = (100 - 96) / 100 = 0.04$$

$$p_2 = (96 - 89) / 100 = 0.07$$

$$p_3 = (89 - 68) / 100 = 0.21$$

$$p_4 = (68 - 37) / 100 = 0.31$$

$$p_5 = (37 - 13) / 100 = 0.24$$

$$p_6 = (13 - 0) / 100 = 0.13$$

It is clear that no resistor can survive beyond six months. Hence, a resistor which has survived for five months would certainly fail during the six month. We assume that the resistors failing during a month are accounted at the end of the month.

Let, $N_i =$ No. of resistors replaced at the end of the i th month.

$$N_0 = 1,000$$

$$N_1 = N_0 p_1 = 1,000 \times 0.04 = 40$$

$$N_2 = N_0 p_2 + N_1 p_1 = 1,000 \times 0.07 + 40 \times 0.04 = 72$$

$$N_3 = N_0 P_3 + N_1 P_2 + N_2 P_1$$

$$= (1,000 \times 0.21) + (40 \times 0.07) + (72 \times 0.04) = 216.$$

$$N_4 = N_0 P_4 + N_1 P_3 + N_2 P_2 + N_3 P_1$$

$$= (1,000 \times 0.31) + (40 \times 0.21) + (72 \times 0.07) + (216 \times 0.04)$$

$$\Rightarrow 332.$$

$$N_5 = N_0 P_5 + N_1 P_4 + N_2 P_3 + N_3 P_2 + N_4 P_1$$

$$= (1,000 \times 0.24) + (40 \times 0.31) + (72 \times 0.21) + (216 \times 0.07) +$$

$$(332 \times 0.04) = 296.$$

$$N_6 = N_0 P_6 + N_1 P_5 + N_2 P_4 + N_3 P_3 + N_4 P_2 + N_5 P_1$$

$$= (1,000 \times 0.13) + (40 \times 0.24) + (72 \times 0.31) + (216 \times 0.21) +$$

$$(332 \times 0.07) + (296 \times 0.04) = 242.$$

Determination of Individual replacement cost.

$$\text{Expected life of } \gamma \text{ each resistor} = \sum_{i=1}^6 i \times P_i.$$

$$= (1 \times 0.04) + (2 \times 0.07) + (3 \times 0.21) +$$

$$(4 \times 0.31) + (5 \times 0.24) + (6 \times 0.13)$$

$$= 4.03 \text{ months.}$$

$$\text{Average number of failures/month} = \frac{1,000}{4.03}$$

$$= 248 \text{ (approx.)}$$

Therefore,

Cost of Individual replacement \Rightarrow

$$= (\text{No. of failures/month}) \times (\text{Individual replacement cost/resistor})$$

$$= 248 \times 10 = \text{Rs. } 2480/-$$

Determination of group replacement cost.

Cost / resistor when replaced Simultaneously = Rs. 4.00.

Cost / resistor when replaced Individually = Rs. 10.00.

The costs of group replacement Policy for several replacement periods are summarized in Table.

Calculations of costs for Preventive Maintenance.
(Table) :-

End of month	Cost of replacing 1,000 resistors at a time	Cost of replacing resistors Individually during given replacement period	Total Cost (B+C)	Average Cost/month (D/A)
A	B (Rs)	C (Rs)	D (Rs)	E (Rs).
1	4,000	$40 \times 10 = 400$	4,400	4,400.00
2	4,000	$(40 + 72) \times 10 = 1,120$	5,120	2,560.00
3	4,000	$(40 + 72 + 216) \times 10 = 3,280$	7,280	2,426.67*
4	4,000	$(40 + 72 + 216 + 332) \times 10 = 6,600$	10,600	2650.00.

* (Indicates the minimum average cost/month)

From table, it is clear that the Average Cost/month is minimum for the third month. Thus, the group replacement period is three months.

Result :

Individual replacement cost/month = Rs. 2480.00.

Minimum group replacement cost/month = Rs. 2426.67.

Since the minimum group replacement cost/month is less than the individual replacement cost/month, the group replacement Policy is the best & hence all the resistors are to be replaced one in three months and the resistors which fail during this three months period are to be replaced Individually.

UNIT V- DEPRECIATION

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation- Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

PART – A

1. What is Benefit-Cost ratio?

(Apr/May 2015)

The ratio between the equivalent benefit and equivalent costs is called the benefit cost ratio.

$$\text{i.e., BC ratio} = \frac{\text{Equivalent benefits}}{\text{Equivalent costs}}$$

2. What is meant by inflation?

(Apr/May 2014)

- ✓ Inflation may be defined as a sustained in the general price level.
- ✓ It is an economic condition where there is a rise in prices resulting in the fall in the purchasing power of money

3. Define the following: Depreciation and book value.

(Nov/Dec 2012)

- ✓ Depreciation is the process of allocating the acquisition cost of the tangible assets less salvage value, if any, in a systematic and a rational manner over the estimated life of the asset.
- ✓ Book value: The value at which an asset is carried on a balance sheet. In other words, the cost of an asset minus accumulated depreciation.

