

DEVELOPMENTS IN THE BUSINESS ENVIRONMENT

BASIC CONCEPTS AND FORMULAE

1. TOTAL QUALITY MANAGEMENT

TQM is a systematic process for identifying and implementing solution & prioritized opportunities for improvement.

The TQM approach highlights the need for a customer oriented approach to management reporting, eliminating some of our more traditional reporting practices. Performance measurement and quality improvement are not the sole domain of manufacturing industry, but detailed applications of the new management accounting practices to the professional service environment.

1.1 Six C's Of TQM

- i) *Commitment*
- ii) *Culture*
- iii) *Continuous improvement.*
- iv) *Co-operation*
- v) *Customer focus*
- vi) *Control*

2. ACTIVITY BASED COST MANAGEMENT (ABM)

The use of ABC as a costing tool to manage costs at activity level is known as Activity Based Cost Management (ABM). ABM is a discipline that focuses on the efficient and effective management of activities as the route to continuously improving the value received by customers. ABM utilizes cost information gathered through ABC. It determines what drives the activities of the organization and how these activities can be improved to increase the profitability.

2.1 Core Areas In Activity Based Cost Management

- **Cost Object**—It is an item for which cost measurement is required e.g. a product or a customer.

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- **Cost Driver**—It is a factor that causes a change in the cost of an activity. There are two categories of cost driver:
- **Resource Cost Driver**—It is a measure of the quantity of resources consumed by an activity. It is used to assign the cost of a resource to an activity or cost pool.
- **Activity Cost Driver**—It is a measure of the frequency and intensity of demand, placed on activities by cost objects. It is used to assign activity costs to cost objects.

2.2 Stages In Activity Based Costing

These stages are:

- i) Identification of the activities that have taken place in the organisation.
- ii) Assigning costs to cost pool for each activity.
- iii) Spreading of support activities across the primary activities.
- iv) Determining cost driver for each activity.
- v) Assigning the costs of activities to products according to product demand for activities.

2.3 Value-added activities (VA): The value-added activities are those activities which are necessary for the performance of the process. Such activities represents work that is valued by the external or internal customer. The customers are usually willing to pay (in some way) for the service. For example polishing a furniture by a manufacturer dealing in furniture is value added activity.

2.4 Non-value-added activities (NVA) : The NVA activity represents work that is not valued by the external or internal customer. NVA activities do not improve the quality or function of a product or service, but they can adversely affect costs and prices. Non-value added activities create waste, result in delay of some sort, add costs to the products or services and for which the customer is not willing to pay. Moving materials and machine set up for a production run are examples of NVA activities.

2.5 Business Application of ABM

- (i) *Cost reduction*
- (ii) *Activity Based Budgeting*

- (iii) *Business process re-engineering*
- (iv) *Benchmarking*
- (v) *Performance measurement*

3. ACTIVITY BASED BUDGETING (ABB)

Activity-based budgeting is a process of planning and controlling the expected activities for the organisation to derive a cost-effective budget that meets forecast workload and agreed strategic goals. An activity-based budget is a quantitative expression of the expected activities of the firm, reflecting management's forecast of workload and financial and non-financial requirements to meet agreed strategic goals and planned changes to improve performance.

3.1 Key Elements of ABB

- (i) type of work/activity to be performed;
- (ii) quantity of work/activity to be performed; and
- (ii) cost of work/activity to be performed.

4. TARGET COSTING

It can be defined as "a structured approach to determining the cost at which a proposed product with specified functionality and quality must be produced, to generate a desired level of profitability at its anticipated selling price". It is an important part of a comprehensive management process aimed at helping an organization to survive in an increasingly competitive environment. In this sense the term "target costing" is a misnomer:

4.1 Features of Target Costing System

1. Target costing is viewed as an integral part of the design and introduction of new products
2. For any given product, a target selling price is determined using various sales forecasting techniques.
3. Integral to setting the target selling price is the establishment of target production volumes, given the relationship between price and volume.
4. The next stage of the target costing process is to determine cost reduction targets.
5. It should be noted that a fair degree of judgement is needed where the allowable cost and the target cost differ.

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6. The total target is broken down into its various components, each component is studied and opportunities for cost reductions are identified. These activities are often referred to as *value engineering* (VE) and *value analysis* (VA).

4.2 Problems with Target Costing

1. The development process can be lengthened to a considerable extent since the design team may require a number of design iterations before it can devise a sufficiently low-cost product that meets the target cost and margin criteria.
2. A large amount of mandatory cost cutting can result in finger-pointing in various parts of the company, especially if employees in one area feel they are being called on to provide a disproportionately large part of the savings.
3. Representatives from number of departments on the design team can sometimes make it more difficult to reach a consensus on the proper design

4.3 Most Useful Situations for Target Costing

Target costing is most useful in situations where the majority of product costs are locked in during the product design phase. This is the case for most manufactured products, but few services.

4.4 Impact of Target Costing on Profitability

Target costing improves profitability in two ways.

1. It places such a detailed continuing emphasis on product costs throughout the life cycle of every product that it is unlikely that a company will experience runaway costs;
2. It improves profitability through precise targeting of the correct prices at which the company feels it can field a profitable product in the marketplace that will sell in a robust manner.

5. LIFE CYCLE COSTING

CIMA defines life cycle costing as the practice of obtaining over their life time, the best use of physical asset at the lowest cost of entity.

Life cycle costing is different to traditional cost accounting system which report cost object profitability on a calendar basis i.e. monthly, quarterly and annually. In contrast life cycle costing involves tracing cost and revenues on a product by product bases over several calendar periods.

5.1 Phases in the Life Cycle of a Product

The life cycle of a product consists of four phases viz.,
Introduction;

1. Growth
2. Maturity
3. Saturation
4. Decline

5.2 Characteristics of Product Life Cycle

The major characteristics of product life-cycle concept are as follows :

- (i) The products have finite lives and pass through the cycle of development, introduction, growth, maturity, decline and deletion at varying speeds.
- (ii) Product cost, revenue and profit patterns tend to follow predictable courses through the product life cycle.
- (iii) Profit per unit varies as products move through their life cycles.
- (iv) Each phase of the product life-cycle poses different threats and opportunities that give rise to different strategic actions.
- (v) Products require different functional emphasis in each phase-such as an R&D emphasis in the development phase and a cost control emphasis in the decline phase.
- (vi) Finding new uses or new users or getting the present users to increase their consumption may extend the life of the product.

6. VALUE CHAIN ANALYSIS

Value chain analysis requires a strategic framework or focus for organising internal and external information, for analysing information, and for summarising findings and recommendations. Because value chain analysis is still evolving, no uniform practices have yet been established. However, borrowing recent concepts from strategists and organisation experts, three useful strategic frameworks for value chain analysis are

6.1 Steps in the Value Chain Analysis

The way the value chain approach helps these organisations to assess competitive advantage includes the use of following steps of analysis :

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- (i) **Internal cost analysis** :rganisations use the value chain approach to identify sources of profitability and to understand the cost of their internal processes or activities. The principal steps of internal cost analysis are:
 - 1. Identify the firm's value-creating processes.
 - 2. Determine the portion of the total cost of the product or services attributable to each value-creating process.
 - 3. Identify the cost drivers for each process.
 - 4. Identify the links between processes.
 - 5. Evaluate the opportunities for achieving relative cost advantage.
- (ii) **Internal differentiation analysis** — to understand the sources of differentiation (including the cost) within internal value-creating processes; and
- (iii) **Vertical linkage analysis** — to understand the relationships and associated costs among external suppliers and customers in order to maximise the value delivered to customers and to minimise cost.
- (iv) **Core Competencies Analysis** — Core competencies should tie together the portfolio of end products and help a firm excel in dominating its industry. Core competencies need to be continually validated. In the early 1970s, Timex held half of the global market for watches with its core competence in low-cost management of precision manufacturing. By the mid-1970, the watch industry moved to digital technology, making Timex's core competence irrelevant.

7. COST CONTROL AND COST REDUCTION

7.1 Cost Control

Cost Control involves continuous comparisons of actual with the standards or budgets to regulate the former. Standards or budgets once set up are not attended during the period or until some mistakes are discovered in standards.

7.2 Cost reduction

Cost reduction is the achievement of real and permanent reduction in unit cost of products manufactured. It, therefore, continuously attempts to achieve genuine savings in cost of production distributing, selling and

administration. It does not accept a standard or budget as or fined. It rather challenges the standards/budgets continuously to make improvement in them. It attempts to excavate, the potential savings buried in the standards by continuous and planned efforts. Cost control relax that dynamic approach, it usually dealt with variances leaving the standards intact.

8. COMPUTER -AIDED MANUFACTURING

Computer-aided manufacturing process is carried out by a range of machinery together with its concomitant software. Maximum elements of CAM are computer numerical control (CNC) and robotics.

CNC machines are programmable machine tools. These are capable of performing a number of machining tasks, e.g. cutting, grinding, moulding, bending etc. Human operators will tire and are error prone. CNC machines are able to repeat the same operation continuously in identical manner, with high accuracy level.

9. JUST IN TIME

A complete JIT system begins with production, includes deliveries to a company's production facilities, continues through the manufacturing plant, and even includes the types of transactions processed by the accounting system. Most important in JIT system is to ensure receiving of products/spare parts/materials from its suppliers on the exact date and at the exact time when they are needed in order to reduce excessive inventory in stock.

9.1 Steps in JIT

- Evaluation of supplier by purchase staff in regards to quality of supply and reliability.
- Visit of supplier site and inspection of supply quality there to ensure quality and time etc
- A small cluster of machines are operated who can monitor each output part from machine to machine within the cell and can immediately identify defective output
- Empowered workforce are allowed to stop their machines when they see a problem and take all action for immediate resolution of the bulk of performance problems.

9.2 Reduction of following inventory costs though JIT :

- Interest cost related to the debt that funds the inventory investment
- Cost of inventory that becomes obsolete over time

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- Cost of rent for inventory storage facilities
- Cost of all equipment used in the warehouse
- Cost of warehouse utilities
- Cost of warehouse employees
- Cost of insurance needed to cover the possible loss of inventory

9.3 Backflushing in a JIT System

Backflushing requires no data entry of any kind until a finished product is completed. At that time the total amount finished is entered into the computer system, which multiplies it by all the components listed in the bill of materials for each item produced. This yields a lengthy list of components that should have been used in the production process and which is subtracted from the beginning inventory balance to arrive at the amount of inventory that should now be left of hand. Back the entire production process. Given the large transaction volumes associated with JIT, this is an ideal solution to the problem.

10. MANUFACTURING RESOURCES PLANNING

It is a part of production operation system. In early 1960's a material acquisition plan was first introduced known as Material Requirement Plan (MRP-I). MRP-2 is latest all-round development of that plan.

10.1 Objective of material requirement planning:

- i) Determine for final products namely, what should be produced and at what time.
- ii) Ascertaining the required units of production of sub-assemblies.
- iii) Determining the requirement for materials based on an up-to-date bill of materials file (BOM).
- iv) Computing inventories, WIP, batch sizes and manufacturing and packaging lead times.
- v) Controlling inventory by ordering bought-in components and raw materials in relation to the orders received or forecast rather than the more usual practice of ordering from stock-level indicators.

11. SYNCHRONOUS MANUFACTURING

It has been defined as: an all-encompassing manufacturing management philosophy that includes a consistent set of principles, procedures, and

techniques where every action is evaluated in terms of the common global goal of the organization.

11.1 Principles Associated With Synchronous Manufacturing

1. Do not focus on balance idle capacities; focus on synchronizing the production flow.
2. The marginal value of time at a bottleneck resource is equal to the throughput rate of the products processed by the bottleneck.
3. The marginal value of time at a non-bottleneck resource is negligible.
4. The level of utilization of a non-bottleneck resource is controlled by other constraints within the system.
5. Resources must be utilized, not simply activated.
6. A transfer batch may not, and many times should not, be equal to the process batch.
7. A process batch should be variable both along its route and over time.

12. BUSINESS PROCESS RE-ENGINEERING

Business process re-engineering involves examining business processes and making substantial changes in the day to day operation of the organization. It involves the redesign of work by changing the activities.

12.1 Aim of Business Process Re-Engineering

The aim of business process re-engineering is to improve the key business process in an organization by focusing on

- (a) simplification,
- (b) cost reduction,
- (c) improved quality and
- (d) enhanced customer satisfaction

14. THROUGHPUT ACCOUNTING

Throughput Accounting (TA) is a method of performance measurement which relates production and other costs to throughput. Throughput accounting product costs relate to usage of key resources by various products. It assumes that a manager has a given set of resources available and these have been efficiently used to process purchased materials and components to generate sales revenue.

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The cost of all other is deemed at least time related rather than fixed.

Throughput is influenced by:

- Selling price
- Direct purchase price
- Usage of direct materials
- Volume of throughput.

14.1 Constraints on Throughput

- the existence of an uncompetitive selling price
- the need to deliver on time to particular customers
- the lack of product quality and reliability
- the lack of reliable materials suppliers
- the existence of shortage of production resources.

15. THEORY OF CONSTRAINTS

The theory of constraint focuses its attention on constraints and bottlenecks within the organization which hinder speedy production. The main concept is to maximize the rate of manufacturing output i.e. the throughput of the organisation. This requires to examine the bottlenecks and constraints.

15.1 Bottlenecks

A bottleneck is an activity within the organisation where the demand for that resource is more than its capacity to supply. A constraint is a situational factor which makes the achievement of objectives/throughput more difficult than it would otherwise be.

15.2 Constraints

Constraints may take several forms such as lack of skilled employees, lack of customers orders or the need to achieve a high level of quality product output. Using above definition, therefore, a bottleneck is always a constraint but a constraints need not be a bottleneck.

15.3 Idea of theory of constraints (TOC)

The theory of constraints (TOC) describes methods to maximize operating income under bottleneck situation. The objective of TOC is to increase throughput contribution while decreasing investments and operating costs. TOC considers a short run time and assumes that operating costs are fixed costs.

The three measurements:

1. Calculate Throughput contribution = sale - direct materials cost of the goods sold.
2. Investments = Sum of materials costs in direct materials, work – in – process, and finished goods inventories; R & D costs; and costs of equipment and buildings.
3. Operating costs equal all costs of operations (other than direct materials) incurred to earn throughput contribution. Operating costs include salaries and wages, rent utilities, and depreciation.

The important concept behind TOC is that the production rate of the entire factory is set at the pace of the bottleneck resource. Hence, in order to achieve the best result TOC emphasises the importance of removing bottlenecks or limiting factor.

THE IMPACT OF CHANGING ENVIRONMENT ON COST AND MANAGEMENT ACCOUNTING

Question 1

How has the composition of manufacturing costs changed during recent years? How has this change affected the design of cost accounting systems?

Answer

Traditionally, manufacturing companies classified the manufacturing costs to be allocated to the products into (a) direct materials. (b) direct labour and (c) indirect manufacturing costs. In the present day context, characterised by intensive global competition, large scale automation of manufacturing process, computerization and product diversification to cater to the changing consumer tastes and preferences has forced companies to refine their costing systems to provide better measurement of the overhead costs used by different cost objects. Accordingly, manufacturing costs are classified in to three broad categories as under:

1. *Direct cost:* As many total costs relating to cost objects as feasible are classified into direct cost. The objective is to trace as many costs as possible in to direct and to reduce the amount of costs classified into indirect because the greater the proportion of direct costs the greater the accuracy of the cost system.
2. *Indirect cost pools:* Increase the number of indirect cost pools so that each of these pools is more homogeneous. In a homogeneous cost pool, all the costs will have the same cause-and-effect relationship with the cost allocation base.

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3. Use cost-and-effect criterion for identifying the cost allocation base for each indirect cost pool.

The change in the classification of manufacturing costs as above has lead to the development of Activity Based Costing (ABC). Activity Based Costing refines a costing system by focusing on individual activities as the fundamental cost objects. An activity is an event, task or unit of work with a specified purpose as for example, designing, set up, etc. ABC system calculates the costs of individual activities and assigns costs to cost objects such as products or services on the basis of the activities consumed to produce the product or provide the service.

TOTAL QUALITY MANAGEMENT**Question 2**

Carlton Ltd. makes and sells a single product; the unit specifications are as follows:

<i>Direct Materials X</i>	<i>:</i>	<i>8 sq. metre at Rs 40 per square metre</i>
<i>Machine Time</i>	<i>:</i>	<i>0.6 Running hours</i>
<i>Machine cost per gross hour</i>	<i>:</i>	<i>Rs. 400</i>
<i>Selling price</i>	<i>:</i>	<i>Rs. 1,000</i>

Carlton Ltd. requires to fulfil orders for 5,000 product units per period. There are no stock of product units at the beginning or end of the period under review. The stock level of material X remains unchanged throughout the period.

Carlton Ltd. is planning to implement a Quality Management Programme (QPM). The following additional information regarding costs and revenues are given as of now and after implementation of Quality Management Programme.

<i>Before the implementation of QMP</i>	<i>After the implementation</i>
<i>1. 5% of incoming material from suppliers scrapped due to poor receipt and storage organisation.</i>	<i>1. Reduced to 3%.</i>
<i>2. 4% of material X input to the machine process is wasted due to processing problems.</i>	<i>2. Reduced to 2.5%</i>
<i>3. Inspection and storage of Material X costs Re. 1 per square metre purchased.</i>	<i>3. No change in the unit rate</i>
<i>4. Inspection during the production cycle, calibration checks on inspection equipment vendor rating and other checks cost Rs.</i>	<i>4. Reduction of 40% of the existing cost.</i>

2,50,000 per period

- | | |
|--|--------------------------------------|
| 5. Production Qty. is increased to allow for the downgrading of 12.5% of the production units at the final inspection stage. Down graded units are sold as seconds at a discount of 30% of the standard selling price. | 5. Reduction to 7.5% |
| 6. Production Quantity is increased to allow for return from customers (these are replaced free of charge) due to specification failure and account for 5% of units actually delivered to customer. | 6. Reduction to 2.5% |
| 7. Product liability and other claims by customers is estimated at 3% of sales revenue from standard product sale. | 7. Reduction to 1%. |
| 8. Machine idle time is 20% of Gross machine hrs used (i.e. running hour = 80% of gross/hrs.). | 8. Reduction to 12.5%. |
| 9. Sundry costs of Administration, Selling and Distribution total – Rs. 6,00,000 per period. | 9. Reduction by 10% of the existing. |
| 10. Prevention programme costs Rs. 2,00,000 | 10. Increase to Rs. 6,00,000. |

The Total Quality Management Programme will have a reduction in Machine Run Time required per product unit to 0.5 hr.

Required:

- Prepare summaries showing the calculation of (i) Total production units (pre inspection), (ii) Purchase of Materials X (square metres), (iii) Gross Machine Hours.
- In each case, the figures are required for the situation both before and after the implementation of the Quality Management Programme so that orders for 5,000 product units can be fulfilled.

Prepare Profit and Loss Account for Carlon Ltd. for the period showing the profit earned both before and after the implementation of the Total Quality Programme.

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Answer

(a)

	Existing		After TQM Programme
i. Total production units (Preinspection)			
Total sales requirements	5,000		5,000
Specification losses 5%	250	2.5%	125
	5,250		5,125
Downgrading at inspection	750		416
$\frac{12.5}{87.5} \times 5,250$		$\frac{7.5}{92.5} \times 5,125$	
Total units before inspection	6,000		5,541
ii Purchase of material 'X' (Sq Mtr)			
Material required to meet pre inspection production requirement $6,000 \times 8 \text{ SqMtr}$	48,000 SqMtr	$5,541 \times 8 \text{ SqMtr}$	44,328 SqMtr
Processing loss $\frac{4}{96} \times 48,000$	2,000		1,137
		$\frac{2.5}{97.5} \times 44,328$	
Input to the process	50,000		45,465
Scrapped material $\frac{5}{95} \times 50,000$	2,632		1,406
		$\frac{3}{97} \times 45,465$	
Total purchases	52,632		46,871
iii Gross Machine Hours			
Initial requirements $6,000 \times 0.6$	3,600	$5,541 \times 0.5$	2,771
Idle time $\frac{20}{80} \times 3,600$	900	$\frac{12.5}{87.5} \times 2,771$	396
Gross time	4,500		3,167

(b)	Profit and loss statement	
	Rs	Rs
Sales revenue 5,000 Units× Rs 1,000	50,00,000	50,00,000
Sales downgraded 750 Units×Rs 700	5,25,000 416 Units × Rs 700	2,91,200
	55,25,000	52,91,200
Costs:		
Material 52,632 Sq Mtr ×Rs 40	21,05,280 46,871Sq Mtr × Rs 40	18,74,840
Inspection and storage costs 52,632 Sq Mtr ×Re 1	52,632 46,871Sq Mtr × Re 1	46,871
Machine cost 4,500 Hrs × Rs 400	18,00,000 3,167 Hrs× Rs 400	12,66,800
Inspection and other cost	2,50,000 2,50,000 × 60%	1,50,000
Product liability (3% × 50,00,000	1,50,000 1% × 50,00,000	50,000
Sundry cost of selling, distribution and administration.	6,00,000 6,00,000 × 90%	5,40,000
Preventive programme cost	2,00,000	6,00,000
	51,57,912	45,28,511
Net profit	3,67,088	7,62,689

Question 3

What are the essential requirements for successful implementation of TQM?

Answer

Commitment: Quality improvement must be everyone's job. Clear commitment from the top management, steps necessary to provide an environment for changing attitudes and breaking down barriers to quality improvement must be provided. Support and training for this must be extended.

Culture: Proper training must be given to effect changes in culture and attitude.

Continuous Improvement: Recognition of room for improvement continually as a process, and not merely a one-off programme.

Cooperation: Must be ensured by involving employees by resorting to mutually agreeable improvement strategies and associated performance measures.

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Customer Focus: Perfect service with zero defectives with satisfaction to end user whether external customer or internal customer.

Control: Documentation, procedures and awareness of current practices ensure checking deviation from the intended course of implementation.

Question 4

Discuss the benefits accruing from the implementation of a Total Quality Management programme in an organization.

Answer

The benefits accruing from the implementation of a Total Quality Management programme in an organisation are:

- (i) There will be increased awareness of quality culture in the organization.
- (ii) It will lead to commitment to continuous improvement.
- (iii) It will focus on customer satisfaction.
- (iv) A greater emphasis on team work will be achieved.

Question 5

TQ Ltd. implemented a quality improvement programme and had the following results:

	2007	2008
	<i>(Figures in Rs. '000)</i>	
Sales	6,000	6,000
Scrap	600	300
Rework	500	400
Production inspection	200	240
Product warranty	300	150
Quality training	75	150
Materials inspection	80	60

You are required to:

- (i) *Classify the quality costs as prevention, appraisal, internal failure and external failure and express each class as a percentage of sales.*
- (ii) *Compute the amount of increase in profits due to quality improvement.*

Answer**(i) Classification of Quality Costs**

	Figures Rs. '000			
	2007	% of sales	2008	% of sales
Sales	<u>6,000</u>		<u>6,000</u>	
Prevention				
Quality training	<u>75</u>	1.25	<u>150</u>	2.5
Appraisal				
Product Inspection	<u>200</u>		<u>240</u>	
Materials Inspection	<u>80</u>		<u>60</u>	
	<u>280</u>	4.67	<u>300</u>	5
Internal Failure				
Scrap	<u>600</u>		<u>300</u>	
Rework	<u>500</u>		<u>400</u>	
	<u>1100</u>	18.33	<u>700</u>	11.67
External Failure				
Product warranty	<u>300</u>	5	<u>150</u>	<u>2.5</u>
	<u>1755</u>	29.25	<u>1300</u>	<u>21.67</u>

- (ii) Cost reduction was effected by 7.58% (29.25 – 21.67) of sales, which is an increase in profit by Rs.4,55,000.

Question 6

What are the critical success factors for the implementation of a “Total Quality Management” programme?

Answer

Critical success factors of TQM:

- Focus on customer needs.
- Everyone in the organisation should be involved.
- Focus on continuous improvement.
- Design quality in product and production process.

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- Effective performance measurement system.
- Rewards and performance measurements should be renewed.
- Appropriate training and education to everyone to understand the aim of TQM.

Question 7

Explain four P's of quality improvement principles.

Answer

The Four P's quality improvement principles are as below:

1. *People*: It will quickly become apparent that some individuals are not ideally suited to the participatory process. Lack of enthusiasm will be apparent from a generally negative approach and a tendency to have prearranged meeting which coincide with the meetings of TOM teams.
2. *Process*: The rhetoric and inflexibility of a strict Deming approach will often have a demotivating effect on group activity.
3. *Problem*: Experience suggests that the least successful groups are those approaching problems that are deemed to be too large provide meaningful solutions within a finite time period.
4. *Preparation*: A training in the workings of Deming- like processes is an inadequate preparation for the efficient implementation of a quality improvement process.

ACTIVITY BASED COST MANAGEMENT

Question 8

ABC electronics makes audio player model 'AB 100'. It has 80 components. ABC sells 10,000 units each month at Rs.3,000 per unit. The cost of manufacturing is Rs.2,000 per unit or Rs.200 lakhs per month for the production of 10,000 units. Monthly manufacturing costs incurred are as follows:

	(Rs. Lakhs)
Direct material costs	100.00
Direct manufacturing labour costs	20.00
Machining costs	20.00
Testing costs	25.00
Rework costs	15.00
Ordering costs	0.20

*Engineering costs*19.80200.00

Labour is paid on piece rate basis. Therefore, ABC considers direct manufacturing labour cost as variable cost.

The following additional information is available for 'AB 100'

- (i) Testing and inspection time per unit is 2 hours.*
- (ii) 10 per cent of 'AB 100' manufactured are reworked.*
- (iii) It currently takes 1 hour to manufacture each unit of 'AB 100'*
- (iv) ABC places two orders per month for each component. A different supplier supplies each component.*

ABC has identified activity cost pools and cost drivers for each activity. The cost per unit of the cost driver for each activity cost pool is follows:

<i>Manufacturing Activity</i>	<i>Description of activity</i>	<i>Cost driver</i>	<i>Cost per unit of cost driver</i>
1. Machine costs	Machining components	Machine hours of capacity	Rs.200
2. Testing costs	Testing components and finished products. (Each unit of 'AB 100' is tested individually)	Testing hours	Rs.125
3. Rework costs	Correcting and fixing errors and defects	Units of 'AB 100' reworked	Rs.1,500 per unit
4. Ordering costs	Ordering of components	Number of orders	Rs.125 per order
5. Engineering costs	Designing and managing of products and processes	Engineering hours	Rs.1,980 per engineering hour

Over a long-run horizon, each of the overhead costs described above vary with chosen cost drivers. In response to competitive pressure ABC must reduce the price of its product to Rs.600 and to reduce the cost by at least Rs.400 per unit. ABC does not anticipate increase in sales due to price reduction. However, if it does not reduce price it will not be able to maintain the current sales level.

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Cost reduction on the existing model is almost impossible. Therefore, ABC has decided to replace 'AB 100' by a new model 'AB 200', which is a modified versions of 'AB 100'. The expected effect of design modifications are as follows:

- (i) *The member of components will be reduced to 50.*
- (ii) *Direct material costs to be lower by Rs.200 per unit.*
- (iii) *Direct manufacturing labour costs to be lower by Rs.20 per unit.*
- (iv) *Machining time required to be lower by 20 per unit.*
- (v) *Testing time required to be lower by 20 per cent.*
- (vi) *Rework to decline to 5 per cent.*
- (vii) *Machining capacity and engineering hours capacity to remain the same.*

ABC currently out sources the rework on defective units.

Required:

- (i) *Compare the manufacturing cost per unit of 'AB 100' and 'AB 200'.*
- (ii) *Determine the immediate effect of design change and pricing decision on the operating to apply to 'AB 200'.*

Ignore income tax, Assume that the cost per unit of each cost driver for 'AB 100' continues to apply to 'AB 200'.