4. What is service output method of depreciation?

(May/June 2009)

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

P = first cost of the asset

F = salvage value of the asset

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

x = quantity of service rendered in a period.

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

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

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

5. List few causes of depreciation.

(May/June 2012)

The causes of depreciation are:

- Wear and tear
- Depletion
- Obsolescence
- Lapse of time

6. What are the assumptions for straight line method for Calculating depreciation? (May/June 2012)

In this method of depreciation, a fixed sum is charged as the depreciation amount throughout the lifetime of an asset such that the accumulated sum at the end of the life of the asset is exactly equal to the purchase value of the asset.

Here, we make an important assumption that inflation is absent.

Let

P = first cost of the asset,

F = salvage value of the asset

n = life of the asset,

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

D_t = depreciation amount for the period t .

The formulae for depreciation and book value are as follows:

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

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

7. Give the expression for the calculation of depreciation under sum of years-digits method of depreciation. (Apr/May 2010)

In this method of depreciation also, it is assumed that the book value of the asset decreases at a decreasing rate. If the asset has a life of eight years, first the sum of the years is computed as Sum of the years = 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8

$$= 36 = n(n + 1)/2$$

The rate of depreciation charge for the first year is assumed as the highest and then it decreases. The rates of depreciation for the years 1–8, respectively are as follows:

$$8/36, 7/36, 6/36, 5/36, 4/36, 3/36, 2/36, \text{ and } 1/36.$$

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

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

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

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

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

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

8. What is Sinking fund method of depreciation? (Nov/Dec 2009)

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

Let

P = first cost of the asset,

F = salvage value of the asset,

n = life of the asset,

i = rate of return compounded annually,

A = the annual equivalent amount,

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

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

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

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

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

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

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

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

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

9. Write the methods to find the depreciation of an asset. (May/June 2009)

The various methods used in depreciation calculation are:

1. Straight line method
2. Declining method
3. Sum of the years digits method
4. Sinking fund or annuity method
5. Service output method

10. What is amortization? (May/June 2013)

Amortization is a routine decrease in value of an intangible asset, or the process of paying off a debt over time through regular payments. Amortization refers to the expensing of intangible capital assets (intellectual property: patents, trademarks, copyrights. Etc.) in order to show their decrease in value as a result of use or passage of time.



PART – B

1. Explain the various methods of Depreciation. (16)(Apr/May 2015)

There are several methods of accounting depreciation fund. These areas follows:

1. Straight line method of depreciation
2. Declining balance method of depreciation
3. Sum of the years—digits method of depreciation
4. Sinking-fund method of depreciation
5. Service output method of depreciation

1. Straight Line Method of Depreciation

In this method of depreciation, a fixed sum is charged as the depreciation amount throughout the lifetime of an asset such that the accumulated sum at the end of the life of the asset is exactly equal to the purchase value of the asset.

Here, we make an important assumption that inflation is absent.

Let

P = first cost of the asset,

F = salvage value of the asset

n = life of the asset,

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

D_t = depreciation amount for the period t .

The formulae for depreciation and book value are as follows:

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

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

2. Declining Balance Method of Depreciation

- In this method of depreciation, a constant percentage of the book value of the previous period of the asset will be charged as the depreciation amount for the current period.
- This approach is a more realistic approach, since the depreciation charge decreases with the life of the asset which matches with the earning potential of the asset.
- The book value at the end of the life of the asset may not be exactly equal to the salvage value of the asset. This is a major limitation of this approach.

Let

P = first cost of the asset,

F = salvage value of the asset,

n = life of the asset,

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

K = a fixed percentage, and

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

The formulae for depreciation and book value are as follows:

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

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

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

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

3. Sum of Year – digit method:

In this method of depreciation also, it is assumed that the book value of the asset decreases at a decreasing rate. If the asset has a life of eight years, first the sum of the years is computed as Sum of the years = 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8

$$= 36 = n(n + 1)/2$$

The rate of depreciation charge for the first year is assumed as the highest and then it decreases. The rates of depreciation for the years 1–8, respectively are as follows:

$$8/36, 7/36, 6/36, 5/36, 4/36, 3/36, 2/36, \text{ and } 1/36.$$

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

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

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

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

$$\begin{aligned} D_t &= \frac{n - t + 1}{n(n + 1)/2} (P - F) \\ B_t &= (P - F) \frac{(n - t)}{n} \frac{(n - t + 1)}{(n + 1)} + F \end{aligned}$$

4. Sinking fund method:

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

Let P = first cost of the asset,

F = salvage value of the asset,

n = life of the asset,

i = rate of return compounded annually,

A = the annual equivalent amount,

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

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

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

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

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

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

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

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

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

5. Service output method:

In some situations, it may not be realistic to compute depreciation based on time period.

In such cases, the depreciation is computed based on service rendered by an asset. Let

P = first cost of the asset

F = salvage value of the asset

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

x = quantity of service rendered in a period.

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

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

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

2. A State government is planning a hydroelectric Project for a river basin. In addition to the Production of electric Power, this Project will Provide flood control, irrigation and re-creation benefits. The estimated benefits and costs that are expected to be derived from this Project are as follows:

Initial cost = Rs. 8,00,00,000.

Annual Power Sales = Rs. 60,00,000.

Annual flood control Savings = Rs. 30,00,000.

Annual Irrigation benefits = Rs. 50,00,000.

Annual recreation benefits = Rs. 20,00,000.

Annual operating & Maintenance Costs = Rs. 30,00,000.

Life of the Project = 50 Years.

Check whether the State Government should Implement the Project (Assume $i = 12\%$).

Solution: Initial Cost = Rs. 8,00,00,000.

Annual Power Sales = Rs. 60,00,000.

Annual flood control Savings = Rs. 30,00,000.

Annual Irrigation benefits = Rs. 50,00,000.

Annual recreation benefits = Rs. 20,00,000.

Annual operating & Maintenance Costs = Rs. 30,00,000

Life of the Project = 50 Years, $i = 12\%$

Total annual benefits = Flood control Savings + Irrigation benefits + Recreation benefits.

= Rs 30,00,000 + Rs 50,00,000 +
Rs 20,00,000

⇒ Rs 1,00,00,000.

$$\begin{aligned} \text{Present worth of the benefits} &= \text{Total annual benefits} \times (P/A, 12\%, 50) \\ &= 1,00,00,000 \times 8.3045. \\ &= \text{Rs. } 8,30,45,000. \end{aligned}$$

$$\begin{aligned} \text{Present worth of costs} &= \text{Initial cost} + \text{Present worth of annual operating and Maintenance cost} - \text{Present worth of Power sales.} \\ &= \text{Rs. } 8,00,00,000 + 30,00,000 \times (P/A, 12\%, 50) \\ &\quad - 60,00,000 (P/A, 12\%, 50). \\ &= \text{Rs. } 8,00,00,000 + 30,00,000 \times 8.3045 - \\ &\quad 60,00,000 \times 8.3045. \\ &= \text{Rs. } 5,50,86,500. \end{aligned}$$

$$\begin{aligned} \text{Bc ratio} &= \frac{\text{Present worth of benefits.}}{\text{Present worth of costs.}} \\ &= \frac{8,30,45,000}{5,50,86,500} = 1.508. \end{aligned}$$

Since, the Bc ratio is more than 1, the state government can implement the hydroelectric project

300A Company has Purchased an equipment whose first cost is Rs 1,00,000 with an estimated life of eight Years. The estimated Salvage Value of the equipment at the end of its lifetime is Rs 20,000. Determine the depreciation charge and book value at the end of various Years Using the Straight line method of depreciation.

Solution:

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

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

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

$$D_t = \frac{P - F}{n}$$

$$= \frac{(1,00,000 - 20,000)}{8}$$

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

In this method of depreciation, the value of D_t is the same for all the Years. The calculations pertaining to B_t for different values of t are Summarized.

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

If we are Interested in Computing D_t and B_t for a specific Period (t), the formulae can be Used. In this approach, it should be noted that the depreciation is the same for all the periods.

- (ii) A company has purchased a bus for its officers for Rs 10,00,000 the expected life of the bus is eight years. The salvage value of the bus at the end of its life is Rs 1,50,000. Find the following using the sinking fund method of depreciation.
- (i) Depreciation at the end of the third year & fifth year.
 - (ii) Book value at the end of the second year & sixth year.

Solution:

$$P = 10,00,000$$

$$F = 1,50,000$$

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

$$D_t = \frac{P-F}{n}$$

$$= \frac{10,00,000 - 1,50,000}{8} = 1,06,250.$$

$$\text{Rate} = \frac{D_t}{P} \times 100.$$

$$= \frac{1,06,250}{10,00,000} \times 100 \Rightarrow 10\% \text{ (or) } 0.10.$$

Calculation of depreciation:

$$D_t = P-F \times [A/F, i, n] \times [F/P, i, t-1]$$

$$= 10,00,000 - 1,50,000 \times 0.0874$$

$$= 74,290.$$

Calculation of depreciation & book value of Bus.

End of Year	Fixed D_t	Net D_t	Book value.
0	74,290	-	10,00,000
1	74,290	74,290	9,25,710
2	74,290	81,719	8,43,991.
3	74,290	89,891	7,54,100
4	74,290	90,708	6,63,392
5	74,290	90,790	5,72,602
6	74,290	90,798	4,81,804
7	74,290	90,799	3,91,005
8	74,290	90,799	3,00,206.