Answer

- (i) **Comparison of manufacturing cost per unit.**

	<i>Audio Player Model</i>	
	<i>'AB 100'</i>	<i>'AB 200'</i>
	<i>Rs.</i>	<i>Rs.</i>
Direct material cost	1,000.00	800.00
Direct manufacturing labour cost	200.00	180.00
Machining costs	200.00	160.00
Testing costs	250.00	200.00
Rework costs	150.00	75.00
Ordering costs	2.00	1.25
Engineering costs	<u>198.00</u>	<u>198.00</u>
Total manufacturing cost per unit	<u>2,000.00</u>	<u>1,614.25</u>

Working notes for audio player model 'AB 200'

- (i) Machining hours and cost: Machining hours = (1 hour – 0.20 hours) or 0.80 hours
Machining cost is 0.80 hours × Rs.200 or Rs.160
- (ii) Testing hours and cost: Testing hours = 2 hours × (1 hour – 0.20) or 1.60 hours.
Testing cost is 1.60 hours × Rs.125 or Rs.200
- (iii) Rework cost per unit:
Rework units = 5% × 10,000 units or 500 units. Rework cost = 500 units × Rs.1,500 or Rs.7,50,000. Rework cost per unit Rs.7,50,000 / 10,000 units or Rs.75 per unit.
- (iv) Ordering cost:
No. of orders per month 50 components × 2 orders = 100
Ordering cost per month 100 orders × Rs.125 per order = Rs.12,500
Ordering cost per unit = Rs.12,500 / 10,000 units = Rs.1.25 per unit.
- (v) It is assumed that total available engineering hours will be used for manufacturing 'AB 200' model of audio player.

(ii) Effect of design change and pricing decision on operating income of ABC.

(Rs. Lakhs)

Revenue loss on 10,000 units		(40)
(Rs.10,000 units × Rs.400)		
Saving in cost:		
Direct material costs	20.00	
(Rs.200 × 10,000 units)		
Direct manufacturing labour costs	2.00	
(Rs.20 × 10,000 units)		
Rework costs	<u>7.50</u>	<u>29.50</u>
(5% × 10,000 units × Rs.1,500)		
Net effect on operating income		<u>(10.50)</u>

Advanced Management Accounting

Conclusion:

Operating income per month will be reduced by Rs. 10.50 Lakhs.

Effects of reduction in components, machining time, and testing time will not have any immediate effect, because it is difficult to adjust the available facilities in ordering department, machining department and testing department.

Question 9

XYZ Ltd. manufactures four products, namely A, B, C and D using the same plant and process. The following information relates to a production period: (11 Marks)

Product	A	B	C	D
Output in units	720	600	480	504
Cost per unit:	Rs.	Rs.	Rs.	Rs.
Direct Material	42	45	40	48
Direct labour	10	9	7	8
Machine hours per unit	4 hrs.	3 hrs.	2 hrs.	1 hr.

The four products are similar and are usually produced in production runs of 24 units and sold in batches of 12 units. Using machine hour rate currently absorbs the production overheads. The total overheads incurred by the company for the period is as follows:

	Rs.
Machine operation and Maintenance cost	63,000
Setup costs	20,000
Store receiving	15,000
Inspection	10,000
Material handling and dispatch	2,592

During the period the following cost drivers are to be used for the overhead cost:

Cost	Cost driver
Setup cost	No. of production runs
Store receiving	Requisition raised
Inspection	No. of production runs
Material handling and dispatch	Orders executed

It is also determined that:

- Machine operation and maintenance cost should be apportioned between setup cost, store receiving and inspection activity in 4:3:2.
- Number of requisition raised on store is 50 for each product and the no. of order executed is 192, each order being for a batch of 12 of a product.

Required:

- Calculate the total cost of each product, if all overhead costs are absorbed on machine hour rate basis.
- Calculate the total cost of each product using activity base costing.
- Comment briefly on differences disclosed between overhead traced by present system and those traced by activity based costing.

Answer

(a) Total cost of different products (overhead absorption on Machine hour basis)

	A Rs.	B Rs.	C Rs.	D Rs.
Direct material	42	45	40	48
Direct labour	10	09	07	08
Overhead	72	54	36	18
Cost of production per unit	124	108	83	74
Out put in unit	720	600	480	504
Total cost	89,280	64,800	39,840	37,296

Machine hours $(720 \times 4 + 600 \times 3 + 480 \times 2 + 504 \times 1) = 6,144$ hours.

Rate per hour = $\frac{\text{Rs } 1,10,592}{6,144 \text{ hours}} = \text{Rs } 18 \text{ per hour.}$

(b) Activity based costing system

	Set up	Store receiving	Inspection
Machine operation and maintenance cost of Rs 63,000 to be distributed in the ratio of 4: 3: 2.	28,000	21,000	14,000

Advanced Management Accounting

Cost	Rs	Drivers	No	Cost per unit of driver (Rs)
Set up	48,000	Production runs	96	500
Store receiving	36,000	Requisitions raised	200	180
Inspection	24,000	Production runs	96	250
Material handling and disp	2,592	Orders	192	13.50

Production Run for A (720/24) = 30 ; B (600/24) = 25 ; C (480/24) = 20 ; D (504/24) = 21.

	A (Rs)	B(Rs)	C(Rs)	D(Rs)
Direct material	30,240	27,000	19,200	24,192
Direct labour	7,200	5,400	3,360	4,032
Setup	15,000	12,500	10,000	10,500
Store receiving	9,000	9,000	9,000	9,000
Inspection	7,500	6,250	5,000	5,250
Material handling and dispatch	810	675	540	567
Total cost	69,750	60,825	47,100	53,541
Per unit cost	96.875	101.375	98.125	106.23

(c)

	A	B	C	D
Cost per unit (a)	124	108	83	74
Cost per unit (b)	96.88	101.38	98.13	106.23
Difference	(27.12)	(6.62)	15.13	32.23

The total overheads which are spread over the four products have been apportioned on different bases, causing the product cost to differ substantially: in respect of product A and D a change from traditional machine hour rate to an activity system may have effect on price and profits to the extent that pricing is based on cost plus approach.

Question 10

During the last 20 years, KL Ltd's manufacturing operation has become increasingly automated with Computer-controlled robots replacing operators. KL currently manufactures over 100 products of varying levels of design complexity. A single plant

wise overhead absorption rate, based on direct labour hours, is used to absorb overhead costs.

In the quarter ended March, KL's manufacturing overhead costs were:

(Rs. '000)

Equipment operation expenses	125
Equipment maintenance expense	25
Wages paid to technicians	85
Wages paid to Store men	35
Wages paid to despatch staff	40
	310

During the quarter, the company reviewed the Cost Accounting System and concluded that absorbing overhead costs to individual products on a labour hour absorption basis is meaningless. Overhead costs should be attributed to products using an Activity Based Costing (ABC) system and the following was identified as the most significant activities:

- (i) Receiving component consignments from suppliers
- (ii) Setting up equipment for production runs
- (iii) Quality inspections
- (iv) Despatching goods as per customer's orders.

It was further observed that in the short-term KL's overheads are 40% fixed and 60% variable. Approximately, half the variable overheads vary in relating to direct labour hours worked and half vary in relation to the number of quality inspections.

Equipment operation and maintenance expenses are apportioned as:

- Component stores 15% , manufacturing 70% and goods dispatch 15%

Technician's wages are apportioned as:

- Equipment maintenance 30% , set up equipment for production runs 40% and quality inspections 30%

During the quarter:

- (i) a total of 2000 direct labour hours were worked (paid at Rs. 12 per hr.)
- (ii) 980 components consignments were received from suppliers
- (iii) 1020 production runs were set up
- (iv) 640 quality inspections were carried out

Advanced Management Accounting

(v) 420 orders were dispatched to customers.

KL's production during the quarter included components R, S and T. The following information is available:

	Component R	Component S	Component T
Direct labour Hrs worked	25	480	50
Direct Material	Rs. 1,200	Rs. 2,900	Rs. 1,800
Component Consignments Recd.	42	24	28
Production runs	16	18	12
Quality Inspections	10	8	18
Orders (goods) despatched	22	85	46
Quantity produced	560	12,800	2,400

Required:

- (1) Calculate the unit cost of R, S and T components, using KL's existing cost accounting system.
- (2) Explain how an ABC system would be developed using the information given. Calculate the unit cost of components R, S and T using ABC system.

Answer

- (1) Single factory direct labour hour overhead rate = $\frac{\text{Rs } 3,10,000}{2,000} = \text{Rs } 155$ per direct labour hour

Computation of unit cost (existing system)

	R (Rs)	S(Rs)	T(Rs)
Direct labour cost @ Rs 12 per hour	300	5,760	600
Direct material	1,200	2,900	1,800
Overheads(direct labour hours × Rs 155 per hour)	3,875	74,400	7,750
	5,375	83,060	10,150
Quantity Produced (No)	560	12,800	2,400
Cost per unit	9.60	6.49	4.23

(2) ABC system involves the following stages,

1. Identifying the major activities that take place in an organisation.
2. Creating a cost pool /cost centre for each activity
3. Determining the cost driver for each activity
4. Assigning the cost of activities to cost objects (e.g. products, components, customers etc)

The most significant activities have been identified e.g. receiving components consignments from suppliers, setting up equipment for production runs, quality inspections, and despatching orders to customers. The following shows the assignment of the costs to these activities,

(Rs ,000)

	<i>Receiving supplies</i>	<i>Set ups</i>	<i>Quality inspection</i>	<i>Despatch</i>	<i>Total</i>
Equipment operation expenses	18.75	87.50		18.75	125.00
Maintenance	3.75	17.50		3.75	25.00
Technicians wages initially allocated to Maintenance(30% of Rs 85,000= Rs 25,500 and then reallocated on same basis on maintenance)	3.83	17.85		3.82	25.50
Balance of technicians wages allocated to set ups and quality inspections		34.00	25.50		59.50
Stores wages - Receiving	35.00				35.00
Despatch wages - Despatch				40.00	40.00
	61.33	156.85	25.50	66.32	310.00

Note: Equipment operation expenses and Maintenance allocated on the basis 15%,70% and 15% as specified in the question.

Advanced Management Accounting

The next stage is to identify the cost drivers for each activity and establish cost driver rates by dividing the activity costs by a measure of cost driver usage for the period. The calculations are as follows:-

$$\text{Receiving supplies} \left(\frac{\text{Rs } 61,330}{980} \right) = \text{Rs } 62.58 \text{ per component.}$$

$$\text{Performing set ups} \left(\frac{1,56,850}{1,020} \right) = \text{Rs } 153.77 \text{ per set up}$$

$$\text{Despatching goods} \left(\frac{66,320}{420} \right) = \text{Rs } 157.93 \text{ per despatch}$$

$$\text{Quality inspection} \left(\frac{25,500}{640} \right) = \text{Rs } 39.84 \text{ per quality inspection}$$

Finally, costs are assigned to components based on their cost driver usage. The assignments are as follows,

	<i>R (Rs)</i>	<i>S(Rs)</i>	<i>T(Rs)</i>
Direct labour	300	5,760	600
Direct materials	1,200	2,900	1,800
Receiving supplies	2,628.36	1,501.92	1,752.24
Performing set ups	2,460.32	2,767.86	1,845.24
Quality inspections	398.40	318.72	717.12
Despatching goods	3,474.46	13,424.05	7,264.78
Total costs	10,461.54	26,672.55	13,979.38
No of units produced	560	12,800	2,400
Cost per unit	18.682	2.08	5.82

For components, the overhead costs have been assigned as follows,

(Component R)

Receiving supplies (42 receipts at Rs 62.58)

Performing set ups (16 production runs at Rs 153.77)

Quality inspections (10 at Rs 39.84)

Despatching goods (22 at Rs 157.93).

Question 11

Give two examples for each of the following categories in activity based costing:

- (i) Unit level activities
- (ii) Batch level activities
- (iii) Product level activities
- (iv) Facility level activities.

Answer

Examples:

- | | |
|-----------------------------|--|
| (i) Unit level activities | (i) Use of indirect materials |
| | (ii) Inspection or testing of every item produced or say every 100 th item produced |
| | (iii) Indirect consumables |
| (ii) Batch level activities | (i) Material ordering |
| | (ii) Machine set up costs |
| | (iii) Inspection of products—like first item of every batch |
| (iii) Product level | (i) Designing the product |
| | (ii) Producing parts to a certain specification |
| | (iii) Advertising costs, if advertisement is for individual products |
| (iv) Facility level | (i) Maintenance of buildings |
| | (ii) Plant security |
| | (iii) Production manager's salaries |
| | (iv) Advertising campaigns promoting the company |

Question 12

“Cost can be managed only at the point of commitment and not at the point of incidence. Therefore, it is necessary to manage cost drivers to manage cost.” Explain the statement with reference to structural and executional cost drivers.

Advanced Management Accounting

Answer

A firm commits costs at the time of designing the product and deciding the method of production. It also commits cost at the time of deciding the delivery channel (e.g. delivery through dealers or own retail stores). Costs are incurred at the time of actual production and delivery. Therefore, no significant cost reduction can be achieved at the time when the costs are incurred. Therefore, it is said that costs can be managed at the point of commitment. Cost drivers are factors that drive consumption of resources. Therefore, management of cost drivers is essential to manage costs. Structural cost drivers are those which can be managed by effecting structural changes. Examples of structural cost drivers are scale of operation, scope of operation (i.e. degree of vertical integration), complexity, technology and experience or learning. Thus, structural cost drivers arise from the business model adopted by the company. Executional cost drivers can be managed by executive decisions, examples of executional cost drivers are capacity utilization, plant layout efficiency, product configuration and linkages with suppliers and customers. It is obvious that cost drivers can be managed only at the point of structural and operating decisions, which commit resources to various activities.

Question 13

What is the fundamental difference between Activity Based Costing System (ABC) and Traditional Costing System? Why more and more organisations in both the manufacturing and non-manufacturing industries are adopting ABC?

Answer

In the traditional system of assigning manufacturing overheads, overheads are first allocated and apportioned to cost centres (production and support service cost centres) and then absorbed to cost objects (e.g. products). Under ABC, overheads are first assigned to activities or activity pools (group of activities) and then they are assigned to cost objects. Thus, ABC is a refinement over the traditional costing system. Usually cost centres include a series of different activities. If different products create different demands on those activities, the traditional costing system fails to determine the product cost accurately. In that situation, it becomes necessary to use different rates for different activities or activity pools.

The following are the reasons for adoption of ABC by manufacturing and non-manufacturing industries:

- (i) Fierce competitive pressure has resulted in shrinking profit margin. ABC helps to estimate cost of individual product or service more accurately. This helps to formulate appropriate marketing / corporate strategy.

- (ii) There is product and customer proliferation. Demand on resources by products / customers differ among product / customers. Therefore, product / customer profitability can be measured reasonably accurately, only if consumption of resources can be traced to each individual product / customer.
- (iii) New production techniques have resulted in the increase of the proportion of support service costs in the total cost of delivering value to customers. ABC improves the accuracy of accounting for support service costs.
- (iv) The costs associated with bad decisions have increased substantially.
- (v) Reduction in the cost of data processing has reduced the cost of tracking resources consumption to large number of activities.

Question 14

Biscuit Ltd. Manufactures 3 types of biscuits, A, B and C, in a fully mechanised factory. The company has been following conventional method of costing and wishes to shift to Activity Based Costing System and therefore wishes to have the following data presented under both the systems for the month.

<i>Inspection cost</i>	<i>Rs. p.m.</i>	<i>73,000</i>
<i>Machine – Repairs & Maintenance</i>	<i>Rs. p.m.</i>	<i>1,42,000</i>
<i>Dye cost</i>	<i>Rs. p.m.</i>	<i>10,250</i>
<i>Selling overheads</i>	<i>Rs. p.m.</i>	<i>1,62,000</i>

	<i>Product A</i>	<i>B</i>	<i>C</i>
<i>Prime cost (Rs. per unit)</i>	<i>12</i>	<i>9</i>	<i>8</i>
<i>Selling price (Rs. per unit)</i>	<i>18</i>	<i>14</i>	<i>12</i>
<i>Gross production (units/production run)</i>	<i>2,520</i>	<i>2,810</i>	<i>3,010</i>
<i>No. of defective units / production run</i>	<i>20</i>	<i>10</i>	<i>10</i>
<i>Inspection:</i>			<i>C</i>
<i>No. of hours / production run</i>	<i>3</i>	<i>4</i>	<i>4</i>
<i>Dye cost / production run (Rs.)</i>	<i>200</i>	<i>300</i>	<i>250</i>
<i>No. of machine hours / production run</i>	<i>20</i>	<i>12</i>	<i>30</i>
<i>Sales – No. of units / month</i>	<i>25,000</i>	<i>56,000</i>	<i>27,000</i>

The following additional information is given:

- (i) *No accumulation of inventory is considered. All good units produced are sold.*

Advanced Management Accounting

- (ii) All manufacturing and selling overheads are conventionally allocated on the basis of units sold.
- (iii) Product A needs no advertisement. Due to its nutritive value, it is readily consumed by diabetic patients of a hospital. Advertisement costs included in the total selling overhead is Rs. 83,000.
- (iv) Product B needs to be specially packed before being sold, so that it meets competition. Rs. 54,000 was the amount spent for the month in specially packing B, and this has been included in the total selling overhead cost given.

You are required to present productwise profitability of statements under the conventional system and the ABC system and accordingly rank the products.

Answer

Sales	A	B	C	Total
(i) Units Rs.	25,000	56,000	27,000	1,08,000
Selling price/unit	18	14	12	
(ii) Sales Value (Rs.)	4,50,000	7,84,000	3,24,000	15,58,000
(iii) Prime Cost Overhead	12	9	8	
(iv) No. of units/run	2,520	2,810	3,010	
(v) Prime Cost Rs.	3,02,400	5,05,800	2,16,720	
(vi) Gross Margin (ii – v)	1,47,600	2,78,200	1,07,280	5,33,080
	Total	A	B	C
Inspection Cost	73,000	15,000	40,000	18,000
$\left(\frac{7,3000}{146} \times 30/80/36 \text{ respectively} \right)$				
Machine Maintenance	1,42,000	40,000	48,000	54,000
$\left(\frac{1,42,000}{710} \times 200/240/270 \text{ respectively} \right)$				
Dye Cost	<u>10,250</u>	<u>2,000</u>	<u>6,000</u>	<u>2,250</u>
Sub Total	<u>2,25,250</u>	<u>57,000</u>	<u>94,000</u>	<u>74,250</u>
Selling Overhead Advertisement	83,000	–	56,000	27,000
$\left(\frac{83,000}{56,000 + 27,000} \times 56/27 \text{ respectively} \right)$				

Developments in the Business Environment

Other Overheads	25,000	5,787	12,963	6,250
$\left(\frac{25,000}{108} \times 25/56/27 \text{ respectively} \right)$				
Packing			<u>54,000</u>	
Sub Total Selling Overhead	<u>1,62,000</u>	<u>5,787</u>	<u>1,22,963</u>	<u>33,250</u>

Workings:

	A	B	C	Total
Gross Production/unit /run (1)	2,520	2,810	3,010	
Defectives/run (2)	20	10	10	
Good units / run (3)	2,500	2,800	3,000	
Sales (Goods units)(4)	25,000	56,000	27,000	
No. of runs (5)	10	20	9	
Gross Production (6) = (1) × (5)	25,200	56,200	27,090	
Prime Cost / unit (7)	12	9	8	
Prime Cost (8) Rs.	3,02,400	5,05,800	2,16,720	10,24,920
Inspection hours/run (9)	3	4	4	
Inspection hours (10) = (9) × (5)	30	80	36	146
M/c hours / run (11)	20	12	30	
M/c hours (12) = (1) × (5)	200	240	270	710
Dye Cost/run (13)	200	300	250	
Dye cost (14) (13) × (5)	2,000	6,000	2,250	10,250

Conventional Accounting System

	Total	A	B	C
Sales – units / Production (good units)	1,08,000	25,000	56,000	27,000
Gross Margin (Rs.)	5,33,080	1,47,600	2,78,200	1,07,280
Production overheads (Rs.)	2,25,250	52,141	1,16,797	56,313

Advanced Management Accounting

Selling Overhead (Rs.)	1,62,000	37,500	84,000	40,500
Sub-Total Overhead (Rs.)	3,87,250	89,641	2,00,797	96,813
Net profit (Rs.)	1,45,830	57,959	77,403	10,467
Ranking		II	I	III

Activity Based System

	A	B	C
Sales – units / Production (good units)	25,000	56,000	27,000
Gross Margin (Rs.)	1,47,600	2,78,200	1,07,280
Production overheads (Rs.)	57,000	94,000	74,250
Selling Overhead (Rs.)	5,787	1,22,963	33,250
Sub-Total Overhead (Rs.)	62,787	2,16,963	1,07,500
Net profit (Rs.)	84,813	61,237	(220)
Ranking	I	II	III

Question 15

A company manufactures three types of products namely P, Q and R. The data relating to a period are as under:

	P	Q	R
Machine hours per unit	10	18	14
Direct labour hours per unit @ Rs. 20	4	12	8
Direct Material per unit (Rs.)	90	80	120
Production (units)	3,000	5,000	20,000

Currently the company uses traditional costing method and absorbs all production overheads on the basis of machine hours. The machine hour rate of overheads is Rs. 6 per hour.

The company proposes to use activity based costing system and the activity analysis is as under:

	P	Q	R
Batch size (units)	150	500	1,000
Number of purchase orders per batch	3	10	8
Number of inspections per batch	5	4	3

The total production overheads are analysed as under:

Machine set up costs	20%
Machine operation costs	30%
Inspection costs	40%
Material procurement related costs	10%

Required:

- (i) Calculate the cost per unit of each product using traditional method of absorbing all production overheads on the basis of machine hours.
- (ii) Calculate the cost per unit of each product using activity based costing principles.

Answer

- (i) Cost per unit using traditional method of absorbing all production overheads on the basis of machine hours:

Products	P	Q	R
	Rs.	Rs.	Rs.
Direct materials	90	80	120
Direct labour (4:12:8 hours) × Rs. 20	80	240	160
Production Overheads (10:18:14 hours) × Rs. 6	<u>60</u>	<u>108</u>	<u>84</u>
Cost per unit	<u>230</u>	<u>428</u>	<u>364</u>

- (ii) 1. Cost per unit of each product using activity based costing:

Products	P	Q	R	Total
A. Production (units)	3,000	5,000	20,000	
B. Batch size (units)	150	500	1000	
C. Number of batches [A ÷ B]	20	10	20	50
D. Number of purchase order per batch	3	10	8	
E. Total purchase orders [C × D]	60	100	160	320
F. Number of inspections per batch	5	4	3	
G. Total inspections [C × F]	100	40	60	200

Advanced Management Accounting

2. Total Production overhead

A.	Machine hours per unit	10	18	14
B.	Production units	3,000	5,000	20,000
C.	Total machine hours [A × B]	30,000	90,000	2,80,000

Total machine hours = 4,00,000

Total production overheads = 4,00,000 × Rs. 6 = Rs. 24,00,000.

3. Cost driver rates:

<i>Cost Pool</i>	<i>%</i>	<i>Overheads Rs.</i>	<i>Cost Driver Units</i>	<i>Cost Driver Rate Rs.</i>
Set up	20%	4,80,000	50	9,600 per set up
Inspection	40%	9,60,000	200	4,800 per inspection
Purchases	10%	2,40,000	320	750 per purchase
Machine hours	30%	7,20,000	4,00,000	1.80 per Machine Hour

4. Cost per unit of P, Q and R:

<i>Products</i>	<i>P</i>	<i>Q</i>	<i>R</i>
Production (units)	3,000	5,000	20,000
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>
Direct Materials (90:80:120)	2,70,000	4,00,000	24,00,000
Direct Labour (80:240:160)	2,40,000	12,00,000	32,00,000
Overheads:			
Machine related costs @ Rs. 1.80/hour (30,000:90,000:2,80,000)	54,000	1,62,000	5,04,000
Set-up costs @ Rs. 9600 / set up (20 : 10 : 20)	1,92,000	96,000	1,92,000
Inspection costs @ Rs. 4800 / inspection (100 :40 : 60)	4,80,000	1,92,000	2,88,000
Purchase related costs @ Rs. 750 / purchase (60 : 100 : 160)	45,000	75,000	1,20,000
Total costs	12,81,000	21,25,000	67,04,000
Cost per unit (Total cost ÷ units)	427.00	425.00	335.20

Question 16

A bank offers three products, viz., deposits, Loans and Credit Cards. The bank has selected 4 activities for a detailed budgeting exercise, following activity based costing methods.

The bank wants to know the product wise total cost per unit for the selected activities, so that prices may be fixed accordingly.

The following information is made available to formulate the budget:

Activity	Present Cost (Rs.)	Estimation for the budget period
(i) ATM Services:		
(a) Machine maintenance	4,00,000	(all fixed, no change)
(b) Rents	2,00,000	(fully fixed; no change)
(c) Currency Replenishment Cost	1,00,000	(expected to double during budget period)
	7,00,000	(This activity is driven by no. of ATM transactions)
(ii) Computer Processing	5,00,000	(Half this amount is fixed and no change is expected)
		(The variable portion is expected to increase to three times the current level).
		This activity is driven by the number of computer transactions.
(iii) Issuing Statements	18,00,000	Presently, 3 lac statements are made. In the budget period, 5 lac statements are expected;
		For every increase of one lac statement, one lac rupees is the budgeted increase (this activity is driven by the number of statements)
(iv) Computer Inquiries	2,00,000	Estimated to increase by 80% during the budget period. (This activity is driven by telephone minutes).

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The activity drivers and their budgeted quantifies are given below:

	Deposits	Loans	Credit Cards
No. of ATM Transactions	1,50,000	-	50,000
No. of Computer Processing Transactions	15,00,000	2,00,000	3,00,000
No. of Statements to be issued	3,50,000	50,000	1,00,000
Telephone Minutes	3,60,000	1,80,000	1,80,000

The bank budgets a volume of 58,600 deposit accounts, 13,000 loan accounts, and 14,000 Credit Card Accounts.

You are required to:

- Calculate the budgeted rate for each activity.
- Prepare the budgeted cost statement activity wise.
- Find the budgeted product cost per account for each product using (i) and (ii) above.

Answer**Budget Cost Statement**

Activity	Activity Cost (Rs.) (Budgeted)	Activity Driver	No. of Units of Activity Driver (Budget)	Activity Rate (Rs.)	Deposits	Loans	Credit Cards
1. ATM Services	8,00,000	ATM Transaction	2,00,000	4	6,00,000	-	2,00,000
2. Computer Processing	10,00,000	Computer Transaction	20,00,000	0.50	7,50,000	1,00,000	1,50,000
3. Issuing Statements	20,00,000	No. of Statements	5,00,000	4.00	14,00,000	2,00,000	4,00,000
4. Customer Inquiries	3,60,000	Telephone Minutes	7,20,000	0.50	1,80,000	90,000	90,000
Budgeted	41,60,000				29,30,000	3,90,000	8,40,000

Developments in the Business Environment

Cost							
Units of product as estimated in the budget period					58,600	13,000	14,000
Budgeted Cost per unit of the product					50	30	60

Working Notes:

- (i) ATM $4,00,000 + 2,00,000 + 2 \times 1,00,000 = 8,00,000$
- (ii) Computer $5,00,000$ (Fixed = $2,50,000$) Variable = $10,00,000$
 $2,50,000$ increase to 3 times = $7,50,000$
- (iii) Issuing Statements $2,00,000 + 80\% \times 2,00,000 = 2 + 1.6 = 3,60,000.$

Question 17

The following are Product Nova Shaft's data for next year budget:

Activity	Cost Driver	Cost Driver volume/year	Cost Pool
Purchasing	Purchase orders	1,500	Rs.75,000
Setting	Batches produced	2,800	Rs.1,12,000
Materials handling	Materials movements	8,000	Rs.96,000
Inspection	Batches produced	2,800	Rs.70,000
Machining costs	Machine hours	"50,000"	Rs.1,50,000

Purchase orders	25
Output	15,000 units
Production batch size	100 units
Materials movements per batch	6
Machine hours per unit	0.1

Required:

- (i) Calculate the budgeted overhead costs using activity based costing principles.
- (ii) Calculate the budgeted overhead costs using absorption costing (absorb overhead using machine hours).
- (iii) How can the company reduce the ABC for Product Nova Shaft?