Result: Depreciation at the end of third year is Rs. 89,891, at end of fifth year is Rs. 90,790.

Book value of the bus at the end of the second year is Rs. 8,43,991 and at the end of sixth year is Rs. 4,81,804.

4. The beta drug company has just purchased a Capsulation machine for Rs. 20,00,000. The plant engineer estimates that the machine has a Useful life of five years and a Salvage Value of Rs. 25,000. at the end of its Useful life. Compute the depreciation schedule for the machine by each of the following depreciation Methods.

- (a) Straight line method of depreciation.
- (b) Sum-of-Years digits method of depreciation.
- (c) Double declining ~~rate~~ balance method of depreciation.

Solution:

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

$$F = \text{Rs. } 25,000$$

$$n = 5 \text{ years.}$$

(i) Straight line method of depreciation:

$$D_t = \frac{P-F}{n}$$

$$= \frac{20,00,000 - 25,000}{5}$$

$$= \frac{19,75,000}{5} \Rightarrow \text{Rs. } 3,95,000.$$

$$\text{Rate of depreciation} = \frac{D_t}{P} \times 100$$

$$= \frac{3,95,000}{20,00,000} \times 100.$$

$$= 20\%$$

(ii) Sum of the Years digit method of depreciation:

Formula:

$$\text{Sum} = \frac{n(n+1)}{2}$$

$$= \frac{5(5+1)}{2} \Rightarrow \frac{30}{2} \Rightarrow 15$$

Therefore the rate for 1-5 years respectively $5/15, 4/15, 3/15, 2/15$ & $1/15$.

(ii) Double Declining balance method of depreciation:

Formula:

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

Where

$$K = 0.2 \times 200\% \text{ (or) } 40\%$$

$$B = 20,00,000.$$

Depreciation schedule for a machine with initial book value of Rs. 20,00,000.

End of Years	Straight line method (D_t)	Sum of the Years digits method (D_t)	Declining method (D_t)
0	-	-	-
1	3,95,000	6,58,333	8,00,000
2	3,95,000	5,26,667	4,80,000
3	3,95,000	3,95,000	2,88,000
4	3,95,000	2,63,333	1,72,800
5	3,95,000	1,31,667	1,03,680

(8) (May/June 2013)

5(ii). A company purchased machinery for Rs. 1,00,000. Its installation costs amounted to Rs. 10,000. Its estimated life is 5 years, and the scrap value is Rs. 5,000. Calculate the amount & rate of depreciation.

Solution:

$$P = \text{Rs. } 1,00,000 + \text{Rs. } 10,000$$

$$= \text{Rs. } 1,10,000,$$

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

$$n = 5 \text{ years.}$$

Find:

1. Depreciation for the period t , D_t .
2. Rate of depreciation.

Formula to Find: $D_t = \left(\frac{P-F}{n} \right)$

$$(i) \text{ Depreciation for the period } (D_5) \left. \vphantom{\begin{matrix} (i) \\ (ii) \end{matrix}} \right\} = \frac{1,10,000 - 5,000}{5}$$

$$= \text{Rs. } 21,000.$$

$$(ii) \text{ Rate of depreciation} = \frac{D_t}{P_t} \times 100.$$

$$= \frac{21,000}{1,10,000} \times 100$$

$$= 19.09\%$$

Result:

- (i) Depreciation for the Period $(D_5) \left. \vphantom{\begin{matrix} (i) \\ (ii) \end{matrix}} \right\} = \text{Rs. } 21,000.$
- (ii) Rate of depreciation = 19.09%.

5. (ii) Write about the procedure to adjust inflation.

(8) (May/June 2013)

Inflation Adjusted Decisions:

- Inflation is the rate of increase in the prices of goods per period. So, it has a compounding effect. Thus, prices that are inflated at a rate of 7% per year will increase 7% in the first year, and for the next year the expected increase will be 7% of these new prices.
- If economic decisions are taken without considering the effect of inflation into account, most of them would become meaningless and as a result the organizations would end up with unpredictable return.

Procedure to Adjust Inflation:

A procedure to deal with this situation is summarized now.

- 1. Estimate all the costs/returns associated with an investment proposal in terms of today's rupees.
2. Modify the costs/returns estimated in step 1 using an assumed inflation rate so that at each future date they represent the costs/returns at that date in terms of the rupees that must be expended/received at that time, respectively.
3. As per our requirement, calculate either the annual equivalent amount or future amount or present amount of the cash flow resulting from step 2 by considering the time value of money.