Advanced Management Accounting**Answer****(i) Computation of the activity based overheads**

Step 1: Compute cost per unit of cost driver = Cost pool / cost driver volume

Activity	Cost Driver	Cost Pool (a)	Cost driver volume/yr (b)	Cost/Unit of cost driver (a)/(b)
Purchasing	Purchase orders	Rs.75,000	1,500	Rs.50/pruchse order
Setting	Batches produced	Rs.112,000	2,800	Rs.40/batch
Materials handling	Material movements	Rs. 96,000	8,000	Rs.12/movement
Inspection	Batches produced	Rs.70,000	2,800	Rs.25/batch
Machining	Machine hours	Rs.150,000	50,000	Rs.3/machine hour

Step 2: Compute the volume of cost drivers consumed by Product Nova Shaft

Purchase orders (given) = 25

Batches = $15,000/100 = 150$

Materials movement = $150 \text{ batches} \times 6 = 900$

Machine hours = $15,000 \text{ units} \times 0.1 = 1,500$

Step 3: Compute the Activity Based Overheads Cost for Product Nova Shaft

Activity	Cost Driver	Costing Rate / Cost Driver Unit Rs.		
Purchasing	Purchase orders	50	25 order × Rs.50	Rs.1,250
Setting	Batches produced	40	150 batches × Rs.40	Rs.6,000
Material handling	Material movements	12	900 movement × Rs.12	Rs.10,800
Inspection	Batches produced	25	150 batches × Rs.25	Rs.3,750
Machining	Machine hours	3	1,500 hours × Rs.3	<u>Rs.4,500</u>
				Rs.26,300

(ii) Computation of budgeted overheads costs for Product Nova Shaft using absorption costing

Budgeted overheads = (Rs.75,000 + Rs.96,000 + Rs.112,000 + Rs.70,000 + Rs.150,000) = Rs.503,000

Budgeted absorption cost/machine hour = Rs.503,000 / 50,000 = Rs.10.06

Budgeted machining hours for Product Nova Shaft = 1,500

Budgeted absorbed overhead = 1,500 × Rs.10.06 = Rs.15,090

(iii) Ways in which the company can reduce the ABC for product Nova Shaft:

- Reduce the number of batches by increasing the batch size which will then reduce the setting up overhead, materials handling and inspection costs.
- Reduce the number of purchase orders
- Innovate ways of speeding up production so that the machining hours are reduced

Question 18

X Ltd. is engaged in the production of four products: A, B, C and D. The price charged for the four products are Rs.180, Rs.175, Rs.130 and Rs.180 respectively, Market research has indicated that if X Ltd can reduce the selling prices of its products by Rs.5, it will be successful in getting bulk orders and gain a significant share of market of those products. The company's profit markup is 25 per cent on cost of the product. The relevant information of products are as follows:

Products	A	B	C	D
Output in units	600	500	400	600
Cost per unit:				
Direct material (in Rs.)	40	50	30	60
Direct labour (in Rs.)	28	21	14	21
Machine hours (per unit)	4	3	2	3

The four products are usually produced in production runs of 20 units and sold in batches of 10 units. The production overhead is currently absorbed by using a machine hour rate, and the total of the production overheads for the period has been analysed as follows:

	(Rs.)
Machine department costs	52,130
Setup costs	26,250

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<i>Stores receiving</i>	18,000
<i>Inspection/Quality Control</i>	10,500
<i>Material handling and dispatch</i>	23,100

The cost drivers to be used for the overhead costs are as follows:

<i>Cost</i>	<i>Cost drivers</i>
<i>Setup costs</i>	<i>Number of production runs</i>
<i>Store receiving</i>	<i>Requisitions raised</i>
<i>Inspection/Quality control</i>	<i>Number of production runs</i>
<i>Materials handling and dispatch</i>	<i>Order executed</i>

The number of requisitions raised in the stores was 100 for each product and the number of orders executed was 210, each order being for a batch of 10 units of a product.

You are required:

- (i) To compute the target cost for each product.*
- (ii) To compute total cost of each product using activity based costing.*
- (iii) Compare target cost and activity based cost of each product and comment whether the price reduction is profitable or not.*

Answer

- (i)** The target cost of each product after reduction is computed as follows:

<i>Product</i>	<i>Present Price (Rs)</i>	<i>Proposed Price (Rs)</i>	<i>Target Cost (Rs) (with 25% Margin)</i>
A	180	175	140
B	175	170	136
C	130	125	100
D	180	175	140

- (ii)** Statement showing cost/unit of Driver as per ABC

<i>Cost</i>	<i>Amount</i>	<i>Driver</i>	<i>No.</i>	<i>Cost/unit of Driver</i>
Set-ups	26,250	Production runs	105*	Rs.250.00
Stores receiving	18,000	Requisition	400**	Rs.45.00
Inspection/Quality	10,500	Production runs	105	Rs.100.00

Developments in the Business Environment

Handling/Dispatch	23,100	Orders	210	Rs.110.00
Machine Department	52,130	Machine Hrs.	6,500	Rs.8.02

* Production runs = $(600/20) + (500/20) + (400/20) + (600/20) = 105$

** Requisitions = 100 for each product or 400 total

Machine hours = $2,400 + 1,500 + 800 + 1,800 = 6,500$ hours.

Statement showing Total Cost and Cost Per Unit as per ABC

<i>Item</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
	Rs.	Rs.	Rs.	Rs.
Direct Material	24,000	25,000	12,000	36,000
Direct Labour	16,800	10,500	5,600	12,600
Set-up	7,500	6,250	5,000	7,500
Stores receiving	4,500	4,500	4,500	4,500
Inspection/Quality	3,000	2,500	2,000	3,000
Handling/Dispatch	6,600	5,500	4,400	6,600
Machine Dept. Cost	19,248	12,030	6,416	14,436
Total Cost	81,648	66,280	39,916	84,636
Output (Units)	600	500	400	600
Cost per unit	136.08	132.56	99.79	141.06

(iii) Comparison of Actual Cost and Target Cost

<i>Cost</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
	Rs.	Rs.	Rs.	Rs.
Actual	136.08	132.56	99.79	141.06
Target	140.00	136.00	100.00	140.00
Difference	(-) 3.92	(-) 3.44	(-) 0.21	(+) 1.06

Comment:

The total actual cost of A, B and C product is less than the target cost so there is no problem in reducing the cost of these product by Rs.5 from the present price. It will increase the profitability of the company but the cost of D is slightly more than the target cost, it is therefore, suggested that the company should either control it or redesign it.

Advanced Management Accounting

VALUE CHAIN ANALYSIS

Question 19

What is the concept of 'Value-chain' and why is it important for Cost Management?

Answer

Value chain is the linked set of value creating activities from the basic raw materials and components sources to the ultimate end use of the product or service delivered to the customer.

The six business functions contained in the value chain are (i) Research and Development, (ii) Design (iii) Production (iv) Marketing (v) Distribution and (vi) Customer service.

The objective of value chain is to serve as means of increasing the customer satisfaction and managing costs effectively. Coordination of the individual parts of the value chain activities creates conditions to improve customer satisfaction in terms of cost efficiency, quality and delivery. A firm which performs value chain activities more efficiently and at a lower cost than its competitors will be able to gain competitive advantage. The following methodology should be adopted.

1. The firm should identify the industry value chain and then assign costs, revenues and assets to value activities.
2. Diagnose the cost drivers regulating each value activity.
3. Develop sustainable cost advantage either by controlling cost drivers better than competitors or by reconfiguring the chain value.

By analyzing costs, revenues and assets in each activity systematically a company can achieve low cost. Thus value chain helps managers in deciding how to apply the organization's valuable physical and human resources to each linked process so as to achieve cost effectiveness.

Question 20

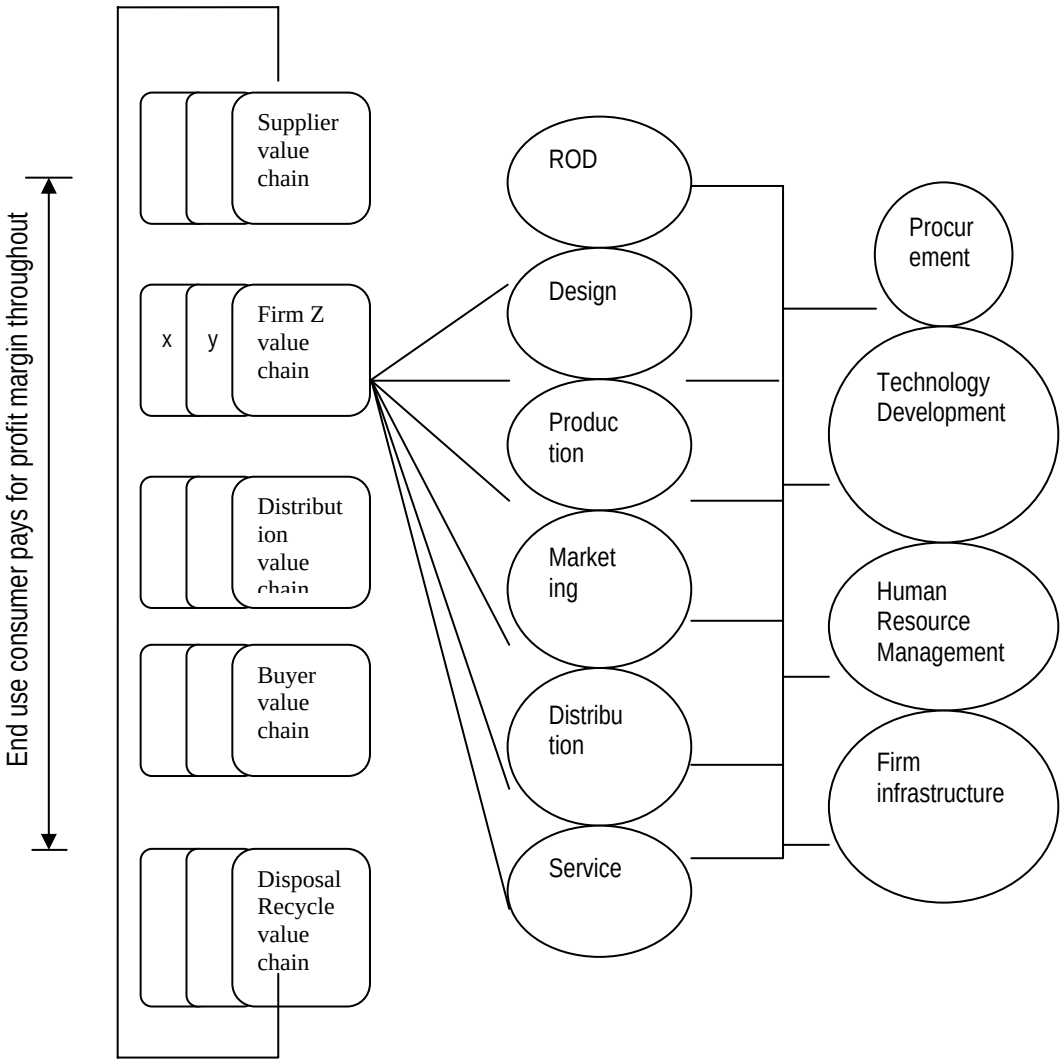
Explain with a diagram the value chain activities within the firm with suitable classifications under primary and support activities and also the industry value chain indicating what the end use consumer pays for.

Answer

Industry Value Chain
the firm

Value Chain Activities within

Primary Activities Support Activities



Question 21

How can value analysis achieve cost reduction?

Advanced Management Accounting

Answer

Value analysis can do cost reduction in the following manner:

- By identifying and removing unnecessary components in a product which had utility earlier.
- By introducing component substitution at a lesser cost without affecting the quality of the product.
- By simplifying the product design.
- By introducing alternative methods with less cost but improved efficiency.

Question 22

Define the term 'value-chain'. Mention three 'useful strategic frameworks of the value-chain analysis.

Answer

Value chain is the linked set of value-creating activities all the way from basic raw material sources for component suppliers through to the ultimate end-use product or service delivered to the customer. Porter's described the value chain as the internal processes or activities a company performs "to design, produce, market, deliver and support its product". He further stated that "a firm's value chain and the way it performs individual activities are a reflection of its history, its strategy, its approach of implementing its strategy, and the underlying economics of the activities themselves". The business activities are classified in to primary activities and support activities.

Primary activities are those activities which are involved in transforming the inputs in to outputs, delivery and after sales service. Support activities are intended to support the primary activities like for example procurement, human resources management, etc.

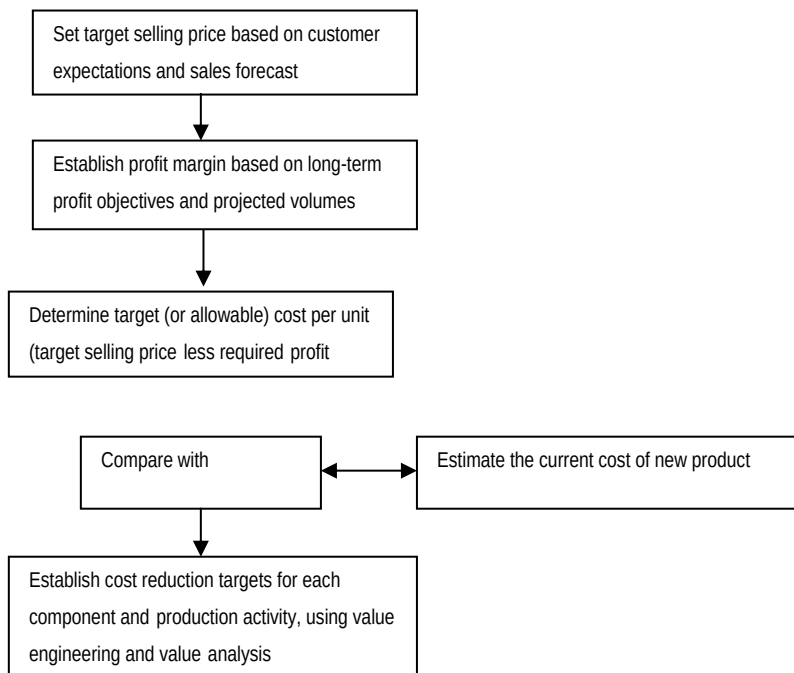
Three useful strategic frameworks for value chain analysis are:

- Industry structure analysis;
- Core competencies; and
- Segmentation analysis.

TARGET COSTING LIFE CYCLE COSTING

Question 23

List the steps involved in target costing process with the help of a block diagram.

Answer**Target Costing Process****Question 24**

What is Target Costing? It is said that implementation of the target costing technique requires intensive marketing research. Explain why intensive marketing research is required to implement target costing technique.

Answer

Target cost is the difference between estimated selling price of a proposed product with specified functionality and quality and the target margin. This is a cost management technique that aims to produce and sell products that will ensure the target margin. It is an integral part of the product design. While designing the product, the company needs to understand what value target customers will assign to different attributes and different aspects of quality. This requires use of techniques like value engineering and value analysis. Intensive marketing research is required to understand customer preferences and the value they assign to each attribute and quality parameter. This insight is required to be developed must before the product is introduced. The company plays within the space between the maximum attributes and quality that the company can offer and the

Advanced Management Accounting

minimum acceptable to target customers. Therefore in absence of intensive marketing research, the target costing technique cannot be used effectively.

Question 25

Discuss, how target costing may assist a company in controlling costs and pricing of products.

Answer

Target costing may assist control of costs and pricing of product as under:

- (i) Target costing considers the price that ought to be charged by a company to achieve a given market share.
- (ii) Target costing should take life cycle costs in to consideration.
- (iii) If there is a gap between the target cost and expected cost, ways and means of reducing or eliminating it can be explored.
- (iv) The target cost may be used for controlling costs by comparison.

Question 26

What is total-life-cycle costing approach? What is it important?

Answer

Total life cycle costing approach:

Life cycle costing estimates, tracks and accumulates the costs over a product's entire life cycle from its inception to abandonment or from the initial R & D stage till the final customer servicing and support of the product. It aims at tracing of costs and revenues on product by product basis over several calendar periods throughout their life cycle. Costs are incurred along the product's life cycle starting from product's design, development, manufacture, marketing, servicing and final disposal. The objective is to accumulate all the costs over a product life cycle to determine whether the profits earned during the manufacturing phase will cover the costs incurred during the pre and post manufacturing stages of product life cycle.

Importance:

Product life cycle costing is important for the following reasons:

- (i) When non-production costs like costs associated with R & D, design, marketing, distribution and customer service are significant, it is essential to identify them for target pricing, value engineering and cost management. For example, a poorly designed software package may involve higher costs on marketing, distribution and after sales service.

- (ii) There may be instances where the pre-manufacturing costs like R & D and design are expected to constitute a sizeable portion of life cycle costs. When a high percentage of total life cycle costs are likely to be so incurred before the commencement of production, the firm needs an accurate prediction of costs and revenues during the manufacturing stage to decide whether the costly R & D and design activities should be undertaken.
- (iii) Many costs are locked in at R & D and design stages. Locked in or Committed costs are those costs that have not been incurred at the initial stages of R & D and design but that will be incurred in the future on the basis of the decisions that have already been taken. For example, the adoption of a certain design will determine the product's material and labour inputs to be incurred during the manufacturing stage. A complicated design may lead to greater expenditure on material and labour costs every time the product is produced. Life cycle budgeting highlights costs throughout the product life cycle and facilitates value engineering at the design stage before costs are locked in.

Total life-cycle costing approach accumulates product costs over the value chain. It is a process of managing all costs along the value chain starting from product's design, development, manufacturing, marketing, service and finally disposal.

Question 27

Explain the essential features of Life-cycle costing.

Answer

Essential features of Life Cycle Costing:

Product Life Cycle costing involves:

- Tracing of costs and revenue of product over several calendar period- throughout their entire life cycle.
- Emphasis is on Cost and revenue accumulation over the entire life cycle of the product.
- Life cycle costing traces research and design.
- It focuses on development costs, incurred to individual products over their entire life cycles.
- Total magnitude of research and development costs are reported and compared with product revenues generated in later periods.

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Question 28

Meena is a news reporter and feature writer for an economic daily. Her assignment is to develop a feature article on 'Product Life-cycle Costing', including interviews with the Chief Financial Officers (CFO) and operating managers. Meena has been given a liberal budget for travel so as to research into company's history, operations, and market analysis for the firm she selects for the article.

Required:

- (i) *Meena has asked you to recommend industries and firms that would be good candidates for the article. What would you advice? Explain your recommendations. (June 2009, 3 Marks)*

Answer

The product life cycle span the time from the initial R & D on a product to when customer service and support is no longer offered for that product.

Life Cycle Costing technique is particularly important when:

- (a) High percentage of total life-cycle costs are incurred before production begins and revenue are earned over several years and
- (b) High fraction of the life cycle costs are locked in at the R & D and design stages.

Meena should identify those industries and then companies belonging to those industries where above mentioned feature are prevalent. For example, Automobile and Pharmaceutical Industries companies like Tata Automobile, M&M, Ranbexy and Dabur will be good candidates for study on product life cycle costing.

JUST IN TIME

Question 29

X Video Company sells package of blank video tapes to its customer. It purchases video tapes from Y Tape Company @ Rs140 a packet. Y Tape Company pays all freight to X Video Company. No incoming inspection is necessary because Y Tape Company has a superb reputation for delivery of quality merchandise. Annual demand of X Video Company is 13,000 packages. X Video Co. requires 15% annual return on investment. The purchase order lead time is two weeks. The purchase order is passed through Internet and it costs Rs2 per order. The relevant insurance, material handling etc Rs3.10 per package per year. X Video Company has to decide whether or not to shift to JIT purchasing. Y Tape Company agrees to deliver 100 packages of video tapes 130 times per year (5 times every two weeks) instead of existing delivery system of 1,000 packages 13 times a year with additional amount of Rs0.02 per package. X Video Co. incurs no

stock out under its current purchasing policy. It is estimated X Video Co. incurs stock out cost on 50 video tape packages under a JIT purchasing policy. In the event of a stock out, X Video Co. has to rush order tape packages which costs Rs4 per package. Comment whether X Video Company should implement JIT purchasing system.

Z Co. also supplies video tapes. It agrees to supply @ Rs13.60 per package under JIT delivery system. If video tape purchased from Z Co., relevant carrying cost would be Rs3 per package against Rs3.10 in case of purchasing from Y Tape Co. However Z Co. doesn't enjoy so sterling a reputation for quality. X Video Co. anticipates following negative aspects of purchasing tapes from Z Co.

- To incur additional inspection cost of 5 paisa per package.

Average stock out of 360 tapes packages per year would occur, largely resulting from late deliveries. Z Co. cannot rush order at short notice. X Video Co. anticipates lost contribution margin per package of Rs8 from stock out.

- Customer would likely return 2% of all packages due to poor quality of the tape and to handle this return an additional cost of Rs25 per package.

Comment whether X Video Co places order to Z Co

Answer

(i) Comparative Statement of cost for purchasing from Y Co Ltd under current policy & JIT

Particulars	Current Policy	JIT
	Rs	Rs
Purchasing cost	18,20,000	18,20,260
	(13,000 × 140)	(13,000 × 140.02)
Ordering cost	26.00(2×13 orders)	260.00(2×130 orders)
Opportunity carrying cost	10,500.00	1,050.15
	(1/2×1000×140×15%)	(1/2×100×140.02×15%)
Other carrying cost (Insurance, material handling etc)	1,550.00(1/2×1000×3.10)	155.00
Stock out cost		200(4 × 50)
Total relevant cost	18,32,076	18,21,925.15

Comments: As may be seen from above, the relevant cost under the JIT purchasing policy is lower than the cost incurred under the existing system. Hence, a JIT purchasing policy should be adopted by the company.

Advanced Management Accounting

(ii) Statement of cost for purchasing from Z Co Ltd.

Particulars	Rs.
Purchasing cost	1,76,800 (13,000x13.60)
Ordering Cost	260.00 (2x130 orders)
Opportunity Carrying Cost	102.00
Cost	(1/2×100×13.60× 15%)
Other Carrying Cost	150.00 (1/2×100×3.00)
Stock out Cost	2,880 (8x360)
Inspection Cost	650.00 (13,000 x .05)
Customer Return Cost	6,500.00 (13,000 x 2% x 25)
Total Relevant Cost	1,87,342

Comments : The comparative costs are as follows,

Under current policy	Rs 18,32,076.00
Under purchase under JIT	Rs 18,21,925.10
Under purchase from Z Co Ltd	Rs 1,87,342.00

Package should be bought from Z Co as it is the cheapest.

Question 30

How does the JIT approach help in improving an organisation's profitability?

Answer

JIT approach helps in the reduction of costs/increase in prices as follows:

- (i) Immediate detection of defective goods being manufactured so that early correction is ensured with least scrapping.
- (ii) Eliminates/reduces WIP between machines within working cell.
- (iii) OH costs in the form of rentals for inventory, insurance, maintenance costs etc. are reduced.
- (iv) Higher product quality ensured by the JIT approach leads to higher premium in the selling price.
- (v) Detection of problem areas due to better pdn/scrap reporting/labour tracing and inventory accuracy lead to reduction in costs by improvement.

Question 31

Explain, how the implementation of JIT approach to manufacturing can be a major source of competitive advantage.

Answer

JIT provides competitive advantage in the following ways:

- (i) Stocks of raw materials and finished goods are eliminated, stock holding costs are avoided.
- (ii) JIT aims at elimination of non-value added activities and elimination of cost in this direction will improve competitive advantage.
- (iii) It affords flexibility to customer requirements where the company can manufacture customized products and the competitive advantage is thereby improved.
- (iv) It focuses the direction of performance based production of high quality product.
- (v) It minimize waiting times and transportation costs.

Question 32

Differentiate between 'Traditional Management Accounting' and 'Value Chain Analysis in the strategic framework'.

Answer

Traditional management accounting focuses on internal information. It often places excessive emphasis on manufacturing costs. It also assumes that cost reduction must be found in the "value-added" process i.e. selling price less the cost of raw material. The value chain analysis approach encompasses external and internal data, uses appropriate cost drivers for all major value-creating processes, exploits linkages throughout the value chain, and provides continuous monitoring of a firm's strategic competitive advantages.

Value Chain vs. Traditional Management Accounting

	Traditional Management Accounting	Value Chain Analysis in the strategic framework
1.	If focuses on internal information	Focuses on external informations.
2.	Application of single cost driver at the overall firm level is taken.	Application of multiple cost drivers i.e. structural and executional are taken for each value activity.
3.	It assume that cost reduction must be found in the value added process	Exploits linkages throughout the value chain i.e. within firm, with suppliers and customers.

Advanced Management Accounting

4.	Insights for strategic decisions somewhat limited in traditional management accounting	Identity cost driver at the individual activity level and develop cost / differentiation advantage either by controlling those drivers better than competitors by reconfiguring the value chain.
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Question 33

Describe the Just-in-time systems.

Answer

A complete JIT system begins with production, includes deliveries to a company's production facilities, continues through the manufacturing plant and even includes the types of transactions processed by the accounting system.

- (i) The company must ensure that it receives its supplies on time, preferably directly at the production facility that needs them. The company engineers must assist suppliers at their premises and ensure defect free supplies. Thus raw material inventory is reduced if correct quantities are delivered as per production schedules.
- (ii) Long set-up times are reduced into short ones by eliminating inefficiency. Thus the WIP is reduced and so is the number of products before defects are identified.
- (iii) A 'Kanban' card, which authorizes production of the right quantity by its feeder machine ensures 'pulling' the production process and elimination of inventory. Another method is the introduction of a working cell, which is a cluster of machines run by a single trained operator. This also identifies defects quickly and reduces maintenance costs. Both methods are used together.
- (iv) Work force is trained to be empowered to halt operations, understand more about the system, product flow, different machines and thus, elaborate reporting of a past variance is eliminated.
- (v) Suppliers may be paid based on production units adjusted for defects.

Question 34

What do you mean by back-flushing in JIT system? What are the problems that must be corrected before it will work properly?

Answer

Backflushing requires no data entry of any kind until a finished product is completed. At that time the total amount finished is entered into the computer system, which multiplies it by all the components listed in the bill of materials for each item produced. This yields a

lengthy list of components that should have been used in the production process and which is subtracted from the beginning inventory balance to arrive at the amount of inventory that should now be left of hand. Back the entire production process. Given the large transaction volumes associated with JIT, this is an ideal solution to the problem.

The following problems must be corrected before it will work properly:

- (i) Production reporting
- (ii) Scrap reporting
- (iii) Lot tracing
- (iv) Inventory accuracy.

THROUGHPUT ACCOUNTING

Question 35

Vikram Ltd. produces 4 products using 3 different machines. Machine capacity is limited to 3,000 hours for each machine. The following information is available for February, 2009:

Products	A	B	C	D
<i>Contribution (Sales-direct material) Rs.</i>	1,500	1,200	1,000	600
<i>Machine Hours Required/Unit :</i>				
<i>Machine 1</i>	10	6	2	1
<i>Machine 2</i>	10	9	3	1.5
<i>Machine 3</i>	10	3	1	0.5
<i>Estimated Demand (units)</i>	200	200	200	200

From the above information you are required to identify the bottleneck activity and allocate the machine time.

Answer

Machine	Time required for products				Total Time	Time Available	Machine utilization
	A	B	C	D			
1	2000	1200	400	200	3800	3000	126.67%
2	2000	1800	600	300	4700	3000	156.67%
3	2000	600	200	100	2900	3000	96.67%

Advanced Management Accounting

Since Machine 2 has the highest machine Utilization it represents the bottleneck activity hence product, ranking & resource allocation should be based on contribution/machine hour of Machine 2.

Allocation of Resources						
	A	B	C	D	Machine Utilization	Spare Capacity
Contribution per unit (Rs.)	1500	1200	1000	600		
Time required in Machine 2	10	9	3	1.5		
Contribution per Machine – hour (Rs.)	150	133.33	333.33	400		
Rank as per contribution / mach. Hour	3 rd	4 th	2 nd	1 st		
Allocation of Machine 2 time	$200 \times 10 = 2000$	100 (balancing figure)	$200 \times 3 = 600$	$200 \times 1.5 = 300$	3000	
Production Quantity	200	$100/9=11.11$	200	200		
Allocation Machine 1 time	2000	$11.11 \times 6 = 66.66$	400	200	2666.66	333.34
Allocation of Machine 3 time	2000	$11.11 \times 3 = 33.33$	200	100	2333.33	666.67

Question 36

A company produces three products A, B and C. The following information is available for a period:

	A	B	C
Contribution	30	25	15
(Rupees per unit)			
(Sales – Direct materials)			

Machine hours required per unit of production:

	Hours			Throughout accounting ratio
	A	B	C	
Machine 1	10	2	4	133.33%
Machine 2	15	3	6	200%
Machine 3	5	1	2	66.67%

Estimated sales demand for A, B and C are 500 units each and machine capacity is limited to 6,000 hours for each machine.

You are required to analyse the above information and apply theory of constraints process to remove the constraints.

How many units of each product will be made?

Answer

Throughout Accounting ratio is highest for 'Machine 2'.

∴ 'Machine 2' is the bottleneck

Contribution per unit of bottleneck machine hour:

Total 'Machine 2' hours available = 6,000

	A	B	C
A. Contribution per unit (Rs.)	30	25	15
B. 'Machine 2' hours	15	3	6
C. Contribution per 'Machine 2' hours (A / B)	2	8.33	2.50
D. Ranking	3	1	2
E. Maximum Demand	500	500	500
'Machine 2' hours required (B × E)	7,500	1,500	3,000
'Machine 2' hours available	1,500	1,500	3,000
Units	100	500	500

Shut Down & Divestment

Question 37

What is divestment strategy? Highlight the main reasons for divestments.