Apprise Education, Reprise Innovations

Question Paper Code : 71926

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Eighth Semester

Mechanical Engineering

MG 2451/GE 1451/MG 81/080120038/10177 GE 009 — ENGINEERING
ECONOMICS AND COST ANALYSIS(Common to Production Engineering, Automobile Engineering, Material Science and
Engineering)

(Regulation 2008/2010)

(Common to PTMG 2451/10177 GE 009 – Engineering Economics and Cost Analysis
for B.E. (Part-Time) Mechanical Engineering – Regulation – 2009/2010)

Time : Three hours

Maximum : 100 marks

Use of statistical tables are permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Economics.
2. Define marginal costing.
3. Mention any two criteria for buy decision.
4. Define effective interest rate.
5. What is the concept of 'future worth method of comparison'?
6. What is the idea of 'rate of return method of comparison'?
7. What is meant by preventive maintenance?
8. What are the reasons for replacement?
9. What is depreciation?
10. What is Benefit-Cost ratio?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Mention about the Law of supply and demand. (8)
 (ii) Suguna associates has the following details : (8)
 Fixed cost = Rs. 20,00,000
 Variable cost per unit = Rs. 100
 Selling price per unit = Rs. 200
 Find out :
 (1) The break-even point in quantity
 (2) The break-even point in sales [Rupees].
 Or
- (b) (i) Explain the scope of Engineering Economics. (8)
 (ii) Explain the steps in the process planning. (8)
12. (a) (i) Mention the basic principles of brain storming. (8)
 (ii) A person wishes to have a future sum of Rs. 1,00,000 for his son's education after 10 years from now. What is the single payment that he should deposit now so that he gets the desired amount after 10 years? The bank gives 15% interest rate compounded annually.
 Or
- (b) (i) Write briefly about the time value of money. (8)
 (ii) A person is planning for his retired life. He has 10 more years of service. He would like to deposit Rs. 8,500 at the end of the first year and thereafter he wishes to deposit the amount with an annual decrease of Rs. 500 for the next 9 years with an interest rate of 15%. Find the total amount at the end of the 10th year of the above series. (8)
13. (a) An engineer has two bids for an elevator to be installed in a new building. The details of the bids for the elevators are as follows :

Bid	Engineer's estimates		
	Initial cost (Rs.)	Service life (years)	Annual operations and maintenance cost (Rs.)
Alpha elevator inc.	4,50,000	15	27,000
Beta elevator inc.	5,40,000	15	28,500

Determine which bid should be accepted, based on the present worth method of comparison assuming 15% interest rate, compounded annually. (16)

Or

- (b) Discuss the concept of make or buy decision and explain the functions of value engineering.

14. (a) The following table gives the operation cost, maintenance cost and salvage value at the end of every year of a machine whose purchase value is Rs. 20,000. Find the economic life of the machine assuming interest rate, $i = 15\%$ (16)

End of year (n)	Operation cost at the end of year (Rs.)	Maintenance cost at the end of year (Rs.)	Salvage value at the end of year (Rs.)
1	3,000	300	9,000
2	4,000	400	8,000
3	5,000	500	7,000
4	6,000	600	6,000
5	7,000	700	5,000
6	8,000	800	4,000
7	9,000	900	3,000
8	10,000	1,000	2,000
9	11,000	1,100	1,000
10	12,000	1,200	0

Or

- (b) Two years ago, a machine was purchased at a cost of Rs. 2,00,000 to be useful for eight years. Its salvage at the end of its life is Rs. 25,000. The annual maintenance cost is Rs. 25,000. The market value of the present machine is Rs. 1,20,000. Now, a new machine to cater to the need of the present machine is available at Rs. 1,50,000 to be useful for six years. Its annual maintenance cost is Rs. 14,000. The salvage value of the new machine is Rs. 20,000. Using an interest rate of 12%, find whether it is worth replacing the present machine with the new machine. (16)

15. (a) Explain the various methods of depreciation.

Or

- (b) Explain the procedure to adjust inflation and discuss the determination of economic life of asset.

Reg. No. :

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Question Paper Code : 91700

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Eighth Semester

Mechanical Engineering

MG 2451/GE 1451/MG S1/080120038/10177 GE 009 — ENGINEERING
ECONOMICS AND COST ANALYSIS(Common to Production Engineering/Automobile Engineering, Material Science
and Engineering)

(Regulation 2008/2010)

(Common to PTMG 2451/10177 GE 009 – Engineering Economics and Cost Analysis
for B.E. (Part-Time) Mechanical Engineering – Regulation – 2009/2010)

Time : Three hours

Maximum : 100 marks

Use of Statistical Tables are permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. How does Marshall explain the Law of Demand?
2. What is Margin of Safety?
3. What is Time value of Money?
4. What is Value Engineering?
5. List out the quantitative and qualitative factors to be considered in 'Make or Buy Decision'.
6. What is statement of changes in financial position based on net working capital known as?
7. List out the functional elements of Maintenance Programme.
8. List out the preventive Maintenance activities.
9. What is depreciation?
10. Explain in few words the various types of Depreciation.

PART B — (5 × 16 = 80 marks)

11. (a) State and explain the factors influencing Process design.

Or

(b) Explain why the demand curve slopes downward.

12. (a) Sri Nethra Industries Ltd. Offers 12% interest on Fixed deposits. What is the effective rate of interest if compounding is done.

(i) Half yearly (6)

(ii) Quarterly (5)

(iii) Monthly. (5)

Or

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

13. (a) Discuss the Present worth method (Revenue Dominated Cash flow Diagram).

Or

(b) Discuss the Annual Equivalent Method (Revenue Dominated Cash flow Diagram).

14. (a) Discuss the types of Maintenance.

Or

(b) There are 10,000 bulbs in a decorative set. When any bulb fails to be replaced, the cost of replacing a bulb individually is Rs. 1 only. If all the bulbs are replaced at the same time, the cost per bulb would be reduced to Rs. 0.35. The Percentage of bulbs surviving at the end of Month(t) i.e S(t) and the probability of failures during the month (t) i.e P(t) are given below.

t	0	1	2	3	4	5	6
S(t)	100	97	90	70	30	15	0
P(t)	-	0.03	0.07	0.20	0.40	0.15	0.15

Determine the optimal replacement Policy.

15. (a) A machine is purchased for Rs. 45,000 and has a life of 20 years. Its salvage value is estimated to be Rs. 3,000. Using the sum of years digital method, calculate Annual Depreciation charges for first, sixth, and eleventh, sixteenth and twentieth years.

Or

- (b) Calculate the Depreciation, accumulated Depreciation and book value for the following Data using Declined Balance Method.

Initial Investment	=	Rs 24,000
Salvage value	=	Rs. 3,000
Time	=	5 years.

91700

3

PART B — (5 × 16 = 80 marks)

11. (a) Explain in detail the different elements of cost.

Or

(b) Discuss about the simple economic analysis.

12. (a) Discuss about the different interest formula and their applications.

Or

(b) What are the different approaches for make or buy decisions?

13. (a) Write about the revenue dominated cash flow diagram and cost dominated cash flow diagram.

Or

(b) A tyre company decided for new tyre for its vehicles and finalized on the following alternatives.

Brands	Types of warranty (Months)	Price per tyre (Rs.)
A	12	1200
B	24	1800
C	36	2100

If the company feels that the warranty period is a good estimate of the tyres life and that a nominal interest rate (compounded annually) of 12% is appropriate, which tyre should it buy?

14. (a) Explain different types of maintenance in detail.

Or

(b) Two years ago, a machine was purchases at a cost of Rs. 2,00,000 to be useful for eight years. Its salvage value at the end of its life is Rs. 25,000. The annual maintenance cost is Rs. 25,000. The market value of the present machine is Rs. 1,20,000. Now, a new machine to cater to the need of the present machine is available at Rs. 1,50,000 to be useful for six years. Its annual maintenance cost is Rs. 14, 000. The salvage value of the new machine is Rs.20,000. Using an interest rate of 12% find whether it is worth replacing the present machine with the new machine.

15. (a) Write about the procedure to inflation adjustment decisions.

Or

(b) Write about the methods of depreciation with examples.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Mention the factors influencing demand and supply. (8)
(ii) Explain the method of deriving the selling price of a product. (8)

Or

- (b) (i) In the design of a jet engine part, the designer has a choice of specifying either an aluminum alloy casting or a steel casting. Either material will provide equal service, but the aluminum alloy casting will weigh 1.2 kg as compared with 1.35 kg for the steel casting. The aluminum can be cast Rs.80/kg and the steel for Rs.35/kg. The cost of machining per unit is Rs.150 for aluminum and Rs.170 for steel. Every kg of excess weight is associated with a penalty of Rs.1,300 due to increased fuel consumption. Which material should be specified and what is the economic advantage of the selection per unit? (8)
(ii) Explain the steps in process planning. (8)
12. (a) (i) Mention the basic steps of value engineering. (8)
(ii) A person deposits a sum of Rs 20,000 at the interest rate of 18% compounded annually for 10 years. Find the maturity value after 10 years. Use single-payment compound amount formula. (8)

Or

- (b) (i) Write short notes on the time value of money. (8)
(ii) A company has to replace a present facility after 15 years at an outlay of Rs.5,00,000. It plans to deposit an equal amount at the end of every year for the next 15 years at an interest rate of 18% compounded annually. Find the equivalent amount that must be deposited at the end of every year for the next 15 years. Use equal-payment series sinking fund formula. (8)
13. (a) Alpha industry is planning to expand its production operation. It has identified three different technologies for meeting the goal. The initial outlay and annual revenues with respect to each of the technologies are summarized in table. Suggest the best technology which is to be implemented based on the present worth method of comparison assuming 20% interest rate, compounded annually. (16)