Advanced Management Accounting

Answer

Divestment Strategy:

Divestment involves a strategy of selling off or shedding business operations to divert the resources, so released, for other purposes. Selling off a business segment or product division is one of the frequent forms of divestment strategy. It may also include selling off or giving up the control over subsidiary where by the wholly owned subsidiaries may be floated as independently quoted companies.

Reason for Divestment Strategy

1. In case of a firm having an opportunity to get more profitable product or segment but have resource constraint, it may selling off it's unprofitable or less profitable division and utilized the recourse so released. Cost Benefit analysis & Capita Budgeting Method are the useful tool for analyzing this type of situation.
2. In case of purchase of new business, it may be found that some of the part of the acquired business is not upto the mark. In such type of situation disposal of the unwanted part of the business is more desirable than hold it.
3. In case where any business segment or product or subsidiary is pull down the profit of the whole organization, it is better to cut down of that operation of the product or business segment.

EXERCISE

TOTAL QUALITY MANAGEMENT

Question 1

Define Total Quality Management? What are the six Cs for successful implementation of TQM?

Answer

Refer to Chapter 1: Paragraph 1.2.2 & 1.2.5

ACTIVITY BASED COST MANAGEMENT

Question 2

Explain the concept of cost drivers indicate what you will consider as cost drivers for the following business function:

Research & development; and Customer service.

Answer

Refer to Chapter 1: Paragraph : 1.3.3

Question 3

What is activity based costing?

Answer

Refer to Chapter 1: Paragraph: 1.3.2 & 1.3.4

Question 4

What are the areas in which activity based information is used for decision making?

Answer

Refer to Chapter 1: Paragraph: 1.3.9

Question 5

Explain the concept of activity based costing. How ABC system supports corporate strategy?

Answer

Refer to Chapter 1: Paragraph: 1.3.7.3

Question 6

Computo Ltd. manufactures two parts 'P' and 'Q' for Computer Industry.

Advanced Management Accounting

P : annual production and sales of 1, 00,000 units at a selling price of Rs. 100.05per unit.

Q : annual production and sales of 50,000 units at a selling price of Rs. 150 per unit.

Direct and Indirect costs incurred on these two parts are as follows:

	(Rs. in thousand)		
	P	Q	Total
<i>Direct Material cost (variable)</i>	4,200	3,000	7,200
<i>Labour cost (variable)</i>	1,500	1,000	2,500
<i>Direct Machining cost (See Note)*</i>	700	550	1,250
<i>Indirect Costs:</i>			
<i>Machine set up cost</i>			462
<i>Testing cost</i>			2,375
<i>Engineering cost</i>			<u>2,250</u>
			<u>16,037</u>

Note: *Direct machining costs represent the cost of machine capacity dedicated to the production of each product. These costs are fixed and are not expected to vary over the long-run horizon.*

Additional information is as follows:

	P	Q
<i>Production Batch Size</i>	1,000 units	500 units
<i>Set up time per batch</i>	30 hours	36 hours
<i>Testing time per unit</i>	5 hours	9 hours
<i>Engineering cost incurred on each product</i>	8.40 lacs	14.10 lacs

A foreign competitor has introduced product very similar to 'P'. To maintain the company's share and profit, Computo Ltd. has to reduce the price to Rs. 86.25. The company calls for a meeting and comes up with a proposal to change design of product 'P'. The expected effect of new design is as follows:

- *Direct Material cost is expected to decrease by Rs. 5 per unit.*
- *Labour cost is expected to decrease by Rs. 2 per unit.*
- *Machine time is expected to decrease by 15 minutes; previously it took 3 hours to produce 1 unit of 'P'. The machine will be dedicated to the production of new design.*
- *Set up time will be 28 hours for each set up.*

- Time required for testing each unit will be reduced by 1 hour.
- Engineering cost and batch size will be unchanged.

Required:

- Company management identifies that cost driver for Machine set-up costs is 'set up hours used in batch setting' and for testing costs is 'testing time'. Engineering costs are assigned to products by special study. Calculate the full cost per unit for 'P' and 'Q' using Activity-based costing.
- What is the Mark-up on full cost per unit of P?
- What is the Target cost per unit for new design to maintain the same mark up percentage on full cost per unit as it had earlier? Assume cost per unit of cost drivers for the new design remains unchanged.
- Will the new design achieve the cost reduction target?
- List four possible management actions that the Computo Ltd. should take regarding new design.

Answer

- Cost driver per machine set up hour = Rs. 70
- Cost driver per testing hour = Rs. 2.50

	P	Q
(c) Total cost (Rs.)	87,00,000	73,37,000
(d) Cost per unit (Rs.)	87.00	146.74
(e) Percentage of mark up on full cost = 15%		
(f) Target cost per unit (Rs.) = 75.00		

	Cost P.U	Total Cost
(g) Total Cost (Rs.)	77.36	77,36,000

The target cost is Rs. 75 p.u. and estimated cost of new design is Rs. 77.36 p.u. The new design does not achieve the target cost set by Computo Ltd. Hence the target mark up shall not be achieved.

Question 7

Why are conventional product costing systems more likely to distort product costs in highly automated plants? How do activity-based costing systems deal with such a situation?

Advanced Management Accounting

Answer

Refer to Chapter 1: Paragraph: 1.1

Question 8

Differentiate between 'Value-added' and 'Non-value-added' activities in the context of Activity-based costing.

Give examples of Value-added and Non-value-added activities.

Answer

Refer to Chapter 1: Paragraph: 1.6.6

Question 9

Traditional Ltd. is a manufacturer of a range of goods. The cost structure of its different products is as follows:

Particulars	Product A	Product B	Product C	
Direct materials	50	40	40	Rs./u
Direct labour @ 10 Rs./hour	30	40	50	Rs./u
Production overheads	30	40	50	Rs./u
Total Cost	110	120	140	Rs./u
Quantity produced	10,000	20,000	30,000	Units

Traditional Ltd. was absorbing overheads on the basis of direct labour hours. A newly appointed management accountant has suggested that the company should introduce ABC system and has identified cost drivers and cost pools as follows:

Activity Cost Pool	Cost Driver	Associated Cost
Stores Receiving	Purchase Requisitions	2,96,000
Inspection	Number of Production runs	8,94,000
Dispatch	Orders Executed	2,10,000
Machine Setup	Number of setups	12,00,000

The following information is also supplied:

Details	Product A	Product B	Product C
No. of Setups	360	390	450
No. of Orders Executed	180	270	300
No. of Production runs	750	1,050	1,200
No. of Purchase Requisitions	300	450	500

You are required to calculate activity based production cost of all the three products.

Answer

	A	B	C
Unit Cost	70.49	44.25	33.67
Add: Conversion Cost	80	80	90
Total	150.49	124.25	123.67

VALUE CHAIN ANALYSIS

Question 10

What steps are involved in value chain analysis approach for assessing competitive advantages?

Answer

Refer to Chapter 1: Paragraph: 1.6.6

TARGET COSTING LIFE CYCLE COSTING

Question 11

What is Target Costing and what are the stages to the methodology?

Answer

Refer to Chapter 1: Paragraph: 1.4.3.2 & 1.4.12

Question 12

What is Product Life-cycle Costing ? Describe its characteristics and benefits.

Answer

Refer to Chapter 1: Paragraph: 1.5.5 & 1.5.7

JUST IN TIME

Question 13

What do you mean by 'Back flushing' in JIT system? Explain briefly the problems with back flushing that must be corrected before it will work properly. (4 Marks)

Answer

Refer to Chapter 1: Paragraph: 1.9.4

COST CONCEPTS IN DECISION MAKING

BASIC CONCEPTS & FORMULAE

Basic Concepts

1. **Relevant cost in decision making process:** Costs which are relevant for a particular business option, which are not historical cost but future costs to be associated with different inputs and activities related a business process. Actual, current or historical costs may be used for estimating the future costs of each alternative. The contribution approach, coupled with the ability to distinguish between relevant and irrelevant costs will prove to be a boon for the managers in arriving at correct conclusions in the challenging area of decision making.
2. **Differential cost, Incremental cost and Incremental revenue:** Differential cost (which may be incremental or decremental cost) is the difference in total cost that will arise from the selection of one alternative instead of another. It involves the estimation of the impact of decision alternatives on costs and revenues. The two basic concepts which go together with this type of cost analysis are *incremental revenue* and *incremental costs*. *Incremental revenue* is the change in the total income resulting from a decision. *Incremental costs* represent a change in the total costs resulting from a decision. Such a change in cost is not necessarily variable in nature.
3. **Opportunity cost concept:** The opportunity cost of the value of opportunity foregone is taken into consideration when alternatives are compared. Opportunity Cost is the value of the next best alternative. In other words, it is the opportunity cost lost by diversion of an input factor from one use to another. It is the measure of the benefit of opportunity foregone.

The opportunity cost is helpful to managers in evaluating the various alternatives available when multiple inputs can be employed for multiple uses. These inputs may nevertheless have a cost and this is measured by the sacrifice made by the alternative action in course of choosing another alternatives.
4. **Sunk costs:** Costs which do not change under given circumstance and do not play any role in decision making process are known as sunk costs. They are historical costs incurred in the past. In other words, these are the costs which

Advanced Management Accounting

have been incurred by a decision made in past and cannot be changed by any decision made in the future.

5. **Application of Incremental/Differential Cost Techniques In Managerial Decisions:**

The areas in which the above techniques of cost analysis can be used for making managerial decisions are:

- (i) Whether to process a product further or not.
- (ii) Dropping or adding a product line.
- (iii) Making the best use of the investment made.
- (iv) Acceptance of an additional order from a special customer at lower than existing price.
- (v) Opening of new sales territory and branch.
- (vii) Make or Buy decisions.
- (viii) Submitting tenders
- (ix) Lease or buy decisions
- (x) Equipment replacement decision.

Question 1

Explain briefly the concepts of Opportunity costs and Relevant costs.

Answer

Opportunity cost is a measure of the benefit of opportunity forgone when various alternatives are considered. In other words, it is the cost of sacrifice made by alternative action chosen. For example, opportunity cost of funds invested in business is the interest that could have been earned by investing the funds in bank deposit.

Relevant Cost: Expected future costs which differ for alternative course. It is not essential that all variable costs are relevant and all fixed costs are irrelevant. Fixed, or variable costs that differ for various alternatives are relevant costs. Relevant costs draw our attention to those elements of cost which are relevant for the decision.

E.g. Direct labour under alternative I – Rs.10/ hour

Direct labour under alternative II – Rs.20/hour

Then, direct labour is relevant cost.

Question 2

X is a multiple product manufacturer. One product line consists of motors and the company produces three different models. X is currently considering a proposal from a supplier who wants to sell the company blades for the motors line.

The company currently produces all the blades it requires. In order to meet customer's needs, X currently produces three different blades for each motor model (nine different blades).

The supplier would charge Rs.25 per blade, regardless of blade type. For the next year X has projected the costs of its own blade production as follows (based on projected volume of 10,000 units):

Direct materials	Rs.75,000
Direct labour	Rs.65,000
Variable overhead	Rs.55,000
Fixed overhead:	
Factory supervision	Rs.35,000
Other fixed cost	<u>Rs.65,000</u>
Total production costs	<u>Rs.2,95,000</u>

Assume (1) the equipment utilized to produce the blades has no alternative use and no market value, (2) the space occupied by blade production will remain idle if the company purchases rather than makes the blades, and (3) factory supervision costs reflect the salary of a production supervisor who would be dismissed from the firm if blade production ceased.

- (i) Determine the net profit or loss of purchasing (rather than manufacturing), the blades required for motor production in the next year.*
- (ii) Determine the level of motor production where X would be indifferent between buying and producing the blades. If the future volume level were predicted to decrease, would that influence the decision?*
- (iii) For this part only, assume that the space presently occupied by blade production could be leased to another firm for Rs.45,000 per year. How would this affect the make or buy decision?*

Answer

- (a)** This is a make or buy decision so compare the incremental cost to make with the incremental cost buy.

Advanced Management Accounting

Incremental Costs Per Unit***Make the Blades***

Direct materials (Rs.75,000 ÷ 10,000 units)

Rs.7.50

Direct labour (Rs.65,000 ÷ 10,000 units)

Rs.6.50

Variable overhead (Rs.55,000 ÷ 10,000)

Rs.5.50

Supervision (Rs.35,000 ÷ 10,000)

Rs.3.50

Total cost

Rs.23.00

Compare the cost to make the blades for 10,000 motors. Rs.23.00, with the cost to buy, Rs.25.00 There is a net loss of Rs.2.00 if 'X' chooses to buy the blades.

- (b) 'X' will be indifferent between buying and making the blades when the total costs for making and buying will be equal at the volume level where the variable costs per unit times the volume plus the fixed avoidable costs are equal to the supplier's offered cost of Rs.25.00 per unit times the volume.

(Direct materials + Direct labour + Variable overhead) × Volume + Supervision =, Cost to buy × Volume. Let volume in units = x

$$(7.50 + 6.50 + 5.50) \times x + 35,000 = 25.00x$$

$$19.50x + 35,000 = 25.00x$$

$$35,000 = 25.00 \times x - 19.50 \times x$$

$$35,000 = 5.50 \times x$$

$$x = 6,364 \text{ units of blades}$$

As volume of production decreases, the average per unit cost of in house production increases. If the volume falls below 6,364 motors, then 'X' would prefer to buy the blades from the supplier.

- (c) If the space presently occupied by blade production could be leased to another firm for Rs.45,000 per year, 'X' would face an opportunity cost associated with in house blade production for the 10,000 units of Rs.4.50 per unit.

$$\text{New cost to make} = 23.00 + 4.50 = 27.50$$

Now 'X' should buy because the cost to make, 27.50, is higher than the cost to buy, 25.00.

Question 3

Why is meant by incremental Revenue?

Answer

Incremental Revenue: Incremental revenue is the additional revenue that arise from the production or sale of a group of additional units. It is one of the two basic concepts the other being incremental cost which go together with differential cost analysis. Incremental cost in fact is the added cost due to change either in the level of activity or in the nature of activity.

Question 4

Distinguish between “Marginal cost” and ‘Differential Cost’.

Answer

Marginal cost represents the increase or decrease in total cost which occurs with a small change in output say, a unit of output. In Cost Accounting variable costs represent marginal cost.

Differential cost is the change (increase or decrease) in the total cost (variable as well as fixed) due to change in the level of activity, technology or production process or method of production.

In other words, it can be defined as the cost of one unit of product or service which would be avoided if that unit was not produced or provided.

The main point which distinguishes marginal cost and differential as that change in fixed cost when volume of production increases or decreases by a unit of production. In the case of differential cost variable as well as fixed cost. i.e. both costs change due to change in the level of activity, whereas under marginal costing only variable cost changes due to change in the level of activity.

Question 5

What are the applications of incremental cost techniques in making managerial decisions?

Answer

Incremental cost technique: It is a technique used in the preparation of ad-hoc information in which only cost and income differences between alternative courses of action are taken into consideration. This technique is applicable to situations where fixed costs alter.

The essential pre-requisite for making managerial decisions by using incremental cost technique, is to compare the incremental costs with incremental revenues. So long as the incremental revenue is greater than incremental costs, the decision should be in favour of the proposal.

Advanced Management Accounting

Applications of incremental cost techniques in making managerial decisions

The important areas in which incremental cost analysis could be used for managerial decision making are as under:

- (i) Introduction of a new product
- (ii) Discontinuing a product, suspending or closing down a segment of the business
- (iii) Whether to process a product further or not
- (iv) Acceptance of an additional order from a special customer at lower than existing price
- (v) Opening of new sales territory and branch.
- (vi) Optimizing investment plan out of multiple alternatives.
- (vii) Make or buy decisions
- (viii) Submitting tenders
- (ix) Lease or buy decisions
- (x) Equipment replacement decisions

Question 6

Ranka Builders has been offered a contract by Excel Ltd. to build for it five special Guest Houses for use by top management. Each Guest House will be an independent one. The contract will be for a period of one year and the offer price is Rs. One crore. In addition Excel Ltd. will also provide 2 grounds of land free of cost for the purpose of construction. The Chief Accountant of Ranka Builders has prepared an estimate on the basis of which he has advised that the contract should not be accepted at the price offered. His estimate was as follows:

	<i>Rs. in Lacs</i>
<i>Land (3 Grounds at Rs.20 lacs each)</i>	60
<i>Drawings and design</i>	7
<i>Registration</i>	10
<i>Materials:</i>	
<i>Cement and Sand</i>	6
<i>Bricks and Tiles</i>	4
<i>Steel</i>	10
<i>Others (including interior decoration)</i>	10

Cost Concepts in Decision Making

Labour – Skilled	12
- Unskilled	8
- Supervisor's Salary	5
Overheads General	12
Depreciation	<u>006</u>
Total Cost	<u>150</u>

The Accountant also provides the following information:

Land: The total requirement of land is 3 grounds costing Rs.20 lacs per ground Excel Ltd. will provide 2 grounds free of cost.

Drawing and Design: These have already been prepared and 50% of the cost has already been incurred.

Materials:

- (i) Cement and sand are already in stock and are in regular use. If used for this contract, they have to be replaced at a cost of Rs.8 lacs.
- (ii) Bricks and tiles represent purchases made several months before for a different contract, they have to be sold readily for a net Rs.5 lacs after meeting all further expensed.
- (iii) Others: Material worth Rs.2 lacs relating to interior decoration are in stock for which no alternative use is expected in the near future. However they can be sold for Rs.1 lac.

Labour:

- (i) Skilled workers will be transferred to this project from another project. The Project Manager claimed that if the men were returned to him, he could have earned the company an additional Ps.2 lacs in terms of profits.
- (ii) The supervisor undertakes various tasks in the sites and his pay and continuity of employment will not be affected by the new contract if the contract is taken, he will devote half of his time.

Overheads:

- (i) The equipment that would be used on the contract was bought one year before for Rs.30 lacs and is expected to last for five years. It can also be used on other contracts and the current replacement price will be Rs.32 lacs and in a year's time it will be Rs.25 lacs.

Advanced Management Accounting

- (ii) *The general overheads includes both specific and absorbed overheads. If the contract is not undertaken, Rs.4 lacks of the same can be avoided.*

Ranka Builders has also on hand another project, which would not be executed if the contract from Excel Ltd. were to be accepted. The estimated profit on that project is Rs.10 lacs.

In the light of information given above, you are required to indicate with reasons whether the contract from Excel Ltd. should be accepted or not.

Answer

M/s Ranka Builder's
Statement of relevant costs on the
Acceptance of contract form Excel Ltd.

(Figure in laksh of Rs.)

S. No.	Particulars	Basis for the cost to be relevant	Relevant cost if contract is accepted Rs.	Irrelevant cost if the contract is accepted Rs.
1.	Land cost (Refer to working note 1)		20	
2.	Drawings and design		-	7 (Sunk cost)
3.	Registration	Incremental	10	-
4.	Materials:			
	Cement and sand	Replacement	8	
	Bricks and Tiles	Opportunity	5	
	Steel	Incremental	10	
	Others (Refer to working note 2)		9	
5.	Labour:			
	Skilled	Opportunity	2	
	Unskilled	Incremental	8	
	Supervisor's Salary			5 (Sunk Cost)
6.	Overheads:			
	General	Relevant (avoidable)	4	

Cost Concepts in Decision Making

Depreciation	-	6 (Sunk Cost)
Replacement cost of machine	7	
7. Estimated profit foregone on Opportunity other project foregone	10	
Total	93	

Decision: Since the offer price of contract is Rs.1 crore and its total relevant cost is Rs.93 lacs; these figures clearly shows that the offer should be accepted.

Working notes:

- Rs. (Lacs)
Total cost of 3 grounds of land 60
Cost of ground of land will be borne by Excel Ltd. 40
Cost of 1 ground of land will be borne by M/s Ranka Builders 20
- Others material cost is Rs.10 lacs, it includes material worth Rs.2 lacs, relating to interior decoration, which is a sunk cost, this material can be sold for Rs.1 lac, (which is a relevant opportunity cost) and Rs.8 lacs, material is an incremental cost. Hence total relevant cost of others material is Rs.9 lacs. (Rs.8 lacs, incremental + Rs.1 lac, opportunity cost).
- Since the equipment can also be used on ths contract. Its current replacement price is Rs.32 lacs, and after one year its cost will be Rs.25 lacs. Therefore the relevant opportunity cost of machine is: (Rs.32 lacs – Rs.25 lacs).

Question 7

AB Ltd. manufactures product 'X'. the company operates single shift of 8 hours for 300 days in a year. The capital employed in the business is Rs.18 crores.

The manufacturing operations of the company comprise of four production departments. The company at present produces 9,000 units of product 'X' at maimum capacity. However, the capacity utilization of all the four departments are not equal and the present individual capacity utilizations are as under:

		Department
Capacity Utilisation %	A	75
	B	100
	C	70
	D	50

Advanced Management Accounting

The present return on capital of the company has gone down to 10% from the earlier cut-off rate of 15% due to increased cost of production.

As the company cannot operate more than one shift, the management is considering two alternative proposals to increase the return on capital employed.

Alternative I

To hire out the surplus capacity of departments A, C and D. The cost and revenue projections are as under:

<i>Department</i>	<i>Hire Charges per Hour</i>	<i>Incremental Cost per Hour</i>
A	2,500	2,000
C	1,800	1,500
D	1,600	1,200

Alternative II

To increase the installed capacity of the factory to 12,000 units by adding plant and machinery in department B at a capita cost of Rs.4 crore. Any Balance surplus capacity in other departments after meeting the increased volume to be hired out as per alternative I. The additional units would fetch incremental revenue of Rs.1,600 per unit.

You are required to evaluate the two proposals and suggest to the management, which of the two proposals is to be accepted.

Answer**Working notes:**

- Statement of total available, utilized and surplus capacity hours when 9,000 units of product 'X' are produced.

<i>Departments</i>	<i>Available Capacity hours</i>	<i>Capacity utilized</i>		<i>Surplus Capacity hours</i>
		<i>(in %</i>	<i>(in hours)</i>	
(1)	(2)	(3)	(4) = (2)×(3)	(5)=(2)-(4)
A	2,400 (300 days × 8 hours)	75	1,800	600
B	2,400	100	2,400	NIL
C	2,400	70	1,680	720
D	2,400	50	1,200	1,200

Cost Concepts in Decision Making

2. Statement of total available, utilized and surplus capacity hours when 12,000 units of product 'X' are produced.

<i>Production Department</i>	<i>Available capacity hours</i>	<i>Capacity utilization on 9,000 units</i> <i>Hours</i>		<i>Balance capacity hours</i>	<i>Unit per hour</i>	<i>Hours required for 3,000 additional units</i>	<i>Surplus capacity hours</i>
(1)	(2)	(3)	(4)=(2)× (3)	(5)	(6)	(7)	(8)=(5)- (7)
A	2,400	75	1,800	600	5 $\left(\frac{9,000 \text{ units}}{1,800 \text{ hrs.}}\right)$	600	Nil
B	2,400	100	2,400	Nil	3.75 $\left(\frac{9,000 \text{ units}}{2,400 \text{ hrs.}}\right)$	800	Nil
C	2,400	70	1,680	720	5.36 $\left(\frac{9,000 \text{ units}}{1,680 \text{ hrs.}}\right)$	560	160
D	2,400	50	1,200	1,200	7.5 $\left(\frac{9,000 \text{ units}}{1,200 \text{ hrs.}}\right)$	400	800

Alternative I

Statement of net Revenue (Under Alternative I)

<i>Production</i>	<i>Surplus capacity hours</i> <i>(Refer to W.N.-1)</i>	<i>Hire charges per hour</i>	<i>Total revenue in (Rs. Lacs)</i>	<i>Incremental costs per hour Rs.</i>	<i>Total cost in (Rs. Lacs)</i>	<i>Net revenue in (Rs.)</i>
	(a)	(b)	(c)=(a)×(b)	(d)	(e)=(a)×(d)	(f)=(c)-(e)
A	600	2,500	15.00	2,000	12.00	3.00
B	720	1,800	12.96	1,500	10.80	2.16
D	1,200	1,600	19.20	1,200	14.40	4.90
Total			47.16		37.20	9.96

Advanced Management Accounting

Add: present income (10% of Rs.1,800 lacs) 180.00

Total return 189.96

Return on investment

$$= \frac{\text{Total return}}{\text{Total investment}} \times 100 = \frac{189.96}{1,800} \times 100 = 10.553\%$$

Alternative II

Statement of Net Revenue when 12,000 units of product 'X' are produced and surplus plant capacity (hours) in departments C and D hired out.

<i>Production</i>	<i>Surplus capacity hours (Refer to W.N.-2)</i>	<i>Hire charges per hour</i>	<i>Total revenue in (Rs.Lacs)</i>	<i>Incremental costs per hour Rs.</i>	<i>Total cost in (Rs. Lacs)</i>	<i>Net revenue in (Rs. Lacs)</i>
	(1)	(2)	(3)=(1)×(2)	(4)	(5)=(1)×(4)	(6)=(3)-(5)
C	160	1,800	2.88	1,500	2.40	0.48
D	800	1,600	12.80	1,200	9.60	3.20
Total			15.68		12.00	3.68

Add: Revenue (in lacs) earned on 3,000 additional units sale (3,000 units is × Rs.1,600) 48.00

Add: Present income on investment (10% × Rs.1,800 lacs) 180.00

Total Return (in lacs) 231.69

$$\text{Return on investment} = \frac{231.68 \text{ lacs}}{2,200 \text{ lacs}} \times 100 = 10.53\%$$

Evaluation of two alternative proposals:

Since the return on investment under alternative I is more than that under alternative II; therefore it should be accepted.

Question 8

B Ltd. is a company that has, in stock, materials of type XY that cost Rs.75,000, but that are now obsolete and have a scrap value of only Rs.21,000. Other than selling the material for scrap, there are only two alternative uses for them.

Alternative 1 – Converting the obsolete materials into a specialized product, which would require the following additional work and materials:

<i>Material A</i>	<i>600 units</i>
<i>Material B</i>	<i>1,000 units</i>
<i>Direct Labour</i>	
<i>5,000 hours unskilled</i>	
<i>5,000 hours semi skilled</i>	
<i>5,000 hours highly skilled</i>	
<i>Extra selling and delivery expenses</i>	<i>Rs.27,000</i>
<i>Extra advertising</i>	<i>Rs.18,000</i>

The conversion would produce 900 units of saleable product and these could be sold for Rs.300 per unit.

Material A is already in stock and is widely used within the firm. Although present stocks together with orders already planned, will be sufficient to facilitate normal activity and extra material used by adopting this alternative will necessitate such materials being replaced immediately. Material B is also in stock, stock, but is unlikely that any additional supplies can be obtained for some considerable time, because of an industrial dispute. At the present time material B is normally used in the production of product Z, which sells at Rs.390 per unit and incurs total variable cost (excluding Material B) of Rs.210 per unit. Each unit of product Z uses four units of Material B. The details of Materials A and B are as follows:

	<i>Material A</i>	<i>Material B</i>
	<i>(Rs.)</i>	<i>(Rs.)</i>
<i>Acquisition cost at the time of purchase</i>	<i>100 per unit</i>	<i>Rs.10 per unit</i>
<i>Net realizable value</i>	<i>85 per unit</i>	<i>Rs.18 per unit</i>
<i>Replacement cost</i>	<i>90 per unit</i>	<i>-</i>

Alternative 2 – Adopting the obsolete materials for use as a substitute for a sub-assembly that is regularly used within the firm. Details of the extra work and materials required are as follows:

<i>Material C</i>	<i>1,000 units</i>
<i>Direct Labour:</i>	
<i>4,000 hours unskilled</i>	

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*1,000 hours semi-skilled**4,000 hours highly skilled*

1,200 units of the sub-assembly are regularly used per quarter at a cost of Rs.900 per unit. The adaptation of material XY would reduce the quantity of the sub-assembly purchased from outside the firm to 900 units for the next quarter only. However, since the volume purchased would be reduced, some discount would be lost and the price of those purchased from outside would increase to Rs.1,050 per unit for that quarter.