	Initial outlay (Rs.)	Annual revenue (Rs.)	Life (years)
Technology 1	12,00,000	4,00,000	10
Technology 2	20,00,000	6,00,000	10
Technology 3	18,00,000	5,00,000	10

Or

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

Manufacturer	Down payment (Rs.)	Yearly equal installment (Rs.)	No. of installments
1	5,00,000	2,00,000	15
2	4,00,000	3,00,000	15
3	6,00,000	1,50,000	15

Determine the best alternative based on the annual equivalent method by assuming $i = 20\%$, compounded annually. (16)

14. (a) (i) Write short notes on 'economic life' of an equipment. (8)
- (ii) A firm is considering replacement of equipment, whose first cost is Rs. 4,000 and the scrap value is negligible at the end of any year. Based on experience, it was found that the maintenance cost is zero during the first year and it increases by Rs. 200 every year thereafter. When should the equipment be replaced if $i = 0\%$? (8)

Or

- (b) Two years ago, a machine was purchased at a cost of Rs. 2,00,000 to be useful for eight years. Its salvage at the end of its life is Rs. 25,000. The annual maintenance cost is Rs. 25,000. The market value of the present machine is Rs. 1,20,000. Now, a new machine to cater to the need of the present machine is available at Rs. 1,50,000 to be useful for six years. Its annual maintenance cost is Rs. 14,000. The salvage value of the new machine is Rs. 20,000. Using an interest rate of 12%, find whether it is worth replacing the present machine with the new machine. (16)

15. (a) (i) Distinguish between declining balance method of depreciation and double declining balance method of depreciation. (8)
- (ii) A company has purchased an equipment whose first cost is Rs. 1,00,000 with an estimated life of eight years. The estimated salvage value of the equipment at the end of its lifetime is Rs. 20,000. Determine the depreciation charge and book value at the end of various years using the straight line method of depreciation. (8)

Or

- (b) A state government is planning a hydroelectric project for a river basin. In addition to the production of electric power, this project will provide flood control, irrigation and recreation benefits. The estimated benefits and the cost that are expected to be derived from this project are as follows:

Initial cost = Rs. 8,00,00,000

Annual power sales = Rs. 60,00,000

Annual flood control savings = Rs. 30,00,000

Annual irrigation benefits = Rs. 50,00,000

Annual recreation benefits = Rs. 20,00,000

Annual operating and maintaining cost = Rs.30,00,000

Life of the project = 50 years

Check whether the state government should implement the project
(assume $i = 12\%$). (16)

31603

PART B — (5 × 16 = 80 marks)

11. (a) Write on : Break Even Analysis, Engineering and Economic Efficiency, costs that go into the fixing of product cost. (16)

Or

- (b) (i) From the following information relating to Geetha Ltd., you are required to find out (12)

- (1) P/V ratio;
- (2) BEP;
- (3) Profit;
- (4) Margin of safety.

Total Fixed cost Rs. 4,500

Total Variable cost Rs. 7,500

Total Sales Rs. 15,000

- (ii) Also calculate the volume of sales to earn profit of Rs. 6,000. (4)

12. (a) (i) Explain the criteria for make or buy decision and its approach. (10)

- (ii) Write the equation for Interest compounding of a capital (Yearly, half yearly and Quarterly compounding). (6)

Or

- (b) The management of a company finds that while the cost of making a component part is Rs. 10, the same is available in the market at Rs.9 with an assurance of continuous supply.

Give a suggestion whether to make or buy this part. Give also your views in case the supplier reduces the price from Rs. 9 to Rs.8. (16)

The cost information is as follows :

Particulars	Rs.
Material	3.50
Direct Labour	4.00
Other variable expenses	1.00
Fixed expenses	1.50
Total	10.00

13. (a) Explain the concept Cash flow and different methods of comparison of alternatives. List the merits and Limitation of each method if any.

Or

- (b) Calculate the Average rate of return for projects A and B from the following :

Project	A	B
Investment Rs.	20,000	30,000
Expected life	4 years	5 years

No salvage value.

Projected Net Income (after interest, depreciation and taxes)

Years	Project A Rs.	Project B Rs.
1	2,000	3,000
2	1,500	3,000
3	1,500	2,000
4	1,000	1,000
5	-	1,000
	<u>6,000</u>	<u>10,000</u>

14. (a) (i) What do you mean by Replacement and maintenance Analysis? State and explain different types of replacement. (12)
- (ii) Explain the concept of Life Cycle Analysis cost. (4)

Or

- (b) (i) What are the objectives of plant maintenance? Explain different types of maintenance adopted on an industry. (10)
- (ii) Explain concept of Challenger and Defender. (6)

15. (a) (i) What is functional Depreciation?
- (ii) A company purchased Machinery for Rs.1,00,000. Its installation costs amounted to Rs.10,000. Its estimated life is 5 years and the scrap value is Rs.5,000. Calculate the amount and rate of depreciation. (12)