Material C is not available externally though 1,000 units required would be available from stocks, it would be produced as extra production. The standard cost per unit of Material C would be as follows:

	Rs.
<i>Direct labour, 6 hour unskilled labour</i>	18
<i>Raw materials</i>	13
<i>Variable overhead: 6 hours at Re.1</i>	06
<i>Fixed overhead: 6 hours at Rs.3</i>	18
	55

The wage rate and overhead recover rates for B Ltd. are:

<i>Variable overhead</i>	<i>Re.1 per direct labour hour</i>
<i>Fixed overhead</i>	<i>Re.2 per direct labour hour</i>
<i>Unskilled labour</i>	<i>Re.3 per direct labour hour</i>
<i>Semi-skilled labour</i>	<i>Re.4 per direct labour hour</i>
<i>Highly skilled labour</i>	<i>Re.5 per direct labour hour</i>

The unskilled labour is employed on a casual basis and sufficient labour can be acquired to exactly meet the production requirements. Semi-skilled labour is part of the permanent labour force, but the company has temporary excess supply of this type of labour at the present time. Highly skilled labour is in short supply and cannot be increased significantly in the short-term, this labour is presently engaged in meeting the, demand for product L, which requires 4 hours of highly skilled labour. The contribution from the sale of one unit of product L is Rs.24.

Given the above information, you are required to present cost information advising whether the stocks of Material XY should be sold, converted into a specialized product (Alternative 1) or adopted for use as a substitute for a sub-assembly (Alternative 2).

Answer**Alternative 1 – (Conversion versus immediate sale)**

	Rs.	Rs.	Rs.
Sales revenue 900 units at Rs.300 per unit (Refer to working note 1)			2,70,000
Less: Relevant costs			
Material XY opportunity cost (Refer to working note 2)		21,000	
Material A – units @ Rs.90 per unit (Refer to working note 3)		54,000	
Material B – 1,000 units @ Rs.45 per unit (Refer to working note 4)		45,000	
Direct Labour:			
Unskilled – 5,000 hours @ Rs.3 per hour	15,000		
Semi-skilled	Nil		
Highly skilled – 5,000 hours @ Rs.11 (Refer to working note 5)	<u>55,000</u>	70,000	
Variable overheads 15,000 hours @ Re.1 (Refer to working note 6)		15,000	
Extra selling and delivery expenses	27,000		
Extra advertising	<u>18,000</u>	<u>45,000</u>	<u>2,50,000</u>
Fixed advertising		Nil	
(To remain same, not relevant)			-
Excess of relevant revenues			<u>20,000</u>

Alternative 2 – (Adaptation versus Immediate Sale)

Saving on purchase of sub-assembly

Normal spending – 1,200 units @ Rs.900 per unit	10,80,000		
Less: Revised spending – 900 units @ Rs.1,050 per unit (Refer to working note 7)	9,45,000	1,35,000	
Less: Relevant costs:			
Material XY opportunity cost (Refer to working note 2)	21,000		
Material C – 1,000 units @ Rs.37 (Refer to working note 8)	37,000		

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Direct labour

Unskilled – 4,000 hours @ Rs.3 per hour	12,000	
Semi-skilled	Nil	
Highly skilled – 4,000 hours @Rs.11 per hour (Refer to working note 5, 6)	<u>44,000</u>	56,000
Variable Overheads – 9,000 hours @ Re.1/- per hour (Refer to working note 6)		<u>9,000</u> 1,23,000
Fixed overheads	Nil	-
Net relevant savings		<u>12,000</u>

Evaluation:

The evaluation of two alternatives clearly shows that Alternative 1, yields higher net revenue of Rs.8,000 (Rs.20,000 – Rs.12,000). Hence because of higher net revenue of Alternative 1, it is advisable to convert material XY into a specialized product.

Working notes:

1. There will be a additional sales revenue of Rs.2,70,000 if Alternative 1 is chosen.
2. Acceptance of either Alternative 1 or 2 will mean a loss of revenue of Rs.21,000 from the sale of the obsolete material XY and hence it is an opportunity cost for both of the alternatives. The original purchase cost of Rs.75,000 is a sunk cost and thus not relevant.
3. Acceptance of Alternative 1 will mean that material A must be replaced at an additional cost of Rs.54,000.
4. Acceptance of Alternative 1 will mean diversion of material B from the production of product Z. The excess of relevant revenues over relevant cost for product Z is Rs.180 (Rs.390 – Rs.210) and each unit of product Z uses four units of material B. The lost contribution (excluding the cost of material B which is incurred for both alternatives) will therefore be Rs.45 for each unit of material B that is used for converting the obsolete materials into a specialised product.
5. Unskilled labour can be matched exactly to the company's production requirements. Hence acceptance of either alternative 1 or 2 will cause the company to incur additional unskilled labour cost at Rs.3 for each hours. It is assumed that the semi-skilled labour will be able to meet the extra requirements of either alternatives at no extra cost to the company. Hence, cost of semi-skilled labour will not be relevant. Skilled labour is in short supply and can only be obtained by reducing the production of product L, resulting in a loss of

contribution of Rs.24 (given) or Rs.6 per hour of skilled labour. Hence the relevant labour cost will be Rs.6 (contribution lost per hour) + Rs.5 (hourly rate of skilled labour) i.e. Rs.11 per hour.

6. It is assumed that for each direct labour of input, variable overhead will increase by Re.1 hence for each alternative using additional direct labour hours, variable overheads will increase.
7. The cost of purchasing the sub-assembly will be reduced by Rs.1,35,000 if the second alternative is chosen and so these savings are relevant to the decision.
8. The company will incur additional variable costs, of Rs.37 for each unit of material C that is manufactured, so the fixed overheads for material C viz. Rs.18/- per unit is not a relevant cost.

Question 9

Comment on the use of opportunity cost for the purpose of decision-making

Answer

Decision making: Opportunity costs apply to the use of scarce resources, where resources are not secure, there is no sacrifice from the use of these resources.

Where a course of action requires the use of scarce resources, it is necessary to incorporate the lost profit which will be foregone from using scarce resources.

If resources have no alternative use only the additional cash flow resulting from the course of action should be included in decision making as relevant cost.

Question 10

Explain with one example each that sunk cost is irrelevant in making decisions, but irrelevant costs are not sunk costs. (May 2001)

Answer

Sunk cost is a historical cost incurred in the past. In other words it is a cost of a resource already acquired. Future decisions in respect of this resource will not be affected by it. For example, book value of machinery. Hence sunk costs are irrelevant in decision making.

Irrelevant costs are not necessary sunk costs. For example, when a comparison of two alternative production methods using the same material quantity is made, then direct material cost is not affected by the decision but this material cost is not sunk cost.

Advanced Management Accounting

Question 11

The following are cost data for three alternative ways of processing the clerical work for cases brought before the LC Court System:

	A Manual (Rs.)	B Semi Automatic (Rs.)	C Fully Automatic (Rs.)
Monthly fixed costs			
Occupancy	15,000	15,000	15,000
Maintenance contract	0	3,000	10,000
Equipment lease	<u>0</u>	<u>25,000</u>	<u>1,00,000</u>
	<u>15,000</u>	<u>45,000</u>	<u>1,25,000</u>
Unit variable costs (per report):			
Supplies	40	80	20
Labour	5 hrs × 40	1 hr × 60	0.25 hr × 80
	<u>or 200</u>	<u>or 60</u>	<u>or 20</u>
	<u>240</u>	<u>140</u>	<u>40</u>

Required:

- Calculate cost indifference points. Interpret your results.
- If the present case load is 600 cases and it is expected to go up to 850 cases in near future, which method is most appropriate on cost considerations

Answer

- Statement of cost indifference points between ways of processing the clerical work for cases.

	A and B (Rs.)	A and C (Rs.)	B and C (Rs.)
Differential fixed costs: (I)	30,000	1,10,000	80,000
	(Rs.45,000 – Rs.15,000)	(Rs.1,25,000 – Rs.15,000)	(Rs.1,25,000 – Rs.45,000)
Differential variable costs per case: (II)	100	200	100
	(Rs.240 – Rs.140)	(Rs.240 – Rs.40)	(Rs.140 – Rs.40)

Cost Concepts in Decision Making

Cost indifference point (I/II)	300	550	800
(Differential fixed costs / Differential variable costs per case)	Cases	Cases	Cases

Interpretation of results:

At activity level below the indifference points, the alternative with lower fixed costs and higher variable costs should be used. At activity level above the indifference point alternative with higher fixed costs and lower variable costs should be used.

Thus, if expected number of cases is below 300, alternative A should be used. If expected number of cases are between 301 and 800 use alternative B. If expected number of cases is above 800, use alternative C.

- (ii) Present case load is 600. Therefore, alternative B is suitable. As the number of cases is expected to go up to 850 cases, alternative C is most appropriate.

Question 12

“Sunk cost is irrelevant in decision-making, but irrelevant costs are not sunk costs”. Explain with example.

Answer

Sunk costs are costs that have been created by a decision made in the past and that cannot be changed by any decision that will be made in the future. For example, the written down value of assets previously purchased are sunk costs. Sunk costs are not relevant for decision making because they are past costs.

But not all irrelevant costs are sunk costs. For example, a comparison of two alternative production methods may result in identical direct material costs for both the alternatives. In this case, the direct material cost will remain the same whichever alternative is chosen. In this situation, though direct material cost is the future cost to be incurred in accordance with the production, it is irrelevant, but, it is not a sunk cost.

Question 13

Explain the concept of relevancy of cost by citing three examples each of relevant costs and non-relevant costs.

Answer

Relevant costs are those costs which are pertinent to a decision. In other words, these are the costs which are influenced by a decision. Those costs which are not affected by the decision are not relevant costs.

Advanced Management Accounting

Examples of relevant costs are:

- (1) All variable costs are relevant costs.
- (2) Fixed Costs which vary with the decision are relevant costs.
- (3) Incremental costs are relevant costs.

Examples of non-relevant costs:

- (1) All fixed costs are generally non-relevant.
- (2) Variable costs which do not vary with the decision are not relevant costs.
- (3) Book value of the asset is not relevant.

EXERCISE**Question 1**

ZED Ltd. operates two shops. Product A is manufactured in Shop – 1 and customer's job against specific orders are being carried out in Shop 2. Its annual statement of income is:

	Shop-1 (Product-A) Rs.	Shop-2 (Job Works) Rs.	Total Rs.
Sales/Income	<u>1,25,000</u>	<u>2,50,000</u>	<u>3,75,000</u>
Material	40,000	50,000	90,000
Wages	45,000	1,00,000	1,45,000
Depreciation	18,000	31,500	49,500
Power	2,000	3,500	5,500
Rent	5,000	30,000	35,000
Heat and Light	500	3,000	3,500
Other Expenses	<u>4,500</u>	<u>2,000</u>	<u>6,500</u>
Total	<u>1,15,000</u>	<u>2,20,000</u>	<u>3,35,000</u>
Net Income	10,000	30,000	40,000

The depreciation charges are for machines used in the shops. The rent and heat and light are apportioned between the shops on the basis of floor area occupied. All other costs are current expenses identified with the output in a particular shop.

A valued customer has given a job to manufacture 5,000 units of X for shop-2. As the company is already working at its full capacity, it will have to reduce the output of product-A by 50%, to accept the said job. The customer is willing to pay Rs.25 per unit of X. The material and labour will cost Rs.10 and Rs.18 respectively per units. Power will be consumed on the job just equal to the power saved on account of reduction of output of A. In addition the company will have to incur additional overheads of Rs.10,000.

You are required to compute the following in respect of this job.

- Differential cost;
- Full costs;
- Opportunity costs; and
- Sunk cost.

Advise whether the company should accept the job.

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Answer

ZED Ltd. should not accept the job as there will be a chase disadvantage of Rs.42,750/- as computed below:

	Rs.	Rs.
Incremental revenue		
5,000 units @ Rs.25	1,25,000	
Less: Sale of product A	<u>62,500</u>	62,500
Differential costs (a)		<u>1,05,250</u>
Cash disadvantage		<u>42,750</u>

Question 2

Indicate the major areas of short-term decisions in which differential cost analysis is useful.

Answer

1. Accept – or – reject special order decisions.
2. Make – or – buy decisions.
3. Sell – or – process decisions.
4. Reduce – or – maintain price decisions.
5. Add – or – drop product decisions.
6. Operate – or shut down decisions.

Question 3

“Relevant cost analysis helps in drawing the attention of managers to those elements of cost which are relevant for the decision.”

Answer

Refer Chapter 2: Paragraph: 2.1

Question 4

Briefly explain the concept of ‘Opportunity Costs’.

Answer

Refer to Chapter 2: Paragraph: 2.13

Question 5

Mahila Griha Udyog Industries is considering to supply its products – a special range of namkeens – to a departmental store. The contract will last for 50 weeks, and the details are given below:

<i>Material:</i>	<i>Rs.</i>
<i>X (in stock – at original cost)</i>	<i>1,50,000</i>
<i>Y (on order – on contract)</i>	<i>1,80,000</i>
<i>Z (to be ordered)</i>	<i>3,00,000</i>
<i>Labour</i>	
<i>Skilled</i>	<i>5,40,000</i>
<i>Non-skilled</i>	<i>3,00,000</i>
<i>Supervisory</i>	<i>1,00,000</i>
<i>General overheads</i>	<i><u>10,80,000</u></i>
<i>Total cost</i>	<i>26,50,000</i>
<i>Price offered by department store</i>	<i><u>18,00,000</u></i>
<i>Net Loss</i>	<i><u>8,50,000</u></i>

Should the contract be accepted if the following additional information is considered?

- (i) Material X is an obsolete material. It can only be used on another product, the material for which is available at Rs.1,35,000 (Material X requires some adaptation to be used and cost Rs.27,000).*
- (ii) Material Y is ordered for some other product which is no longer required. It now has residual value of Rs.27,000).*
- (iii) Skilled labour can work on other contracts which are presently operated by semi-skilled labour at a cost of Rs.5,70,000.*
- (iv) Non-skilled labour are specifically employed for this contract.*
- (v) Supervisor staff will remain whether or not the contract is accepted. Only two of them can replace other positions where the salary is Rs.35,000.*

Overheads are charged at 200% of skilled labour. Only Rs.1,25,000 would be avoidable, if the contract is not accepted.

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Answer

<i>Decision</i>	<i>Relevant costs (if contract is accepted) Rs.</i>	<i>Relevant costs (if contract is rejected) Rs.</i>
Total cash outflows: (B)	14,65,000	27,000
Net cash inflows: (A) – (B)	3,35,000	1,83,000

The net benefit on accepting the contract is: Rs.3,35,000 – Rs.1,83,000 = Rs.1,52,000.

The contract should be accepted as it yields a net incremental cash inflow of Rs.1,52,000.

CVP ANALYSIS & DECISION MAKING

BASIC CONCEPTS & FORMULAE

1. Marginal Costing

According to CIMA, Marginal costing is the system in which variable costs are charged to cost units and fixed costs of the period are written off in full against the aggregate contribution.

Marginal costing is not a distinct method of costing like job costing, process costing, operating costing, etc. but a special technique used for marginal decision making. Marginal costing is used to provide a basis for the interpretation of cost data to measure the profitability of different products, processes and cost centre in the course of decision making.

2. Cost-volume-profit analysis

Cost-volume-profit analysis (as the name suggests) is the analysis of three variable viz., cost, volume and profit. Such an analysis explores the relationship existing amongst costs, revenue, activity levels and the resulting profit. It aims at measuring variations of cost with volume. In the profit planning of a business, cost-volume-profit (C-V-P) relationship is the most significant factor.

3. Important Factors in Marginal Costing Decisions

In all recommendations of marginal costing decisions, the following factors are to be considered:

- (i) Whether the product or production line in question makes a contribution.
- (ii) Where a choice is to be made between two courses of action, the additional fixed overhead, if any, should be taken into account.
- (iii) The continuity of demand after expansion or renovation or installation of the sophisticated machine and its impact on the selling price should also be considered.
- (iv) Cost is not the only criterion for decision making. Non-cost factors like the necessity to retain the experienced employees, etc. should also be considered.

Advanced Management Accounting

4. Pricing Decisions under Special Circumstances

If goods were sold in the normal circumstances under normal business conditions, the price would cover the total cost plus a margin of profit. Selling prices are not always determined by the cost of production. They may be determined by market conditions but in the long run they tend to become equal to the cost of production of marginal firm. Therefore, a business cannot continue to sell below the total cost for a long period. Occasionally, a firm may have to sell below the total cost.

*The **problem of pricing** can be summarised under three heads:*

- (i) Pricing in periods of recession,
- (ii) Differential selling prices, and
- (iii) Acceptance of an offer and submission of a tender.

5. Make or Buy Decision

Very often management is faced with the problem as to whether a part should be manufactured or it should be purchased from outside market. Under such circumstances two factors are to be considered:

- (a) whether surplus capacity is available, and
- (b) the marginal cost.

6. Shut Down or Continue Decision

Very often it becomes necessary for a firm to temporarily close down the factory due to trade recession with a view to reopening it in the future. In such cases, the decision should be based on the marginal cost analysis. If the products are making a contribution towards fixed expenses or in other words if selling price is above the marginal cost, it is preferable to continue because the losses are minimised. By suspending the manufacture, certain fixed expenses can be avoided and certain extra fixed expenses may be incurred depending upon the nature of the industry, say, for example, extra cost incurred in protecting the machinery. So the decision is based on as to whether the contribution is more than the difference between the fixed expenses incurred in normal operation and the fixed expenses incurred when the plant is shut down.

7. Export V/S Local Sale Decision

When the firm is catering to the needs of the local market and surplus capacity is still available, it may think of utilising the same to meet export orders at price lower than that prevailing in the local market. This decision is made only when the local sale is earning a profit, i.e., where its fixed expenses have already been

recovered by the local sales. In such cases, if the export price is more than the marginal cost, it is preferable to enter the export market. Any reduction in the price prevailing in the local market to fulfil surplus capacity may have adverse effect on the normal local sales. Dumping in the export market at a lower price will not, however, have any such adverse effect on local sales.

8. Expand or Contract Decision

Whenever a decision is to be taken as to whether the capacity is to be expanded or not, consideration should be given to the following points:

- (a) Additional fixed expenses to be incurred.
- (b) Possible decrease in selling price due to increase in production.
- (c) Whether the demand is sufficient to absorb the increased production.

9. Product Mix Decision

Many times the management has to take a decision whether to produce one product or another instead. Generally decision is made on the basis of contribution of each product. Other things being the same the product which yields the highest contribution is best one to produce. But, if there is shortage or limited supply of certain other resources which may act as a key factor like for example, the machine hours, then the contribution is linked with such a key factor for taking a decision.

10. Price-Mix Decision

When a firm can produce two or more products from the same production facilities and the demand of each product is affected by the change in their prices, the management may have to choose price mix which will give the maximum profit, particularly when the production capacity is limited. In such a situation, the firm should compute all the possible combinations and select a price-mix which yields the maximum profitability.

BASIC FORMULAS

1. Sales-Variable Cost = Contribution = Fixed Cost + Profit
2. $P/V \text{ ratio (or } C/S \text{ ratio)} = \frac{\text{Contribution}}{\text{Sales}}$
 $= \frac{\text{Contribution per unit}}{\text{Selling price per unit}}$
 $= \frac{\text{Change in Contribution}}{\text{Change in Sales}}$
3. Break-even Point: Point where there is no profit or no loss.
 - (i) at BEP, Contribution = Fixed Cost

Thus, Break Even Sales (in sales value) = Fixed Cost $\div$ P/V ratio

Advanced Management Accounting

4. Margin of safety
 - = Sales – BEP sales
 - = Contribution / PV ratio - Fixed cost / PV ratio
 - = Profit / PV ratio
5. BEP Calculation in different scenario:
 - (i) With out limiting factor (non- attributable to a single product)
 - BEP in units = Fixed cost ÷ Average contribution p.u.
 - (when sales mix in units are given)
 - BEP in Rs. = Fixed cost ÷ composite p/v ratio
 - (when sales mix in rupee are given)
 - where composite p/v ratio = $\sum [\text{Sales Mix} \times \text{P/V Ratio}]$
 - (ii) With limiting factor (attributable to a single product)
 - Find contribution per limiting factor & give rank. Find total contribution from 1st rank product. Calculate the amount of fixed cost still to recover. Whether it can be recovered by 2nd rank product or not ?
 - (iii) For Perishable product apply the same concept in case of opening stock with different variable cost.
 - e. BEP in case of process costing is expressed in terms of total raw material input
 - f. In capital budgeting, BEP is that sales volume where $\sum \text{discounted Cash in flow} = \sum \text{discounted Cash out flow}$. In case of perpetuity, the financing charge p.a.= CIF pa
 - g. Potential BE: On the basis of sales out of current period production only.
 - h. Multiple BE: Different BE due to change in sales price, variable costs & fixed costs for different production level.
 - i. Cash BEP = Cash fixed cost , contribution p.u. So do not consider the sunk cost.
 - j. BEP for decision making purpose: Accept that proposal where BEP is lowest provided the profit can not be calculated.
6. Shut down point =
$$\frac{\text{Total fixed cost} - \text{Shut down costs}}{\text{Contribution per unit}}$$

Question 1

Enumerate the limitations of using the marginal costing technique.

Answer

Marginal costing is defined as the ascertainment of marginal cost and of the effect on profit of changes in volume or type of output by differentiating between fixed costs and variable costs. Limitations of Marginal Costing Techniques:

The limitations of using the marginal costing technique are as follows:

1. It is difficult to classify exactly the expenses into fixed and variable category. Most of the expenses are neither totally variable nor wholly fixed.
2. Contribution itself is not a guide unless it is linked with the key factor.
3. Sales staff may mistake marginal cost for total cost and sell at a price; which will result in loss or low profits. Hence, sales staff should be cautioned while giving marginal cost.
4. Overheads of fixed nature cannot altogether be excluded particularly in large contracts, while valuing the work-in-progress. In order to show the correct position fixed overheads have to be included in work-in-progress.
5. Some of the assumptions regarding the behaviour of various costs are not necessarily true in a realistic situation. For example, the assumption that fixed cost will remain static throughout is not correct.

Question 2

Briefly discuss on curvilinear CVP analysis.

Answer

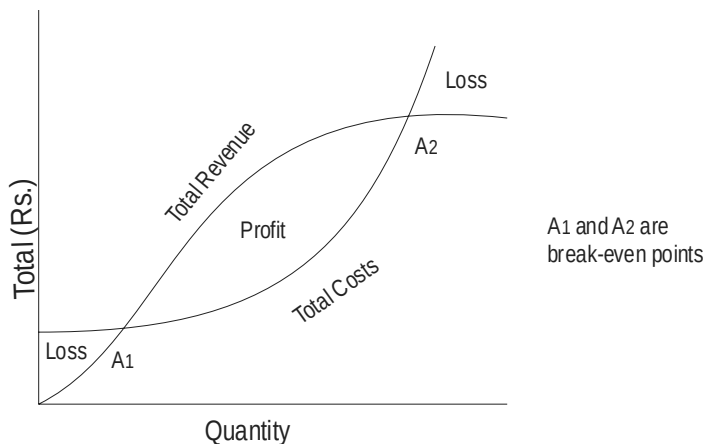
In CVP analysis, the usual assumption is that the total sales line and variable cost line will have linear relationship, that is, these lines will be straight lines. However, in actual practice it is unlikely to have a linear relationship for two reasons, namely:

- after the saturation point of existing demand, the sales value may show a downward trend.
- the average unit variable cost declines initially, reflecting the fact that, as output increase the firm will be able to obtain bulk discounts on the purchase of raw materials and can also benefit from division of labour. When the plant is operated at further higher levels of output, due to bottlenecks and breakdowns the variable cost per unit will tend to increase. Thus the law of increasing costs may operate

Advanced Management Accounting

and the variable cost per unit may increase after reaching a particular level of output.

In such cases, the contribution will not increase in linear proportion i.e. based on the phenomenon of diminishing marginal productivity; the total cost line will not be straight, as assumed but will be of curvilinear shape. This situation will give rise to two break even points. The optimum profit is earned at the point where the distance between sales and total cost is the greatest.



Question 3

A company manufactures two types of herbal product, A and B. Its budget shows profit figures after apportioning the fixed joint cost of Rs.15 lacs in the proportion of the numbers of units sold. The budget for 2002, indicates:

	A	B
Profit (Rs.)	1,50,000	30,000
Selling price / unit (Rs.)	200	120
P/V ratio (%)	40	50

You are required to advise on the best option among the following, if the company expects that the number of units to be sold would be equal.

- Due to exchange in a manufacturing process, the joint fixed cost would be reduced by 15% and the variables would be increased by $7\frac{1}{2}\%$.
- Price of A could be increased by 20% as it is expected that the price elasticity of demand would be unity over the range of price.
- Simultaneous introduction of both the option, viz, (i) and (ii) above.

Answer

1. Contribution per unit of each product:

	<i>Product</i>	
	<i>A</i>	<i>B</i>
	<i>Rs.</i>	<i>Rs.</i>
Contribution per unit	80	60
(Sales × P/V ratio)	(Rs.20 × 40%)	(Rs.12 × 50%)

2. Number of units to be sold:

We know that:

Total contribution – Fixed cost = Profit

Let x be the number of units of each product sold, therefore:

$$(80x + 60x) - \text{Rs.}15,00,000 = \text{Rs.}1,50,000 + \text{Rs.}30,000$$

$$\text{or } x = 12,000 \text{ units}$$

- (i) *Option:* Increase in profit when due to change in a manufacturing process there is reduction in joint fixed cost and increase in variable costs.

	<i>Rs.</i>
Revised contribution from 12,000 units of A due to 7.5% increase in variable cost (12,000 units (Rs.200 – Rs.129))	8,52,000
Revised contribution from 12,000 units of B due to 7.5% increase in variable cost 12,000 units (Rs.120 – Rs.64.50)	6,66,000
Total revised contribution	15,18,000
Less: Fixed cost (Rs.15,00,000 – 15% × Rs.15,00,000)	12,75,000
Revised Profit	2,43,000
Less: Existing profit	1,80,000
Increase in profit	63,000

Advanced Management Accounting

- (ii) Option: Increase in profit when the price of product A increased by 20% and the price elasticity of its demand would be unity over the range of price.

	Rs.
Budgeted revenue from Product A (12,000 units × Rs.200)	24,00,000
Revised demand (in units) (Rs.24,00,000 / Rs.240)	10,000
Revised contribution (in Rs.) [10,000 units × (Rs.240 – Rs.120)]	12,00,000
Less: Existing contribution (12,000 units × Rs.80)	9,60,000
Increase in profit (contribution)	2,40,000

*Note: Since price elasticity of demand is 1, therefore the revenue in respect of products will remain same.

- (iii) Option: Increase in profit on the simultaneous introduction of above two options

	Rs.
Revised contribution from Product A [10,000 units (Rs.240 – Rs.129)]	11,10,000
Revised contribution from Product B [12,000 units (Rs.120 – Rs.64.50)]	6,66,000
Total revised contribution	17,76,000
Less: Revised fixed cost	12,75,000
Revised profit	5,01,000
Less: Existing profit	1,80,000
Increase in profit	3,21,000

Advise: A comparison of increase in profit figures under above three options clearly indicates that the option (iii) is the best as it increases the profit of the concern by Rs.3,21,000.

Note: The budgeted profit/(loss) for 2002 in respect of products A and B should be Rs.2,10,000 and (Rs.30,000) respectively instead of Rs.1,50,000 and Rs.30,000.

Question 4

“Use of absorption costing method for the valuation of finished goods inventory provides incentive for over-production.” Elucidate the statement.

Answer

When absorption costing method is used, production fixed overheads are charged to products and are included in product costs. Consequently, the closing stocks are valued on total cost (including fixed overheads) basis. The net effect is that the charge of fixed overheads to P/L account gets reduced, if the closing stock is greater than the opening stock. This situation has the effect of inflating the profit for the period.

Where stock levels are likely to fluctuate significantly, profits may be distorted if calculated on absorption costing basis. If marginal costing is used, since the fixed costs are charged off to P/L account as period cost, such a situation will not arise. The impact of using absorption costing on profits can be summarised as under:

- When sales are equal to production, profits will be the same under absorption costing and marginal costing.
- If production is higher than sales, the absorption costing will post higher profits than marginal costing.
- If sales are in excess of production, absorption costing will show lower profits than marginal costing.

Since profit calculation in absorption costing can produce strange result, the managers may deliberately alter the stock levels to influence the profits if absorption costing is used. Hence, it is true to say that if absorption costing method is used managers have the incentive to over produce to show better result.

Question 5

A Pharmaceutical company produces formulations having a shelf life of one year. The company has an opening stock of 30,000 boxes on 1st January, 2005 and expected to produce 1, 30,000 boxes as was in the just ended year of 2004. Expected sale would be 1,50,000 boxes. Costing department has worked out escalation in cost by 25% on variable cost and 10% on fixed cost. Fixed cost for the year 2004 is Rs40 per unit. New price announced for 2005 is Rs100 per box. Variable cost on opening stock is Rs40 per box. You are required to compute breakeven volume for the year 2005.