Or

- (b) (i) What do you mean by depreciation? Explain any 4 methods with example. (10)
- (ii) Write on : Inflation, Accelerated Depreciation. (6)

21603

PART B — (5 × 16 = 80 marks)

11. (a) Krishna Company Ltd. have the following details:
- | | | |
|------------------------|---|---------------|
| Fixed cost | = | Rs. 40,00,000 |
| Variable cost per unit | = | Rs. 300 |
| Selling price per unit | = | Rs. 500 |

Find

- (i) The break-even sales quantity
- (ii) The break-even sales
- (iii) If the actual production quantity is 1,20,000, find the following :
 - (1) Contribution
 - (2) Margin of safety by all methods.

Or

- (b) (i) Define break-even point. Draw a break-even chart and explain its components. (8)
- (ii) Discuss the factors which influence demand and supply. (8)

12. (a) (i) Discuss the symptoms favoring the application of VA/VE. (6)
- (ii) A person is planning for his retired life. He has 10 more years of service. He would like to deposit 20% of his salary, which is Rs. 4,000, at the end of the first year, and thereafter he wishes to deposit the amount with an annual increase of Rs. 500 for the next 9 years with an interest rate of 15%. Find the total amount at the end of the 10th year of the above series. (10)

Or

- (b) (i) A company has to replace a present facility after 15 years at an outlay of Rs. 5,00,000. It plans to deposit an equal amount at the end of every year for the next 15 years at an interest rate of 18% compounded annually. Find the equivalent amount that must be deposited at the end of every year for the next 15 years. (10)
- (ii) Discuss the advantages and application areas of values engineering. (6)

13. (a) A company must decide whether to buy machine A or machine B:

	Machine A	Machine B
Initial cost	Rs. 4,00,000	Rs. 2,00,000
Useful life, in years	4	4
Salvage value at the end of machine life	Rs. 2,00,000	Rs. 5,50,000
Annual maintenance cost	Rs. 40,000	0

At 12% interest rate, which machine should he selected? (Use future worth method of comparison).

Or

- (b) A transport company has been looking for a new tyre for its truck and has located the following alternatives :

Brand	Tyre warranty (month)	Price per tyre (Rs.)
A	12	1,200
B	24	1,800
C	36	2,100
D	48	2,700

If the company feels that the warranty period is a good estimate of the tyre life and that a nominal interest rate (compounded annually) of 12% is appropriate, which tyre should it buy?

14. (a) A diesel engine was installed 10 years ago at a cost of Rs. 50,000. It has a present realizable market value of Rs.15,000. If kept, it can be expected to last five years more, with operating and maintenance cost of Rs. 14,000 per year and to have a salvage value of Rs. 8,000 at the end of the fifth year. This engine can be replaced with an improved version costing Rs. 65,000, which has an expected life of 20 years. This improved version will have an estimated annual operating and maintenance cost of Rs. 9,000 and ultimate salvage value of Rs. 13,000. Using an interest rate of 15%, make an annual equivalent cost analysis to determine whether to keep or replace the old engine.

Or

- (b) An electronic equipment contains 1,000 resistors. When any resistor fails, it is replaced. The cost of replacing a resistor individually is Rs. 10. If all the resistors are replaced at the same time, the cost per resistor is Rs. 4. The per cent surviving, $S(i)$ at the end of month i is tabulated as follows :

i	0	1	2	3	4	5	6
$S(i)$	100	96	89	68	37	13	0

Which is the optimum replacement plan?

15. (a) (i) A company has purchased an equipment whose first cost is Rs. 1,00,000 with an estimated life of eight years. The estimated salvage value of the equipment at the end of its lifetime is Rs. 20,000. Determine the depreciation charge and book value at the end of various years using the straight-line method of depreciation. (6)
- (ii) A company has purchased a bus for its officers for Rs. 10,00,000. The expected life of the bus is eight years. The salvage value of the bus at the end of its life is Rs. 1,50,000. Find the following using the sinking fund method of depreciation :
- (1) Depreciation at the end of the third and fifth year
 - (2) Book value at the end of the second year and sixth year. (10)

Or

11556

- (b) (i) An automobile company has purchased a wheel alignment device for Rs. 10,00,000. The device can be used for 15 years. The salvage value at the end of the life of the device is 10% of the purchase value. Find the following using the double declining balance method of depreciation:
- (1) Depreciation at the end of the seventh year
 - (2) Depreciation at the end of the twelfth year
 - (3) Book value at the end of the eighth year (10)
- (ii) The first coat of a road laying machine is Rs. 80,00,000. Its salvage value after five years is Rs. 50,000. The length of road that can be laid by the machine during its lifetime is 75,000 km. In its third year of operation, the length of road laid is 2,000 km. Find the depreciation of the equipment for that year. (6)