Advanced Management Accounting

Answer

Shelf life is one year hence opening stock of 30,000 boxes is to be sold first. Contribution on these boxes is $30,000(100 - 40) = \text{Rs}18,00,000$.

In the question production of 2004 is same as in 2005. Hence fixed cost for the year 2004 is Rs52, 00,000 ($1, 30,000 \times 40$). Therefore fixed cost for the year 2005 is Rs57, 20,000 ($52, 00,000 + 10\% \text{ of } 52, 00,000$).

Variable Cost for the year 2005 ($\text{Rs}40 + 25\% \text{ of Rs}40$) = Rs50 per Unit

Hence Contribution per unit during 2005 is Rs50 ($100 - 50$)

Break even volume is the volume to meet the fixed cost i.e. fixed cost equals to contribution. Therefore, remaining fixed cost of Rs39, 20,000 ($57, 20,000 - 18, 00,000$) to be recovered from production during 2005.

Production in 2005 to reach BEP = $3920000 / 50 = 78,400$ units

Therefore BEP for the year 2005 is 1, 08,400 boxes ($30000 + 78400$)

Question 6

Jay Kay Limited is a single product manufacturing company. The following information relates to the months of May and June, 2003:

	May	June
	Rs.	Rs.
(i) <i>Budgeted Costs and Selling prices:</i>		
Variable manufacturing cost per unit	2.00	2.20
Total fixed manufacturing cost		
(based on budgeted output of 25,000 units per month)	40,000	44,000
Total fixed marketing cost	14,000	15,400
Selling price per unit	5.00	5.50
(ii) <i>Actual production and sales:</i>		
	Units	Units
Production	24,000	24,000
Sales	21,000	26,500
(iii) <i>There was no stock of finished goods at the beginning of May, 2003. There was no wastage or loss of finished goods during May or June, 2003.</i>		
(iv) <i>Actual costs incurred corresponded to those budgeted for each month.</i>		

You are required to calculate the relative effects on the monthly operating profits of applying: (i) Absorption costing and (ii) Marginal costing.

Answer

(a) Quantity tally:

		May 2003	June 2003
Opening Stock	units	—	3,000
Production	units	24,000	24,000
Total	units	24,000	27,000
Sales	units	21,000	26,500
Closing Stock	units	3,000	500
Fixed manufacturing overheads	Rs.	40,000	44,000
Budgeted output	units	25,000	25,000
Fixed overheads absorption rate per unit	Rs.	1.60	1.76

(i) Profitability based on absorption costing:

	May 2003	June 2003
	Rs.	Rs.
Sales:		
May: 21,000 units @ Rs. 5.00	1,05,000	
June: 26,500 units @ Rs. 5.50		1,45,750
Production Costs:		
Variable: May 24,000 units @ Rs. 2.00	48,000	
June 24,000 units @ Rs. 2.20		52,800
Fixed: May 24,000 units @ Rs. 1.60	38,400	
June 24,000 units @ Rs. 1.76		42,240
Total production costs	86,400	95,040
Add: Opening stock		
May Nil		
June 3,000 units @ Res. 3.60*		10,800
Total	86,400	1,05,840

Advanced Management Accounting

Less: Closing stock

May 3,000 units @ Rs. 3.60*	10,800	
June 500 units @ Rs. 3.96*		1,980
Production cost of goods sold	75,600	1,03,860
Marketing fixed costs	14,000	15,400
Total cost of goods sold	<u>89,600</u>	<u>1,19,260</u>
Profit (Sales – COGS)	15,400	26,490
Budgeted output	25,000 units	
Actual output	24,000 units	
Shortfall	1,000 units	
Under recovery of fixed overheads		
May 1,000 units @ Rs. 1.60	1,600	
June 1,000 units @ Rs. 1.76		1,760
Net profit	<u>13,800</u>	<u>24,730</u>

*Total cost = VC + FC

May $2.00 + 1.60 = 3.60$

June $2.20 + 1.76 = 3.96$

(ii) Profitability based on marginal costing:

	May 2003	June 2003
	Rs.	Rs.
Sales	1,05,000	1,45,750
Production cost – variable	48,000	52,800
Add: Opening stock		
May Nil		
June 3,000 units @ Rs. 2.00		<u>6,000</u>
Total	48,000	58,800
Less: Closing stock		
May 3,000 units @ Rs. 2.00	6,000	
June 500 units @ Rs. 2.20		1,100
Variable cost of goods sold	42,000	57,700

CVP Analysis & Decision Making

Contribution			63,000	88,050
<i>Fixed costs:</i>	May	June		
Production	40,000	44,000		
Marketing	14,000	15,400	54,000	59,400
Net profit			9,000	28,650

Question 7

X Ltd. manufactures a semiconductor for which the cost and price structure is given below:

	<i>Rs. per unit</i>
<i>Selling price</i>	500
<i>Direct material</i>	150
<i>Direct labour</i>	100
<i>Variable overhead</i>	50

Fixed cost = Rs. 2 lakhs.

The product is manufactured by a machine, whose spare part costing Rs. 2,000 needs replacement after every 100 pieces of output. This is in addition to the above costs. Assume that no defectives are produced and that the spare part is readily available in the market at all times at Rs. 2,000.

- (i) Prepare the profitability statement for production levels of 2,000 units and 3,000 units, when fixed cost = Rs. 1 lakhs.*
- (ii) What is the break-even point (BEP) for the above data?*
- (iii) Comment on the BEP, if the fixed cost can be reduced to Rs. 1,80,000 from the existing level of 2 lakhs.*

Answer

- (i) X Ltd. Profitability Statement:**

	Volume Level	
Particulars	2000 units	3000 units
	Rs.'000	
Sales	1,000	1,500

Advanced Management Accounting

Variable costs		
Direct Material	300	450
Direct Labour	200	300
Variable overhead	100	150
Part costs*	40	60
Fixed cost	100	100
Total cost	740	1,060
Profit	260	440

*Part cost: $\frac{2,000}{100} \times 2,000 = 40,000$ $\frac{3,000}{100} \times 60,000 = 2,000$

- (ii) **For computing the BEP:** Parts cost although a step fixed cost can be considered as variable for the limited purpose of computing the range in which BEP occurs.

The variable parts cost per unit is Rs. $20 \left(\frac{2,000}{100} \right)$.

Range in which the BEP occur	$\frac{1,00,000}{(200 - 20)} = 555.55$	$\frac{2,00,000}{(200 - 20)} = 1,111.11$
Range	501–600	1,101–1,200
General Fixed Cost	1,00,000*	2,00,000
Parts cost	$(6 \times 2,000) = 12,000$	$(12 \times 2,000) = 24,000$
Total Fixed Cost	1,12,000	2,24,000
Gross Contribution/unit**	200	200
BEP	560 units	1,120 units

**Gross Contribution per unit

Sales – Direct Material – Direct Labour – Variable Overheads

Rs. 500 – Rs. 150 – Rs. 100 – Rs. 50 = Rs. 200

- (iii) When fixed cost is Rs. 1,80,000. Range of BEP will be $\frac{1,80,000}{180} = 1,000$ (901–1,000)

Since the BEP of 1,000 falls on the upper most limits in the range 901 – 1,000 there will be one more BEP in the subsequent range in 1,001 – 1,100.

Range	901 – 1,000	1,001 – 1,100
	Rs.	Rs.
Gross fixed cost	1,80,000	1,80,000
Parts cost	20,000	22,000
	$10 \times 2,000$	$11 \times 2,000$
Total fixed cost	2,00,000	2,02,000
Gross contribution/unit	200	200
BEP	1,000 units	1,010 units

Question 8

A company has produced 1,500 units against a budgeted quantity of 2,000 units. Actual sales were 1,300 units. The company's policy is to value stocks at standard absorption cost.

Other data are:

Direct material	Rs. 100 per unit
Direct labour	Rs. 100 per unit at normal efficiency
Variable OH	Rs. 50 per unit
Fixed OH at budgeted capacity	Rs. 1,00,000
Variable selling OH	Rs. 26,000
Budgeted fixed selling OH	Rs. 30,000
Actual fixed selling OH	Rs. 25,000
Selling price	Rs. 400 per unit

There was no opening stock.

- Present the profitability statement under absorption costing system.
- Assuming actual labour was 25% below normal efficiency and that 100 units of production had to be scrapped after complete manufacture, compute the actual profit or loss.
- Reconcile the profits under (i) and (ii) above.

Advanced Management Accounting**Answer****(i & ii)** Profitability under absorption costing system Actual profit and loss account

<i>Particulars</i>	<i>Rs. 000's</i>	<i>Particulars</i>	<i>Rs. 000's</i>
Sales (1,300×400)	520	Sales (1,300×400)	520
Absorption costs		Closing Stock (100×300)	30
Opening Stock	Nil	Total	550
Cost of production		Cost	
1,500 units × 300	450	Direct materials (1,500×100)	150
Less: Closing stock (200×300)	60	Direct labour (1,500×100/75%)	200
Net Absorption costs	390	Variable overhead (1,500×50)	75
Add: Under-absorption (500×50)	25	Fixed manufacturing overhead	100
Total absorption costs	415	Fixed Selling overhead	25
Gross profit	105	Variable selling overhead	26
Less: Selling overhead variable	26	Total costs	576
Selling overhead fixed	25		
Profit/(loss)	54	Profit / (Loss)	(26)

Working Notes:

	<i>Rs.</i>	<i>Units</i>
Absorption cost per unit		Budgeted capacity 2,000
Direct materials	100	Production 1,500
Direct labour	100	Under-absorption 500
Variable overhead	50	Sales 1,300
Fixed Overhead (1,00,000 / 2,000)	<u>50</u>	Closing stock 200
Total	<u>300</u>	

(iii) Reconciliation

	<i>Rs. 000's</i>
Profit under absorption costing	54
Less: Labour inefficiency**	(50)
Less: Value of units scrapped	(30)
Actual profit / (loss)	(26)

** (1,500 × (133 1/3 – 100))

Note: In case budgeted fixed selling overheads are considered while arriving at absorption profit a saving of Rs. 5,000 shall need to be identified as part of reconciliation.

Question 9

The following information of a company is available for the year 2006:

	Rs.
Sales	40,000
Raw materials	20,000
Direct wages	6,000
Variable and fixed OH	10,000
Profit	4,000
Units sold	200 Nos.

In the year 2007, wages rate will increase by 50% and fixed cost will decrease by Rs. 600. If 300 units are sold in 2007, the total fixed and variable OH will be 11,400. How many units should be sold in 2007, so that the same amount of profit per unit as in year 2006 may be earned?

Answer

Particulars (Data per unit)	2006	2007
	Rs.	Rs.
Selling price (40,000 /200)		200
Raw materials (20,000 /200)		100
Direct wages (6,000 /200)	30	(30 ×150%) 45
Variable overhead		20
Total variable cost		165
Contribution		35
Profit per unit (4,000 /200)		20
Net contribution per unit to cover fixed overheads		15
Fixed overheads	6,000	5,400
No. of units		5,400/15 = 360 units

Advanced Management Accounting**Working Notes:**

No. of units sold	200	300
Total variable and fixed overheads	10,000	$11,400 + 600 = 12,000$
Differential cost in 2007		100 units Rs. 2,000
Variable overhead per unit		$2,000 / 100 = 20$
Total variable cost	4,000	6,000
Total fixed cost	6,000	$(6,000 - 600) 5,400$

Question 10

A company makes 1,500 units of a product for which the profitability statement is given below:

		Rs.
Sales		1,20,000
Direct materials	30,000	
Direct labour	36,000	
Variable OH	<u>15,000</u>	
Subtotal variable cost		81,000
Fixed cost		<u>16,800</u>
Total cost		<u>97,800</u>
Profit		<u>22,200</u>

After the first 500 units of production, the company has to pay a premium of Rs. 6 per unit towards overtime labour. The premium so paid has been included in the direct labour cost of Rs. 36,000 given above.

You are required to compute the Break-even point.

Answer

Data / Unit	1 – 500	501 – 1,500
	Rs.	Rs.
Sales (1,20,000 / 1,500)	80	80
Direct material (20,000 / 1,000)	20	20
Direct labour	20	26
Variable overheads 15,000 / 1,500	10	10

CVP Analysis & Decision Making

Contribution	30	24
No. of units	500	
Total contribution	15,000	
Fixed costs	16,800	
Shortfall	1,800	
No. of units required above 500 to recover shortfall		$1,800 / 24 = 75$
Break even point		$(500 + 75) = 575$ units

Let X be the Direct Labour per unit upto 500 units.

Total Direct Labour $500X + 1,000 (X + 6) = 36,000$

$$1,500X + 6,000 = 36,000$$

$$X = 20.$$

Therefore, up to 500 units the Direct Labour is Rs. 20. After 500 units it is Rs. 26.

Question 11

A Ltd. Makes and sells a single product. The company's trading results for the year are:

Figs. – Rs. '000 (Year 2007)

Sales		3,000
Direct materials	900	
Direct labour	600	
Overheads	<u>900</u>	<u>2,400</u>
Profits		<u>600</u>

For the year 2008, the following are expected:

- (i) *Reduction in the selling price by 10%.*
- (ii) *Increase in the quantity sold by 50%.*
- (iii) *Inflation of direct material cost by 8%.*
- (iv) *Price inflation in variable overhead by 6%.*
- (v) *Reduction of fixed overhead expenses by 25%.*

It is also known that:

- (a) *In 2006, overhead expenditure totalled to Rs. 8,00,000.*
- (b) *Total overhead cost inflation for 2007 has been 5% more than 2006.*

Advanced Management Accounting

(c) Production and sales volumes have been 25% higher in 2007 than in 2006. The high-low method is being used by the company to estimate overhead expenditure. You are required to:

- Prepare a statement showing the estimated trading results for 2008.
- Calculate the Break-even point for 2007 and 2008.
- Comment on the BEP and profits of the years 2007 and 2008.

Answer

(a)		(i)		Trading Results	
				Figures Rs. '000	
		2006	2007	2008	Workings
Sales:			3,000	4,050	$(3,000 \times 1.5 \times .9)$
			(Refer to Note 1)		
Direct Material			900	1,458	$(900 \times 1.5 \times 1.08)$
Direct Labour			600	900	$(600 \times 1.5 \times 1)$
Variable Overhead			<u>300*</u>	<u>477</u>	$(300 \times 1.06 \times 1.5)$
			(Refer Note 2)		
Total Variable Cost			<u>1,800</u>	<u>2,835</u>	Total variable cost
Contribution			1,200	1,215	
Fixed Overhead			600	450	$(600 \times .75)$
			(Refer to Note 3)		
Total Overhead	800		<u>900</u>	<u>927</u>	
Total Cost			2,400	3,285	
Profits			600	765	
(ii)	P/V Ratio	Contribution/ Sales	40%	30%	
BEP	Fixed Cost/PV Ratio		$\frac{600}{40\%} = 1,500$	$\frac{450}{30\%} = 1,500$	

(Note 1) $3,000 \times 1.5 \times 0.9$

(Note 2) Overhead Cost in 2006 = 800

Increase in price = 5%

$\therefore$ Overhead cost for same production $800 \times 5\% + 800 = 840$.

Overhead increase due to quantity = $900 - 840 = \text{Rs. } 60$

Rs. 60 represents increase in variable Overhead in 2007 due to increase

in quantity by 25%.

$\therefore$ Variable Overhead amount in 2007 = $1\frac{1}{4}$ times

i.e. $\frac{5}{4} = 5 \text{ times } \left(\frac{1}{4} \text{th quantity} \right) = 5 \times 60 = 300$

(Note 3)

In 2007 Total Overhead	900
Variable Overhead (Refer to Note 2)	<u>300</u>
Fixed Overhead	<u>600</u>

(iii)

	2007	2008	Difference	%
BEP	1,500	1,500	0	
Fixed Overhead	600	450	150	25%
PV Ratio	40%	30%	10%	25% $\frac{10}{40}$
Profit	600	765	165	27.5%

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

Both Fixed Cost and P/V ratio have declined by 25% equally. So BEP sales remains the same.

The contribution is only Rs. 1,215 in 2008 though quantity is increased by 50%. This is due to increase in production cost and decrease in selling price. This is more than made up by decrease in fixed cost so that overall profit has increased by 27.5%.

Advanced Management Accounting

Alternative Solution (for identifying variability and fixedness of overheads):

$$V_1 q_1 = \text{Variable Overhead / unit in 2007} \times \text{quantity in 2007}$$

$$V_2 q_2 = \text{Variable Overhead / unit in 2008} \times \text{quantity in 2008}$$

$$V_2 q_2 = V_1 (1.06) (1.5) q_1 = 1.59 V_1 q_1$$

$$V_0 q_0 + F_0 = 800$$

$$V_1 q_0 + F_0 = \underline{840} \text{ where } q_0 \times 1.25 = q_1$$

$$V_1 q_0 - V_0 q_0 = 40$$

$$V_0 q_0 = V_1 q_0 - 40$$

$$V_1 q_0 + F_1 - (V_0 q_0 + F_0) = \frac{5}{100} \times 800 = 40$$

$$\text{i.e. } V_1 q_0 + F_1 = 840$$

$$V_1 q_1 + F_1 = \underline{900}$$

$$V_1 (q_0 - q_1) = -60$$

$$V_1 (q_1 - 1.25 q_0) = -60 \times 1.25$$

$$V_1 (-.25) q_1 = -75$$

$$V_1 q_1 = \frac{-75}{-.25} = 300$$

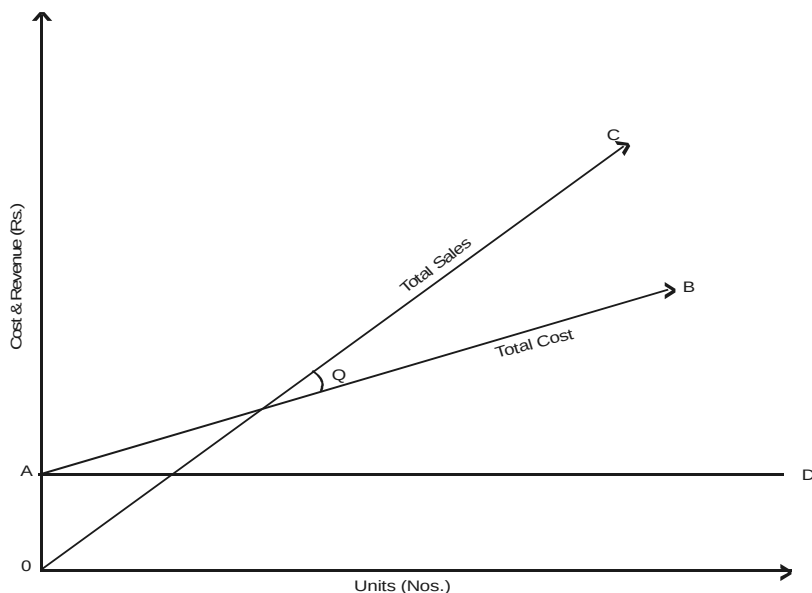
Year 2007	Variable Overhead	300
	Fixed Overhead	<u>600</u>
		900

Question 12

Draw and explain the angle of incidence in a break-even chart. What is its significance to the management?

Answer

(c)



Angle of incidence (θ) is the angle between the total cost line and the total sales line.

If the angle is large, the firm is said to make profits at a high rate and vice-versa.

A high angle of incidence and a high margin of safety indicate sound business conditions.

Question 13

A single product manufacturing company has an installed capacity of 3,00,000 units per annum. The normal capacity utilization of the company is 90%. The company has prepared the following budget for a year:

Variable costs:

Factory costs	Rs. 33 per unit
---------------	-----------------

Selling and Administration costs	Rs. 9 per unit
----------------------------------	----------------

Fixed costs:

Factory costs	Rs. 21,60,000
---------------	---------------

Selling and Administration costs	Rs. 7,56,000
----------------------------------	--------------

Selling Price

Selling price per unit	Rs. 60
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Advanced Management Accounting

The actual production, sales, price and cost data relating to the year under review are as given below:

Production	2,40,000 units
Sales	2,25,000 units
Finished goods stock in the beginning of the year:	15,000 units
Actual factory variable costs exceeded the budget by	Rs. 1,20,000

Required:

- Calculate the budgeted profit and break-even point in units.
- What increase in selling price was necessary during the year under review to maintain the budgeted profit?
- Prepare statements showing the actual profit during the year under review by using (1) absorption costing method and (2) marginal costing method.

Answer

- Contribution per unit:**

	Rs.	Rs.
Selling price per unit		60
Variable costs per unit:		
Factory	33	
Selling & Administration	<u>9</u>	<u>42</u>
Contribution per unit (Selling price – Variable cost)		<u>18</u>

Budgeted Profit:

	Units	Rs.	Rs.
Installed capacity	3,00,000		
Normal capacity utilization (3,00,000 × 90%)	2,70,000		
Total contribution (A) (Contribution per unit × Normal capacity utilization) (2,70,000 × 18)			48,60,000
Fixed Costs (B)			
Factory Costs		21,60,000	
Selling and Administration costs		<u>7,56,000</u>	<u>29,16,000</u>
Profit (A – B)			<u>19,44,000</u>

$$\text{Break - even point (in units)} = \frac{\text{Fixed costs}}{\text{Contribution per unit}}$$

$$= \frac{29,16,000}{18} = 1,62,000.$$

(ii)	1.	Actual variable costs per unit	<i>Rs.</i>	<i>Rs.</i>
		Budgeted factory costs	33	
		Increase in Factory costs per unit		
		$\left(\frac{1,20,000}{2,40,000} \right)$	<u>0.50</u>	33.50
		Selling and Administration costs		<u>9.00</u>
				<u>42.50</u>
	2.	Selling price required to maintain the budgeted profit:		
	A.	Total contribution required (Rs.)		48,60,000
	B.	Actual production (units)		2,40,000
	C.	Contribution desired per unit (A ÷ B) (Rs.)		20.25
	D.	Variable cost per unit (Rs.)		42.50
	E.	Selling price required to maintain budgeted profit (C + D) (Rs.)		62.75
	F.	Increase in selling price necessary Rs. (62.75 – 60)		2.75

(iii) **Fixed overhead recovery rate:**

Fixed factory overheads	<i>Rs.</i> 21,60,000
Normal Production	2,70,000 units
Absorption Rate per unit : 21,60,000 / 2,70,000 = Rs. 8	

Stock analysis:

	<i>Units</i>
Opening stocks	15,000
Add: Production	2,40,000
Total	2,55,000
Less: Sales	2,25,000
Closing stocks	30,000

Advanced Management Accounting

1. Profitability based on Absorption Costing Method:

	Rs.	Rs.
A. Sales (2,25,000 units @ Rs. 60)		<u>1,35,00,000</u>
B. Production costs:		
Variable factory cost: (2,40,000 units × Rs. 33)	79,20,000	
Increase in cost	1,20,000	
Fixed factory costs (2,40,000 units × Rs. 8)	<u>19,20,000</u>	
Total production costs	99,60,000	
Less: Closing stock		
(30,000 units × 99,60,000) / 2,40,000	<u>12,45,000</u>	
	87,15,000	
Add: Opening stock 15,000 units × Rs. 41*	<u>6,15,000</u>	
Production cost of goods sold		93,30,000
C. Selling and Administration Costs:		
Variable costs: 2,25,000 units × Rs. 9	20,25,000	
Fixed Costs	<u>7,56,000</u>	<u>27,81,000</u>
D. Less: Total cost of goods sold (B + C)		<u>1,21,11,000</u>
		13,89,000
Less: Under absorption of factory fixed overheads		
(2,40,000 – 2,70,000 units) × Rs. 8		<u>2,40,000</u>
Profit		<u>11,49,000</u>
Cost of opening stock (per unit)	= Variable Factory cost + Fixed overhead recovery rate	
	= Rs. 33 per unit + Rs. 8 per unit	
	= Rs. 41 per unit.	

Profitability based on Marginal Costing Method:

	Rs.	Rs.
A Sales (2,25,000 units @ Rs. 60)		<u>1,35,00,000</u>
Production variable costs:		
Variable cost (2,40,000 units × Rs. 33)	79,20,000	

CVP Analysis & Decision Making

Increase in cost	<u>1,20,000</u>	
Total	80,40,000	
Less: Closing stock:		
(30,000 × 80,40,000) / 2,40,000	<u>10,05,000</u>	
	70,35,000	
Add: Opening Stock (15,000 units × Rs. 33)	<u>4,95,000</u>	
B Production variable cost of goods sold	75,30,000	
C Variable Selling & Administrative Expenses (2,25,000 × Rs. 9)	20,25,000	
D Total variable costs (B + C)		<u>95,55,000</u>
E Contribution (A – D)		39,45,000
F Less: Fixed overheads: Factory	21,60,000	
Selling & Administration	<u>7,56,000</u>	<u>29,16,000</u>
G Profit (E – F)		<u>10,29,000</u>

Question 14

Bloom Ltd. makes 3 products, A, B and C. The following information is available:

(Figures in Rupees per unit)

	A	B	C
Selling price (peak-season)	550	630	690
Selling price (off-season)	550	604	690
Material cost	230	260	290
Labour (peak-season)	110	120	150
Labour (off-season)	100	99	149
Variable production overhead	100	120	130
Variable selling overhead (only for peak-season)	10	20	15
Labour hours required for one unit of production	8	11	7 (hours)

Material cost and variable production overheads are the same for the peak-season and off-season. Variable selling overheads are not incurred in the off-season. Fixed costs amount to Rs. 26,780 for each season, of which Rs. 2,000 is towards salary for special

Advanced Management Accounting

technician, incurred only for product B, and Rs. 4,780 is the amount that will be incurred on after-sales warranty and free maintenance of only product C, to match competition.

Labour force can be interchangeably used for all the products. During peak-season, there is labour shortage and the maximum labour hours available are 1,617 hours. During off-season, labour is freely available, but demand is limited to 100 units of A, 115 units of B and 135 units of C, with production facility being limited to 215 units for A, B and C put together.

You are required to:

- (i) Advise the company about the best product mix during peak-season for maximum profit.
- (ii) What will be the maximum profit for the off-season?

Answer

(a)

Bloom Ltd.

Peak Season.

Statement of Contribution and BEP (in units)

Figures Rs.

Product	A	B	C
A. Selling Price per unit	<u>550</u>	<u>630</u>	<u>690</u>
Variable Costs per unit:			
Direct Material	230	260	290
Direct Labour	110	120	150
Variable Overhead – Production	100	120	130
Variable Overhead-Selling	<u>10</u>	<u>20</u>	<u>15</u>
B. Total Variable Cost	450	520	585
C. Contribution / unit (A – B)	100	110	105
D. Direct Labour hours / required per unit	8	11	7
E. Contribution per Labour Hour (C / D)	12.5	10	15
F. Ranking	2	3	1
General Fixed Overhead			20,000

CVP Analysis & Decision Making

Specific Fixed overhead	2,000	4,780	<u>6,780</u>
G. Total Fixed Overhead			26,780
H. BEP (units) (for only 1 Product at a time) (G/C)	$\frac{20,000}{100} = 200$	$\frac{22,000}{110} = 200$	$\frac{24,780}{105} = 235$

Maximum units that can be produced of product C with limited labour hours 1,617.

$$= \frac{1,617}{7} = 231.$$

231 < Break Even units.

Hence, Bloom Ltd. cannot produce C.

Next rank = A

Maximum units of A that can be produced with limited labour hours = $\frac{1,617}{8} = 202$ units.

Break Even units of A = 200

∴ Profit if only A is produced

	Rs.
Contribution = Rs. 202 × 100	20,200
Fixed Cost	<u>20,000</u>
Profit	<u>200</u>

Off Season

Bloom Ltd.

Off Season

Statement of Contribution and demand

Figures Rs. per unit

	Product	A	B	C
A	Selling Price	550	604	690
	Direct Material	230	260	290
	Direct Labour	100	99	149
	Production-Variable Overhead	<u>100</u>	<u>120</u>	<u>130</u>

Advanced Management Accounting

B	Total Variable Cost	430	479	569
C	Contribution per unit (A – B)	120	125	121
	Ranking	3	1	2
	Maximum demand	100	115	135
	Overall limit of production			215 units

Statement of profitability under different options

(limit of production = 215 units)

	A	B	C	Total	Fixed Cost	Profit (loss)
Contribution per unit	120	125	121	-		
Option 1: Units	-	115	100	215		
Contribution (Rs.)	-	14,375	12,100	26,475	26,780	(305)
Option 2: Units	100	115	-	215		
Contribution (Rs.)	12,000	14,375	-	26,375	22,000	4,375
Option 3: Units	80	-	135	215		
Contribution (Rs.)	9,600	-	16,335	25,935	24,780	1,155

Best strategy is to produce 100 units of product A and 115 units of product B during off-season.

Maximum profit = Rs. 4,375.

(i) Best strategy for peak-season is to produce 202 units of A.

(ii) Maximum profit for off-season Rs. 4,375.

Question 15

A company has prepared the following budget for the forthcoming year:

	Rs. lakhs
Sales	20.00
Direct materials	3.60
Direct labour	6.40
Factory overheads:	
Variable	2.20

CVP Analysis & Decision Making

<i>Fixed</i>	<i>2.60</i>
<i>Administration overheads</i>	<i>1.80</i>
<i>Sales commission</i>	<i>1.00</i>
<i>Fixed selling overheads</i>	<i><u>0.40</u></i>
<i>Total costs</i>	<i><u>18.00</u></i>
<i>Profit</i>	<i><u>2.00</u></i>

The policy of the company in fixing selling prices is to charge all overheads other than the prime costs on the basis of percentage of direct wages and to add a mark up of one-ninth of total costs for profit.

While the company is confident of achieving the budget drawn up as above, a new customer approached the company directly for execution of a special order. The direct materials and direct labour costs of the special order are estimated respectively at Rs. 36,000 and Rs. 64,000. This special order is in excess of the budgeted sales as envisaged above. The company submitted a quotation of Rs. 2,00,000 for the special order based on its policy. The new customer is willing to pay a price of Rs. 1,50,000 for the special order. The company is hesitant to accept the order below total cost as, according to the company management, it will lead to a loss.

You are required to state your arguments and advise the management on the acceptance of the special order.

Answer**Analysis of Cost and profit:**

	Rs. (lakhs)	Rs. (lakhs)
Direct material	3.60	
Direct labour	<u>6.40</u>	
Prime cost		10.00
Overhead:		
Variable factory overhead	2.20	
Fixed factory overhead	2.60	
Administration overheads	1.80	
Selling commission	1.00	
Fixed selling overheads	<u>0.40</u>	<u>8.00</u>
Total cost		18.00

Advanced Management Accounting

Profit 2.00

Rate of profit on costs $(2/18) = 1/9$

Overhead absorption rate based on direct wages = $(8.00 / 6.40) \times 100 = 125\%$ of direct wages

Break up of new order:	<i>Rs.</i>
Direct Materials	36,000
Direct Labour	64,000
Overheads 125% of direct wages	80,000
Total costs	1,80,000
Profit 1/9	20,000
Selling Price	2,00,000

The following points emerge:

- (i) Factory overheads only are to be recovered on the basis of direct wages.
- (ii) The special order is a direct order. Hence commission is not payable.
- (iii) The budgeted sales are achieved. Hence all fixed overheads are recovered. Hence, no fixed overheads will be chargeable to the special order.

Based on the above, the factory variable overheads recovery rate may be calculated as under:

Total variable factory overheads	Rs. 2.20 lakhs
Direct wages	Rs. 6.40 lakhs
Factory overhead rate = $(2.20 / 6.40) \times 100 = 34.375\%$	

Applying this rate the cost of the special order will be as under:

	<i>Rs.</i>
Direct materials	36,000
Direct labour	64,000
Overheads 34.375% of direct wages	22,000
Total costs	1,22,000
Price offered	1,50,000
Margin	28,000 (more than 1/9)

Hence, the order is acceptable at the price of Rs. 1,50,000.

Question 16

Paints Ltd. manufactures 2,00,000 tins of paint at normal capacity. It incurs the following manufacturing costs per unit:

	Rs.
Direct material	7.80
Direct labour	2.10
Variable overhead	2.50
Fixed overhead	<u>4.00</u>
Production cost / unit	<u>16.40</u>

Each unit is sold for Rs. 21, with an additional variable selling overhead incurred at Rs. 0.60 per unit.

During the next quarter, only 10,000 units can be produced and sold. Management plans to shut down the plant estimating that the fixed manufacturing cost can be reduced to Rs. 74,000 for the quarter.

When the plant is operating, the fixed overheads are incurred at a uniform rate throughout the year. Additional costs of plant shut down for the quarter are estimated at Rs. 14,000.

You are required:

- To advise whether it is more economical to shut down the plant during the quarter rather than operate the plant.*
- Calculate the shut down point for the quarter in terms of numbering units.*

Answer

$$\begin{aligned}
 \text{Contribution per tin} &= \text{Selling Price} - \text{Variable cost} \\
 &= 21 - (7.8 + 2.1 + 2.5 + 0.6) \\
 &= \text{Rs. 8 per tin.}
 \end{aligned}$$

Loss on operation:

$$\text{Fixed cost per annum} = 2,00,000 \text{ units} \times 4 \text{ per unit} = 8 \text{ lakhs.}$$

$$\therefore \text{Fixed cost for 1 quarter} = \frac{8}{4} = 2 \text{ lakhs}$$

Advanced Management Accounting

	Rs.
Fixed cost for the quarter	2,00,000
Less: Contribution on operation ($8 \times 10,000$)	<u>80,000</u>
Expected loss on operation	<u>(1,20,000)</u>

Loss on shut down:

	Rs.
Unavoidable Fixed Cost	74,000
Additional shut down cost	<u>14,000</u>
Loss on shut-down	<u>(88,000)</u>

Conclusion: Better to shut down and save Rs. 32,000.

$$\begin{aligned}
 \text{Shut-down point (number of units)} &= \frac{\text{Avoidable Fixed Cost}}{\text{Contribution per unit}} \\
 &= \frac{2,00,000 - 88,000}{8} \\
 &= \frac{1,12,000}{8} = 14,000 \text{ units.}
 \end{aligned}$$

Question 17

XYZ Ltd. has two divisions, A and B. Division A makes and sells product A, which can be sold outside as well as be used by B. A has a limitation on production capacity, that only 1,200 units can pass through its machining operations in one month. On an average, about 10% of the units that A produces are defective. It may be assumed that out of each lot that A supplies, 10% are defectives. (12 Marks)

When A sells in the outside market, the defectives are not returned, since the transportation costs make it uneconomical for the customer. Instead, A's customers sell the defectives in the outside market at a discount.

But, when B buys product A, it has to fix it into its product, which is reputed for its quality. Therefore, B returns all the defective units to A. A can manually rework the defectives, incurring only variable labour cost and sell them outside at Rs.150 and not having to incur any selling costs on reworked units. If A chooses not to rework, it can only scrap the material at Rs.30 per unit. B can buy product A from outside at Rs.200 per unit, but has to incur Rs.10 per unit as variable transport cost. B can insist to its outside suppliers also that it will accept only good units.

A incurs a variable selling overhead only on units (other than reworked units) sold outside. The following figures are given for the month:

Variable cost of production – Dept. A (Rs./unit)	120
Variable selling overhead (Rs./u)	20
Selling price per unit in the outside market (Rs./u)	200
Current selling price to B (Rs./u)	190
Additional variable labour cost of reworking defectives (Rs./u)	100
Selling price of reworked defectives (Rs./u)	150
Fixed costs for the month (Rs.)	36,000
Maximum demand from B at present (no. of units)	630

The outside demand can be freely had upto 900units.

Given the demand and supply conditions, you are required to present appropriate calculations for the following:

- (i) *Evaluation of the best strategy for A in the present condition.*
- (ii) *If B can buy only upto 540 units and the outside demand is only 600 units, how much should A charge B to maintain the same level of profit as in (i) above?*

Answer

- (i) Contribution per unit against sale to outside = Rs (200-120-20) = Rs 60
 In case of transfer, good units and rejected units are in proportion of 9:1
 In case of transfer, contribution per good unit = Rs (190 – 120) = Rs 70
 In case of transfer, contribution per rejected unit = Rs (150 – 120-100) = Rs -70
 Thus, effective contribution per unit of transfer = Rs (70 x 0.9 – 70x 0.1) = Rs 56
 As contribution per unit against outside sale is higher, the best strategy should be to sell maximum number of unit to outside marker.

Contribution from outside market from sale of 900 units	=	Rs 54,000
		Rs.(900 x 60)
Contribution from transfer of 300 units to B	=	Rs 16,800
		Rs (300 x 56)
Total Contribution from best strategy	=	Rs 70,800
- (ii) If B's demand is 540 unit, total production required = 600 units.

Advanced Management Accounting

(540 / 0.9)

Taking outside market demand of 600, it is within production capacity of 1200 units.

Now contribution from 600 units of outside sale = Rs 36,000

Rs (600 x 60)

Contribution from rejected 60 units = Rs (4,200)

Rs (60 x – 70)

= Rs 31,800

To keep same level of contribution as in (i), the contribution required from transfer of 540 unit to B = Rs 39,000

(Rs 70,800 – 31,800)

Thus, contribution required per unit = Rs 72.22

Rs 39,000 / 540

Hence price to be charged per unit against transfer to B = Rs 192.2

Rs (120 + 72.22)

Alternative Solution:

Let x be the number of units sold outside and y be the number of units sold to B, before B returns 10% as defectives.

Then, $x + y = 1,200$, is the limitation on production capacity of A.**Department A**

	Outside	to B
	Rs.	Rs.
Selling Prices	200	190
Variable Cost – Production	120	120
Variable Cost – Sale	<u>20</u>	--
Total Variable Cost	<u>140</u>	<u>120</u>
Contribution	60	70

Contribution on x units sold outside = $60x$

Out of y units to B, $10\% = \frac{1}{10}y = .1y$ is returned to A. If A scraps, amount got = 30 per unit.

If A reworks and sells, it gets $150 - 100 = 50$ / unit.

∴ Decision to reworks all defectives. i.e. (.1) (y)

Contribution on good units of B = $0.9y \times 70 = 63y$

Contribution on reworked units of B = $(.1) (y) \times 50 = 5y$

Amount of material lost on manufacture of defectives to B = $12y$

$(.1) (y) \times 120$

∴ Contribution on y gross units transferred to B = $56y$

$63y + 5y - 12y$

Total contribution earned by A = $60x + 56y$

where $x + y = 1200$

To maximize contribution, maximize units sold outside.

∴ 900 units – sell outside.

Balance $\frac{300}{1200}$ units (gross transfer to B, of which B gives back 30 defectives)

Contribution : Rs.60 (900) + Rs.56 (300)
 = Rs.54,000 + Rs.16,800

Contribution = Rs.70,800

Fixed Cost = Rs.36,000

(i) Profit = Rs.34,800

(ii) Outside demand = 600 units

Contribution = $600 \times \text{Rs.60} = \text{Rs.36,000}$

Balance to be got = Rs.34,800

= Rs.70,800

Out of Rs.34,800, defectives of B will give

Rs. 3,000 60×50

Rs. 31,800 charge to B for 540 units

Contribution to be obtained from 540 units of B = Rs. 31,800

Add: Production cost of 600 units @ 120/- = Rs. 72,000

Amount charged for 540 units = Rs. 1,03,800

Advanced Management Accounting

$$\therefore \text{Price to be charged to B} = \frac{1,03,800}{540} = 192.22$$

Per good unit transferred, to maintain the same level of profit as in (a).

Question 18

Ret Ltd., a retail store buys computers from Comp Ltd. and sells them in retail. Comp Ltd. pays Ret Ltd. a commission of 10% on the selling price at which Ret sells to the outside market. This commission is paid at the end of the month in which Ret Ltd. submits a bill for the commission. Ret Ltd. sells the computers to its customers at its store at Rs.30,000 per piece. Comp Ltd. has a policy of not taking back computers once dispatched from its factory. Comp Ltd. sells a minimum of 100 computers to its customers.

Comp Ltd. charges prices to Ret Ltd. as follows:

Rs.29,000 per unit, for order quantity 100 units to 140 units.

Rs.26,000 per unit, for the entire order, if the quantity is 141 to 200 units. Ret Ltd. cannot order less than 100 or more than 200 units from Comp Ltd.

Due to the economic recession, Ret Ltd. will be forced to offer as a free gift, a digital camera costing it Rs.4,500 per piece, which is compatible with the computer. These cameras are sold by another Co., Photo Ltd. only in boxes, where each box contains 50 units. Ret Ltd. can order the cameras only in boxes and these cameras cannot be sold without the computer.

In its own store, Ret Ltd. can sell 110 units of the computer. At another far of location, Ret Ltd. can sell upto 80 units of the computer (along with its free camera), provided it is willing to spend Rs.5,000 per unit on shipping costs. In this market also, the selling price that each unit will fetch is Rs.30,000 per unit.

You are required to:

- (i) State what is Ret's best strategy along with supporting calculations.*
- (ii) Compute the break-even point in units, considering only the above costs.*

Answer

	Order Qty 100-140 (Rs.)	Order Qty 141-200 (Rs.)
Selling Price Rs./u	30,000	30,000
Commission @ 10%	3,000	3,000
Sales revenue p. u.	33,000	33,000

CVP Analysis & Decision Making

Less: Variable purchase cost	29,000	26,000
Contribution / unit (before shipping)	4,000	7,000
Less: Shipping cost > 110 units		5,000
Contribution/ units after Shipping		2,000

- (i) Upto 110 units, Reference will earn a contribution of Rs.4,000/u.
- (ii) Between 110 & 140 units, contribution of 4,000 will be wiped out by 5,000 on shipping costs. Hence we should not consider 110 – 140 range.
- (iii) 101 – 110 not to be considered since additional fixed costs 2,25,000 will not be covered by 10 units.
- (iv) Valid consideration, 100 units or 141 to 190 units.

Fixed cost of box of 50 cameras is Rs. 2,25,000

Units		100	141	150	190
No. of Camera Boxes	A	2	3	3	4
Cost of Cameras (Rs.)	B	4,50,000	6,75,000	6,75,000	9,00,000
Contribution (Rs/u) Rs. 4,000	C	400,000			
Contribution (Rs.) first 110 units @ 7,000/u	D		7,70,000	7,70,000	7,70,000
Contribution (Rs.) Balance units @ 2,000/u	E		62,000	80,000	1,60,000
Total Contribution (F = C + D + E) (Rs.)	F	4,00,000	8,32,000	8,50,000	9,30,000
Profit (F) – (B) (Rs.)	G	- 50,000	1,57,000	1,75,000	30,000

Best strategy buy 150 units from Comp. sell 110 at store and 40 outside.

BEP should be between 151 – 191 units

Extra Camera box cost beyond 150 units = 2,25,000

Less: Profit for 150 units = 1,75,000

Extra profit acquired = 50,000

No. of units to cover this additional costs at contribution 2000 Rs./u = $\frac{50,000}{2,000} = 25$

∴ BEP = 150 + 25 = 175 units

Advanced Management Accounting

Alternative Solution to (ii)

The problem involves fixed cost of 50 Computers i.e Rs 2,25,000 for incremental sale of 50.

	Units sold			
	110	140	150	190
Margin per unit = Sales price – buying price + commission (Rs)	4000	4000	7000	7000
Margin (Excluding shipping cost)	4,40,000	5,60,000	10,50,000	13,30,000
Shipping cost (Rs)		30 x 5000	40 x 5000	80 x 5000
For sale beyond 110 units		= 1,50,00	= 2,00,000	= 4,00,000
Contribution (Rs)	4,40,000	4,10,000	8,50,000	9,30,000
Fixed cost (Cost of Computers)	6,75,000	6,75,000	6,75,000	9,00,000
Profit	-2,75,000	-2,65,000	1,75,000	30,000

Best strategy is sales level at 150 units.

The variations of profit is due to incremental fixed cost.

From the profits at different levels, it is seen that the BEP lies between 151 and 190.

Let BEP = X Units

Margin = 7000 X

Shipping Cost = (X -110)x 5000

Cost of Computers = Rs 9,00,000

We have, $7000 X = (X - 110) \times 5000 + 900000$

Or $7X = 5X - 550 + 900$

Or $2X = 350$ or $X = 175$

Thus, BEP = 175 units.

Question 19

Lee Electronic manufactures four types of electronic products, A,B,C and D. All these products have a good demand in the market. The following figures are given to you:

	A	B	C	D
Material cost (Rs./u)	64	72	45	56
Machining Cost (Rs/u @ Rs. 8 per hour)	48	32	64	24
Other variable costs (Rs/u)	32	36	44	20

CVP Analysis & Decision Making

Selling Price (Rs/u)	162	156	173	118
Market Demand (Units)	52,000	48,500	26,500	30,000

Fixed overhead at different levels of operation are :

Level of operation (in production hours)	Total fixed cost (Rs.)
Upto 1,50,000	10,00,000
1,50,000 – 30,00,000	10,50,000
3,00,000 – 4,50,000	11,00,000
4,50,000- 6,00,000	11,50,000

At present, the available production capacity in the company is 4,98,000 machine hours. This capacity is not enough to meet the entire market demand and hence the production manager wants to increase the capacity. The company wants to retain the customers by meeting their demands through alternative ways. One alternative is to sub-contract a part of its production. The sub-contract offer received as under :

	A	B	C	D
Sub-contract Price (Rs./u)	146	126	155	108

The company seeks your advice in terms of products and quantities to be produced and/or sub-contracted, so as to achieve the maximum possible profit. You are required to also compute the profit expected from your suggestion.

Answer

Demand	52,000	48,500	26,500	30,000
	A	B	C	D
Direct Material	64	72	45	56
M/c	48	32	64	24
Other Variable Cost	<u>32</u>	<u>36</u>	<u>44</u>	<u>20</u>
Total Variable Cost	<u>144</u>	<u>140</u>	<u>153</u>	<u>100</u>
Selling Price	162	156	173	118
Contribution (Rs./u)	18	16	20	18
M/s Hours per unit	6	4	8	3
Contribution (Rs./ M/c hr.)	<u>3</u>	<u>4</u>	<u>2.5</u>	<u>6</u>
Ranking	III	II	IV	I

Advanced Management Accounting

Sub-Contract Cost Rs./u)	146	126	155	108
Contribution (Rs./u) on (Sub-Contract)	16	30	18	8

I Division: It is more profitable to sub-contract B, since contribution is higher sub-contract.

1st Level of Operations: 1,50,000 hours, Produce D as much as possible.

Hours required = 30,000 units × 3 = 90,000 hours

Balance hours available: 60,000 hours.

Produce the next best (i.e. A, Since B is better outsourced)

$$\frac{60,000 \text{ hrs}}{6 \text{ hrs/u}} = 10,000 \text{ units of A.}$$

1st Level of Operation:

		Contribution (units)	Contribution (Rs.)
A	Produce 10,000 units	18	1,80,000
A	Outsource 42,000 units	16	6,72,000
B	48,500 units		
	Outsource fully	30	14,55,000
C	26,500 units		
	Outsource fully	18	
D	30,000 units		
	Fully produce	18	5,40,000
	Total Contribution:		33,24,000
	Less: Fixed cost		10,00,000
	Net Gain		23,24,000

2nd Level of Operation:

Both A and C increase contribution by own manufacture only by Rs.2/- per unit. 1,50,000 hrs can produce 25,000 units of A.

∴ Contribution increases by $25,000 \times 2 = 50,000$

(Difference in Contribution sub-contract and own manufacturing) = 2

But increase in fixed Cost = 50,000

At the 2nd level of operation, the increase in contribution by own manufacturing is exactly set up by increase in fixed costs by Rs.50,000/-. It is a point of financial indifference, but other conditions like reliability or possibility of the sub-contractor increasing his price may be considered and decision may then be towards own manufacture.

3rd Level Additional: 1,50,000 hrs available

Unit of A that are needed = [52,000 – 25,000 (2nd Level) – 10,000 (1st Level)]

= 17,000 units × 6 hrs/u = 1,02,000 hrs.

Balance 48,000 hrs are available for C to produce 6,000 units.

Increase in Contribution over Level 1st or 2nd:

A: 17,000 × 2 = Rs.34,000

C: 6,000 × 2 = Rs.12,000

= Rs.46,000

Increase in fixed costs = Rs.50,000

Additional Loss = Rs. 4,000

4th Level Additional: 1,50,000 hrs can give $\frac{1,50,000}{8} = 18,750$ unit of C.

Increase in Contribution 18,750 × 2 = Rs. 37,500

Increase in Cost = (Rs. 50,000)

Level 3rd loss c/fd = (Rs. 4,000)

Level 1st profit will order by = (Rs. 16,500)

Advice: Do not expand capacities; sell maximum

No. of units by operating at 1,50,000 hrs. capacity (level 1st) and gain Rs.23,24,000.

Summary:

Product	Produce (Units)	Sub-Contract (Units)	Contribution (Production)	Contribution (Sub-Contract)	Total Contribution
A	10,000	42,000	1,80,000	6,72,000	8,52,000
B	-	48,500	-	14,55,000	14,55,000
C	-	26,500	-	4,77,000	4,77,000
D	30,000	-	5,40,000	-	5,40,000

Advanced Management Accounting

	33,24,000
Fixed Cost	10,00,000
Profit	23,24,000

Question 20

TQM Limited makes engines for motor cars for its parent company and for two other motor car manufacturers.

On 31st December, the company has sufficient work order for January and one further order for 21,000 engines. Due to recession in the economy, no further order are expected until May when it is hoped economic prospect for the motor car industry will have improved. Recently factory has been working at only 75% of full capacity and the order for 21,000 engines represents about one month production at this level of activity.

The board of directors are currently considering following two options:

- (i) *Complete the order in February and close the factory in March and April.*

OR

- (ii) *Operate at 25 per cent of full capacity for each of three months of February, March and April.*

The costs per month at different levels of activities are as. follows:

	At 75% (Rs.)	At 25% (Rs.)	Idle (Rs.)
<i>Direct Material</i>	5,25,000	1,75,000	--
<i>Direct Labour</i>	5,23,600	1,73,250	--
<i>Factory overhead:</i>			
<i>Indirect material</i>	8,400	4,900	4,900
<i>Indirect labour</i>	1,01,500	59,500	--
<i>Indirect expenses:</i>			
<i>Repairs and maintenance</i>	28,000	28,000	--
<i>Others expenses</i>	52,500	34,300	26,600
<i>Office overheads:</i>			
<i>Staff salaries</i>	1,48,400	98,000	67,550
<i>Other overheads</i>	28,000	19,950	11,200

Other information is as follows:

- Material cost and labour cost will not be incurred where there is no production.
- On the reopening of the factory, one time cost of training and engagement of new personnel would be Rs.65,800 and overhauling cost of plant would be Rs.14,000.
- Parent company can purchase engines from open market at reasonable price.

Required:

- To express your opinion, along with calculations, as to whether the plant should be shut down during the month of March and April or operate 25% of full capacity for three months.
- To list and comment on cost and non-costs factors which might be relevant to the discussion.

Answer

(i)

	Option I At 75% in Feb and close in March and April (Rs.)	Option II At 25% each from Feb – April (Rs.)
Direct Material	5,25,000	5,25,000
Direct Labour	5,23,600	5,19,750
	10,48,600	10,44,750
Factory Overhead :		
Indirect Material	8,400	14,700
Two months idle	9,800	
Indirect Labour	1,01,500	1,78,500
Training cost	65,800	
Indirect Exp. :		
Repairs & Maintenance	28,000	84,000
Over hauling cost	14,000	
Others Expenses	52,500	1,02,900
Idle × 2	53,200	
Office overhead:		

Advanced Management Accounting

Staff Salaries	1,48,400	2,94,000
Idle 67,550 × 2	1,35,100	
Other overheads	28,000	59,850
Idle	22,400	
Total overhead cost	6,67,100	7,33,950
Total cost	17,15,700	17,78,700

The more economic course of action is to operate at 75% capacity for a month only, and close the plant for March and April. This option will save (Rs.17,78,700 – Rs.17,15,700) = Rs.63,000.

(ii) Cost Factors and Non Cost Factors

In regard to the decision on close down of operations or continuing with operations, the factors to be considered are:

(a) Cost factors:

- (1) The proposal which involves the lower total costs will be selected.
- (2) If the company has contracted the purchases from high quality and high price suppliers, a change in the procurement policy to 'shop around' may be considered to obtain economics in purchases.
- (3) The services of unskilled labour, if any, who do not require re-training may be dispensed with. They may be recruited and put on work without incurring training cost on re-opening of the factory. This will save training and idle time cost.
- (4) The possibility of wage freeze may reluctantly be considered as an extreme measure.

Question 21

Fairbilt Furniture Ltd. manufactures three products: Tables, Chairs and Cabinets. The company is in the process of finalizing the plans for the coming year; hence the executives thought it would be prudent to have a look at the product-wise performance during the current year. The following information is furnished:

	Tables	Chairs	Cabinets
Unit selling price	80	60	36
Direct material	28	24	16
Direct labour	20	12	12

CVP Analysis & Decision Making

Factory overheads:			
Variable	8	6	4
Fixed	8	6	1.28
Cost of production	64	48	33.28
Selling, distribution and general administration expenses :			
Variable	4	2	2
Fixed	4	6	1.52
Unit cost (I)	72	56	36.80
Unit profit (loss) (II)	8	4	(0.80)
Sales volume (units)	10,000	15,000	15,000
Profit (loss)	80,000	60,000	(12,000)

For the coming period, the selling prices and the cost of three products are expected to remain unchanged. There will be an increase in the sales of tables by 1,000 units and the increase in sales of cabinets is expected to be 8,000 units. The sales of chairs will remain to be unchanged. Sufficient additional capacity exists to enable the increased demands to be met without incurring additional fixed costs. Some among the executives contend that it will be unwise to go for additional production and sale of cabinets, since it is already making losses at Rs.0.80 per unit. The suggestion is that cabinets should be eliminated altogether.

Do you agree? Substantiate with necessary analysis and determine the product wise and overall profits for the coming year.

Answer

Note: Reconciliation of the figures given for 'cabinets' reveals the fact that the selling price is 36(36.80 – .80)

Fairbilt Furniture Ltd.**Statement showing Product-wise Contribution and Total Profit**

	Tables		Chairs		Cabinets		Total
	Per Unit	Total	Per unit	Total	Per unit	Total	
Sales volume (units)		10,000		15,000		15,000	
Selling price (Rs.)	<u>80</u>	<u>800,000</u>	<u>60</u>	<u>900,000</u>	<u>36</u>	<u>540,000</u>	<u>22,40,000</u>

Advanced Management Accounting

Direct Material	28	280,000	24	360,000	16	240,000	880,000
Direct Labour	20	200,000	12	180,000	12	180,000	560,000
Variable factory overheads	8	80,000	6	90,000	4	60,000	230,000
Variable selling, distribution and administration overhead	4	40,000	2	30,000	2	30,000	100,000
Total variable cost	60	600,000	44	660,000	34	510,000	1,770,000
Contribution	20	200,000	16	240,000	2	30,000	470,000
Fixed factory overheads		80,000		90,000		19,200	189,200
Fixed selling, distribution and administration overheads		40,000		90,000		22,800	152,800
Total fixed overheads							342,000
Total Profit							128,000

The above analysis shows the cabinets make a contribution of Rs.2 per unit. The loss sustained in the previous year is because of the falling sales volume below breakeven level.

Fairbilt Furniture Ltd.**Budgeted Performance for the Coming Year**

	Tables	Chairs	Cabinets
Unit Contribution (Rs.)	20	16	2
Sales Volume (Units)	11,000	15,000	23,000
Total Contribution (Rs.)	220,000	240,000	40,000
Less: Fixed Cost (Rs.)	120,000	180,000	42,000
Profit (Rs.)	100,000	60,000	4,000

The company makes a total profit of Rs.164,000 if all the products are continued. However, if the production of cabinets is discontinued, there will be an adverse effect on

the overall profit of the company. This is because cabinets also contribute toward meeting the fixed costs of the company.

Question 22

An agro-products producer company is planning its production for next year. The following information is relating to the current year:

Products/Corps	A1	A2	B1	B2
Area occupied (acres)	250	200	300	250
Yield per acre (ton)	50	40	45	60
Selling price per ton (Rs.)	200	250	300	270
Variable cost per acre (Rs.)				
Seeds	300	250	450	400
Pesticides	150	200	300	250
Fertilizers	125	75	100	125
Cultivations	125	75	100	125
Direct wages	4,000	4,500	5,000	5,700

Fixed overhead per annum (Rs.) 53,76,000.

The land that is being used for the production of B1 and B2 can be used for either crop, but not for A1 and A2. The land that is being used for A1 and A2 can be used for either crop, but not for B1 and B2. In order to provide adequate market service, the company must produce each year at least 2,000 tons each of A1 and A2 and 1,800 tons each of B1 and B2.

You are required to:

- Prepare a statement of the profit for the current year.
- Profit for the production mix by fulfilling market commitment.
- Assuming that the land could be cultivated to produce any of the four products and there was no market commitment, calculate: Profit amount of most profitable crop and break-even point of most profitable crop in terms of acres and sales value.

Answer

- Calculation of selling price and contribution per acre:

Products	A1	A2	B1	B2	Total
Yield per acre in (tones)	50	40	45	60	
Selling price per tones (Rs.)	200	250	300	270	

Advanced Management Accounting

Sales revenue per acre (Rs.)	10,000	10,000	13,500	16,200	
Variable cost per acre (Rs.)	4,700	5,100	5,950	6,600	
Contribution per acre (Rs.)	5,300	4,900	7,550	9,600	
Area (acres)	2,50	200	300	250	
Total contribution (Rs.)	13,25,000	9,80,000	22,65,000	24,00,000	69,70,000
Less: Fixed Cost					53,76,000
Profit (Rs.)					15,94,000

(ii) Profit Statement for recommended mix

<i>Products</i>	<i>A1</i>	<i>A2</i>	<i>B1</i>	<i>B2</i>	<i>Total</i>
Contribution per acre	5300	4900	7550	9600	
Rank	1	2	2	1	
Minimum Sales Requirement in acres		2000/40 = 50	1800/45 = 40		
Recommended Mix (in Acres)	400	50	40	510	
Total Contribution (Rs.)	21,20,000	2,45,000	3,02,000	48,96,000	75,63,000
Less: Fixed Cost					53,76,000
Profit					21,87,000

(iii) Most profitable crop: Production should be concentrated on B2 which gives highest contribution per acres Rs.9,600.

Overall contribution if complete land is used for B2 (1,000 × 9,600) = Rs.96,00,000

Less: Fixed Cost = Rs.53,76,000

Profit: = Rs.42,24,000

Break even point in acres for B2 = $5376000 \div 9600 = 560$ acres

Break even point in sales value = $560 \times (270 \times 60) = \text{Rs.}90,72,000$

Question 23

LMV Limited manufactures product Z in departments A and B which also manufacture other products using same plant and machinery. The information of product Z is as follows:

CVP Analysis & Decision Making

Items	Department A (Rs.)	Department B (Rs.)
Direct material per unit	30	25
Direct labour per unit (Rs.10 per hour)	30	40
Overhead rates:		
Fixed	8 per hour	4 per hour
Variable	6 per hour	3 per hour
Value of Plant and Machinery	25 lakhs	15 lakhs

Overheads are recovered on the basis of direct labour hours. Variable selling and distribution overheads relating to product Z are amounting to Rs.30, 000 per month. The product requires a working capital of Rs.4, 00,000 at the target volume of 1,500 units per month occupying 30 per cent of practical capacity.

You are required:

- To calculate the price of product Z to yield a contribution to cover 21 percent rate of return on investment.
- Set the minimum selling price of the product if (1) the product is well established in the market; (2) the product is first time launched in the market.

Answer

- Statement showing price of Product Z

Direct Material	Deptt. A	30	
	Deptt. B	<u>25</u>	55
Direct Labour	Deptt. A	30	
	Deptt. B	<u>40</u>	70
Variable overhead	Deptt. A 3×6	18	
	Deptt B 4×3	<u>12</u>	30
Variable selling and distribution overhead 30,000/1,500			20
Total Variable Cost per unit			<u>175</u>
Total hours required for a target of 1,500 units of product Z			
Deptt. A 1500 × 3			4500 hours
Deptt. B 1500 × 4			<u>6000 hours</u>
			<u>10500 hours</u>

Advanced Management Accounting

10500 hours represent 30% capacity

So total capacity per month $10500 / 0.30 = 35000$ hours.

Yearly capacity is $35000 \times 12 = 420000$ hours.

Fixed capital employed in both department = 40.00 Lakhs

(25 lakhs + 15 Lakhs)

Expected return = $0.21 \times 40,00,000 = 840000$

Contribution per hour = $840000 / 420000 = 2.00$ per hour

Working Capital = $0.21 \times 400000 = 84000$

Contribution per unit $84000 / 18000$ unit = 4.67 per unit

Total contribution required Rs.

To cover fixed cost 3 hours of A and 4 of B = $7 \times 2 = 14.00$

To working capital = 4.67

18.67

Fixed charges recovery is based on usage. Full capacity is not being used by product Z and departments are also producing other products using same plant and machinery. Price of Product = Variable cost + contribution required = $175 + 18.67 = 193.67$ per unit.

(ii) Price of product when product is well established in market:

Variable Cost 175

Fixed Cost (24 + 16) 40

Total price 215

The product is first time launched in the market, and then variable cost Rs.175 should form the basis for price fixation.

EXERCISE**Question 1**

AB Ltd. Manufacture foam, carpets and upholstery in its three divisions. Its operating statement for 1995-96 showing the performance of these divisions drawn for the use of management is reproduced below:

(Rupees in '000)

	Manufacturing Divisions			Total
	Foam	Carpets	Upholstery	
Sales revenue	1,600 (A)	1,200	1,200	4,000
Manufacturing Costs Variable	1,200	700	680	2,580
Fixed (Traceable)	-	100	20	120
	1,200	800	700	2,700
Gross Profit	400	400	500	1,300
Expenses: Administration	134	116	172	422
Selling	202	210	232	644
	336	326	404	(B) 1,066
Net Income	64	74	96	234
Division's Ranking	3 rd	2 nd	1 st	-

- (A) Sales include foam transferred to the Upholstery division at its manufacturing cost Rs.2,00,000.
- (B) Common expenses of Rs.1,30,000 and Rs.1,00,000 on account of administration and selling respectively stand apportioned to these divisions at 10% of Gross Profit in case of administration and 2.5 % of Sales in case of selling expense. Rest of Rs.8,36,000 of the expense are traceable to respective divisions.

The manager of the foam division is not satisfied with the above approach of presenting operating performance. In his opinion his division is best among all the divisions. He requests the management for preparation of revised operating statement using contribution approach and showing internal transfer at market price.

You are required to:

- (a) Draw the revised operating Statement using contribution approach and pricing the internal transfer at market price.

Advanced Management Accounting

- (b) Compute relevant ratios to show comparative profitability of these division and rank them in the light of your answer at (a) above. Further, other your comments on the contention of the manager of foam division.
- (c) State why the contribution approach and pricing of internal transfer at market price are more appropriate in realistic assessment of the performance of various divisions.

Answer

				(Rs.'000)
Divisions	Foam	Carpets	Upholstery	Total
(a) Contribution:	480	500	440	1,420
(b) Fixed Cost	256	356	344	956
(c) Net Income of the company				234

Question 2

K. Ltd. Manufactures and sells a range of sport goods. Management is considering a proposal for an advertising campaign, which would cost the company Rs.3,00,000. The marketing department has put forward the following two alternative sales budgets for the following year.

	Product ('000)			
	A	B	C	D
Budget 1 – Without Advertising	216	336	312	180
Budget – 2 With Advertising	240	372	342	198

Selling prices and variable production costs are budgeted as follow:

	Product (Rs. Per unit)			
	A	B	C	D
Selling prices	11.94	14.34	27.54	23.94
Variable Production Costs:				
Direct Material	5.04	6.60	15.24	12.48
Direct Labour	2.04	2.04	3.36	3.18
Variable overheads	0.72	0.72	1.20	1.08

Other Data:

- (1) The variable overheads are absorbed on a machine hour basis at a rate of Rs.1.20 per machine hour.
- (2) Fixed overheads total Rs.30,84,000 per annum.
- (3) Production capacity during the budget period 8,15,000 machine hours.
- (4) Products A and C could be bought in at Rs.10.68 per unit and Rs.24 per unit respectively.

Required:

- (i) Determine whether investment in the advertising campaign would be worthwhile and how production facilities would be best utilised.
- (ii) Explain the assumptions and reasoning behind your advise.

Answer

Statement of production facilities utilisation

Product	Machine hours utilised
A	1,44,000
B	2,23,200
C	2,69,600
D	1,78,000
Total	8,15,000

Question 3

You have been approached by a friend who is seeking your advice as to whether he should give up his job as an engineer, with a current salary of Rs.14,800 per month and go into business on his own, assembling and selling a component which he has invented. He can procure the parts required to manufacture the component from a supplier.

It is very difficult to forecast the sales potential of the component, but after some research, your friend has estimated the sales as follows:

- (i) Between 600 to 900 components per month at a selling price of Rs.250 per component.
- (ii) Between 901 to 1,250 components per month at a selling price of Rs.220 component for the entire lot.

Advanced Management Accounting

The cost of the parts required would be Rs.140 for each completed component. However if more than 1,000 components are produced in each month, a discount of 5% would be received from the supplier of parts on all purchases.

Assembly costs would be Rs.60,000 per month upto 750 components. Beyond this level of activity assembly costs would increase to Rs.70,000 per month.

Your friend has already spent Rs.30,000 on development, which he would write-off over the first five years of the venture.

Required:

- (i) Calculate for each of the possible sales levels at which your friend could expect to benefit by going into the venture on his own.
- (ii) Calculate the break-even point of the venture for each of the selling price.
- (iii) Advise your friend as to the viability of the venture.

Answer

It is not worthwhile to sell between 900 and 1,000 units when no discount is available. Also, it is worthwhile selling at Rs.220 if sales units are in excess of 1,000 units and a discount of 5% is available on the purchase of all components – parts.

Profit on the sale of 1,250 units = 1,250 units × Rs.87 – Rs.84,800 = Rs.23,950

Question 4

SWEET DREAMS LTD. Manufactures and markets three products A, Band C in the State of Haryana and Rajasthan. At the end of first half of 1996-97 the following absorption based profit statement has been drawn by the accountant:

	(Rs. in '000)		
	Haryana	Rajasthan	Total
Sales	3,000	900	3,900
Manufacturing Costs of Sales	<u>2,331</u>	<u>699</u>	<u>3,030</u>
Gross Profit	<u>699</u>	<u>201</u>	<u>870</u>
Administration Expenses (A)	120	36	156
Selling Expenses (B)	184	169	353
Total Expenses	<u>304</u>	<u>205</u>	<u>509</u>
Net Profit	<u>365</u>	<u>(-) 4</u>	<u>361</u>

- (A) The expenses are constant and common to both the States. They stand allocated on the basis of Sales.
- (B) The expenses are semi-fixed but specifically relate to the respective State.

The management is worried to note that the decision taken to market the products in Rajasthan to utilise idle capacity has proved wrong and wish to cover only Haryana State. The incharge marketing division is not satisfied with the above way of profit presentation. He is of the firm opinion that sales effected in the State of Rajasthan is contributing profits. For the next half year he expects no increase in demand in Haryana while for Rajasthan he anticipates to sell B or C more by 50% of existing sales. This will utilise the idle capacity in full.

The product-wise relevant details for the first half of 1996-97 are:

	A	B	C
Sales (in Rs.'000):			
Haryana	1,200	900	900
Rajasthan	300	300	300
Variable Costs (as a % on sales) :			
Manufacturing	40	35	30
Selling	3	2	2
Specific fixed manufacturing expenses (in Rs.'000)	570	470	610

You are required to:

- (a) Prepare s State-wise profit statement for the first half of 1996-97 using contribution approach. Also offer your views on the contention of the management and opinion expressed by incharge marketing division.
- (b) Prepare a product wise profit statement for the same period using contribution approach.
- (c) Submit your well thought out recommendation as to which product should be produced to utilise idle capacity.

Answer

	A	B	C	Total
P/V ratio (Contribution/Sales) × 100	57%	63%	68%	62.23%

Advanced Management Accounting

Recommendation for utilising idle capacity:

A review of the above P/V ratio's shows that the increase of output of product C in Rajasthan is the best. The increase of production after utilising the idle capacity in Rajasthan to the extent of Rs.1,50,000 (i.e. 50% of Rs.3,00,000) would increase the contribution of the company in the state of Rajasthan by Rs.1,02,000 ($68\% \times \text{Rs.1,50,000}$).

Question 5

The relevant data of X Ltd. For its three products A, B and C are as under:

	A	B	C
Direct Material (Rs./Unit)	260	300	250
Direct Labour (Rs./Unit)	130	270	260
Variable Overheads (Rs./Unit)	110	230	180
Selling Price (Rs./Unit)	860	1040	930
Machine Hours Required (per Unit)	12	6	3

The estimated fixed overheads at four different levels of 3,600; 6,000; 8,400 and 10,800 machine hours are Rs.1,00,000; Rs.1,50,000; Rs.2,20,000 and Rs.3,00,000 respectively. The maximum demand of A, B and C in a cost period are 500; 300 and 1,800 units respectively.

You are required to find out (i) the most profitable product-mix at each level and (ii) the level of activity where the profit would be maximum.

Answer

Product	A	B	C
Maximum demand in units	500	300	1,800

Recommendation:

At 8,400 machine hour level of capacity the company would earn maximum profit i.e. Rs.3,20,000.

* Refer to working note.

Question 6

Navbharat Commerce College, Bombay has six sections of B.Com, and two section of M.Com with 40 and 30 students per section respectively. The college plans one-day pleasure trip around the city for the students once in an academic session during winter break to visit park Zoo, planetarium and aquarium.

A transporter used to provide the required number of buses at a flat rate of Rs.700 per bus for the aforesaid purpose. In addition, a special permit fee of Rs.50 per bus is required to be deposited with city Municipal Corporation. Each bus is 52 seater. Two seats are reserved for teachers who accompany in each bus. Each teacher is paid daily allowance of Rs.100 for the day. No other costs in respect of teachers are relevant to the trip.

The approved caterers of the college supply breakfast, lunch and afternoon tea respectively at Rs.7; Rs.30 and Rs.3 per student.

No entrance fee is charged at the park. Entrance fees come to Rs.5 per the zoo and the aquarium. As regards planetarium the authorities charge block entrance fee as under for group of students of educational institutions depending upon the number of students in a group:

No. of students in a Group	Block Entrance Fee
Upto 100	200
101-200	300
201 & above	450

Cost of prizes to be awarded to the winner in different games being arranged in the park depend upon the strength of students in a trip. Cost of prizes to be distributed are:

No. of students in a Trip	Cost of Prizes
Rs.	
Upto 50	900
51-125	1,050
126-150	1,200
151-200	1,300
201-250	1,400
251 & above	1,500

To meet the above costs the college collects Rs.65 from each student who wish to join the trip. The college release subsidy of Rs.10 per student in the trip towards it.

You are required to:

- Prepare a tabulated statement showing total costs at the levels of 60, 120, 180, 240 and 300 students indicating each item of cost.
- Compute average cost per student at each of the above levels.

Advanced Management Accounting

- (c) Calculate the number of students to break even for the trip as the college suffered loss during the previous year despite 72% of the students having joined the trip.

Answer

(a)

No. of students	60	120	180	240	300
Total costs	5,850	9,600	13,500	17,400	21,150

(b)

No. of students:	60	120	180	240	300
Average cost (Rs.)	97.50	80	75	72.50	70.50

(c)

No. of students in the trip	51-100	101-125	126-150	151-200	201-250	251-300
No. of students to break even:	105	140	145	180	220	255

Question 7

A Company produces three products from an imported material. The Cost Structure per unit of the products are as under:

	Product		
	A	B	C
	Rs.	Rs.	Rs.
Sales Value	<u>200</u>	<u>300</u>	<u>250</u>
Direct Material	50	80	60
Direct Wages Rs.6 per hour	60	120	108
Variable Overheads	30	60	54

Out of Direct Material 80% is of the imported material @ Rs.10 per kg.

Prepare a statement showing comparative Profitability of the three products under the following scenarios.

- Imported Material is in restricted supply.
- Production Capacity is limiting factor.

- (iii) When maximum sales potential of products A and B are 1,000 units each and that of product 'C' is 500 units for specific requirement, availability of imported material is restricted 10,000 kgs per month, how the profit could be maximised?

Answer

Products	A	B	C
Contribution per kg (Rs.)	15	6.25	5.83
	4,000	3,600	2,400
No. of units	1,000	562	500

Question 8

Elegant Hotel has a capacity of 100 single rooms and 20 double rooms. It has a sports centre with a swimming pool, which is also used by persons other than residents of the hotel. The hotel has a shopping arcade at the basement and a specialty restaurant at the roof top.

The following information is available:

- (i) Average occupancy: 75% for 365 days of the year.
 (ii) Current costs are:

	Variable cost	Fixed cost
	Rs./per day	Rs./per day
Single Room	400	200
Double Room	500	250

- (iii) Average sales per day of restaurant Rs.1,00,000; contribution is at 30%. Fixed cost Rs.10,00,000.
 (iv) The sports centre/swimming pool is likely to be used by 50 non-residents daily; average contribution per day per non-resident is estimated at Rs.50; fixed cost is Rs.5,00,000 per annum.
 (v) Average contribution per month from the shopping arcade is Rs.50,000; fixed cost is Rs.6,00,000 per annum.

You are required to find out:

- (a) Rent chargeable for single and double room per day, so that there is a margin of safety of 20% on hire of rooms and that the rent for a double room should be kept at 120% of a single room.

Advanced Management Accounting

- (b) Evaluate the profitability of restaurant, sports centre and shopping arcade separately.

Answer

Rent per day of single room (in Rs.)	756 (approx.)
Rent per day of double room (in Rs.)	907 (approx.)
(b) Profitability of restaurant:	Rs. 99,50,000
Profitability of sports centre:	
	Rs.
Contribution of sports centre per day:	4,12,500
Profitability of shopping arcade:	Nil

Question 9

ACE Office Supplies Corporation retails two products – a standard and a deluxe version of a designer ball point pen. The budgeted income statement is as under :

	Standard	Deluxe	Total
Sales (in units)	1,50,000	50,000	2,00,000
	Rs.	Rs.	Rs.
Sales:			
@ Rs.20 per unit	30,00,000	-	-
At Rs.30 per unit	-	15,00,000	45,00,000
Variable Costs:			
At Rs.14 per unit	21,00,000	-	-
At Rs.18 per unit	-	<u>9,00,000</u>	<u>30,00,000</u>
Contribution	9,00,000	6,00,000	15,00,000
Fixed Costs			<u>12,00,000</u>
Profit			<u>3,00,000</u>

Required:

- Calculate the breakeven point in units assuming that the planned sales mix is maintained.
- Calculate the breakeven point in units:
 - if only standard version is sold, and

- (b) if only deluxe version is sold.
- (iii) Suppose 2,00,000 units are sold, but only 20,000 units are of deluxe quality. Calculate the profit. Calculate the breakeven points if these relationships persist in the next accounting period. Compare your answer with the original plan and the answer in requirement (b). what is your major finding?

Answer

- (a) Break even point in units (if only Standard version is sold)
= 2,00,000 units
- (b) Break even point in units (if only Deluxe version is sold)
= 1,00,000 units

Major findings on comparing budgeted sales plan and original sales plan

Sales mix ratio of Standard and Deluxe	Unites to be sold at breakdown		Total units sold	Profit on the sale of 2,00,000 unit
	Standard	Deluxe		
3 : 1	1,20,000	40,000	1,60,000	3,00,000

Question 10

The details of the output presently available from a manufacturing department of Hitech Industries Ltd. Are as follows:

Average output per week 48,000 units from 160 employees

Saleable value of output Rs.6,00,000

Contribution made by the output towards fixed

Expenses and profit Rs.2,40,000

The Board of Directors plans to introduce more automation in the department at a capital cost of Rs.1,60,000. The effect of this will be to reduce the number of employees to 120, but to increase the output per individual employee by 60%. To provide the necessary incentive to achieve the increased output the Board intends to offer a 1% increase in the piecework rate of one rupee per article for every 2% increase in average individual output achieved. To sell the increased output, it will be necessary to decrease the selling price by 4%.

Required:

Calculate the extra weekly contribution resulting from the proposed change and evaluate, for the Board's information, the worth of the project.

Advanced Management Accounting

Answer

- | | | |
|-----|---|-------------------|
| (a) | Proposed piece work rate | = Rs.130 per unit |
| (b) | Proposed sale price per unit | = Rs.12 |
| (c) | Present marginal cost (excluding wages) per unit. | = Rs.6.50 p.u. |

Question 11

Satish Enterprises are leading exporters of Kid's Toys. J Ltd. of U.S.A. have approached Satish Enterprises for Exporting a special toy named "Jumping Monkey". The order will be valid for next three years at 3,000 toys per month. The export price of the toy will be 84.

Cost data per toy is as follows:

	Rs.
Materials	60
Labour	25
Variable overheads	20
Primary packing of the toy	15

The toys will be packed in lots of 50 each. For this purpose a special box, which will contain the 50 toys will have to be purchased, cost being Rs.400 per box.

Satish Enterprises will also have to import a special machine for making the toys. The cost of the machine is Rs.24,00,000 and duty thereon will be at 12%. The machine will have an effective life of 3 years and depreciation is to be charged on straight-line method. Apart from depreciation, annual fixed overheads is estimated at Rs.4,00,000 for the first year with 6% increase in the second year. Fixed overheads are incurred uniformly over the year.

Assuming the average conversion rate to be Rs.50 per \$, you are required to:

- Prepare a monthly and yearly profitability statements for the first year and second year assuming the production at 3,000 today per month.*
- Compute a monthly and yearly break even units in respect of the first year.*
- In what contingency can there be a second break-even point for the month and for the year as a whole?*
- Have you any comments to offer on the above?*

Answer

- (b) (i)** Profit Statement of M/s Satish Enterprises for first and second year on monthly and yearly basis.

	First year		Second Year	
	Monthly Rs.	Yearly Rs.	Monthly Rs.	Yearly Rs.
Profit	108	1,296	106	1,272

Question 12

“Cost is not the only criterion for deciding in favour of shut down” – Briefly explain.

Answer

Refer to Chapter 3: Paragraph 3.5

Question 13

M Company’s Central Services Department is evaluating new coping machines to replace the firm’s current copier, which is worn out. The analysis of alternative machines has been narrowed to three and the estimated costs of operating them are shown below:

	Cost per 100 copies		
	Machine A	Machine B	Machine C
	Rs.	Rs.	Rs.
Materials Cost	60	40	20
Labour Cost	80	30	20
Annual Lease Cost	30,000	58,000	1,00,000

Required:

- Compute the cost indifference points for the three alternatives.*
- What do the cost indifference points suggest as a course of action in this regard?*
- If the management expects to need 87,000 copies next year which copier would be most economical?*

Answer

Cost indifference point for two machines viz.,

- A & B = 400 Nos. (Multiple of 100 copies)
- B & C = 1,400 Nos. (Multiple of 100 copies)
- C & A = 700 Nos. (Multiple of 100 copies)
- Hence from the above we conclude as follows:
From 0 to 400 Nos. (Multiple of 100 copies) use Machine A

Advanced Management Accounting

From 400 to 1,400 Nos. (Multiple of 100 copies) use Machine B

Above 1,400 Nos. (Multiple of 100 copies) use Machine C.

(e) machine B would be most economical.

Question 14

Somesh of Agra presently operates its plant at 80% of the normal capacity to manufacture a product only to meet the demand of Government of Tamil Nadu under a rate contract.

He supplies the product for Rs.4,00,000 and earns a profit margin of 20% on sales realisations Direct cost per unit is constant.

The indirect costs as per his budget projections are:

Indirect costs	20,000 units (80% capacity) Rs.	22,500 units (90% capacity) Rs.	25,000 units (100% capacity) Rs.
Variable	80,000	90,000	1,00,000
Semi-variable	40,000	42,500	45,000
Fixed	80,000	80,000	80,000

He has received an export order for the product equal to 20% of its present operations. Additional packing charges on this order will be Rs.1,000.

Arrive at the price to be quoted for the export order to give him a profit margin of 10% on the export price.

Answer

Price to be quoted	Rs. 50,000
Export price per unit	Rs. 12.50

Question 15

ACE Ltd. has an inventory of 5,000 units of a product left over from last years' production. This model is no longer in demand. It is possible to sell these at reduced prices through the normal distribution channels. The other alternative is to ask someone to take them on "as is where is" basis. The latter alternative will cost the company Rs.5,000.

The company produced 2,40,000 units of the product, last year, when the unit costs were as under:

Manufacturing Costs:

Variable	6.00	
Fixed	1.00	7.00

Selling & Distribution Cost:

<i>Variable</i>	<i>3.00</i>	
<i>Fixed</i>	<i>1.50</i>	<i>4.50</i>
<i>Total Cost</i>		<i>11.50</i>
<i>Selling Price per Unit</i>		<i>14.00</i>

Required:

Should the company scrap the items or sell them at a reduced price? If you suggest the latter, what minimum price would you recommend?

Answer

If the company can get anything more than Rs.2/- per unit, then it is worthwhile to sell the stock of 5,000 units and earn an additional contribution.

PRICING DECISION

BASIC CONCEPTS & FORMULAE

4.1 Role of Pricing Policy

The pricing policy plays an important role in a business because the long run survival of a business depends upon the firm's ability to increase its sales and device the maximum profit from the existing and new capital investment. Although cost is an important aspect of pricing, consumer demand and competitive environment are frequently far more significant in pricing decisions. Thus costs alone do not determine prices. Cost is only one of the many complex factors which determine prices. There must however, be some margin in prices over total cost if capital is to be unimpaired and production maximised by the utilisation of internal surplus.

4.2 Principles of Product Pricing

As already stated cost should not be considered as an important determinant of price. The tendency should be to lower the price in such a way so as to choose a right combination of price and output to maximise profits. The important determinants of price, therefore, are competitive situations prevailing in the market and elasticities. Taking the standard products into consideration, the pricing principles are much the same whether the product is a new one or the one already well established in the market. However the environmental situation and information base are different.

4.3 Pricing of Finished Product

4.3.1 Cost plus pricing: In many business the common method of price determining is to estimate the cost of product & fix a margin of profit.. The term 'cost' here means full cost at current output and wage levels since these are regarded as most relevant in price determination .In arriving at cost of production, it is necessary to determine the size of the unit whose products are to be costed and priced. In order to frame a price policy, one of the element that should receive consideration is the determination of normal capacity.

Advantages:

1. *Fair method*
2. *Assured Profit*
3. *Reduced risks and uncertainties*
4. *Considers market factors*

Disadvantages:

1. *Ignores demand*
2. *Ignores competition*
3. *Arbitrary cost allocation*
4. *Ignores opportunity cost*
5. *Price-Volume relationships*

4.3.2 Rate of Return Pricing: Determination of return on capital employed is one of the most crucial aspect of price fixation process. In this process instead of arbitrarily adding a percentage on cost for profit, the firm determines an average mark up on cost necessary to produce a desired rate of return on its investment.

4.3.3 Variable costs pricing: variable costs which are considered as relevant costs are used for pricing, by adding a mark up to include fixed costs allocation also.

4.3.4 Competitive pricing: When a company sets its price mainly on the consideration of what its competitors are charging, its pricing policy under such a situation is called competitive pricing or competition-oriented pricing.

Different type of competitive pricing in vogue are as follows:

- (i) Going rate pricing
- (ii) Sealed bid pricing
- (i) **Going rate pricing:** It is a competitive pricing method under which a firm tries to keep its price at the **average level** charged by the industry.
- (ii) **Sealed bid-pricing** The bid is the firms offer price, and it is a prime example of pricing based on expectations of how competitors will price rather than on a rigid relation based on the concern's own

costs or demand.

4.3.5 Incremental pricing: Incremental pricing is used because it involves comparison of the impact of decisions on revenues and cost. If a pricing decision results in a greater increase in revenue than in costs, it is favourable.

4.4 Meaning of Pricing Strategies

Pricing strategy is defined as a broad plan of action by which an organisation intends to reach its goal. Some illustrative strategies are:-

- Expanding product lines that enjoy substantial brand equity
- Offer quantity discounts to achieve increase in sales volume.

4.5 Market-Entry strategies

While preparing to enter the market with a new product, management must decide whether to adopt a skimming or penetration pricing strategy.

4.5.1 Skimming pricing: It is a policy of high prices during the early period of a product's existence. This can be synchronised with high promotional expenditure and in the later years *the* prices can be gradually reduced.

4.5.2 Penetration pricing: This policy is in favour of using a low price as the principal instrument for penetrating mass markets early. It is opposite to skimming price. The low price policy is introduced for the sake of long-term survival and profitability and hence it has to receive careful consideration before implementation Penetrating pricing, means a pricing suitable for penetrating mass market as quickly as possible through lower price offers. This method is also used for pricing a new product.

4.6 Price discounts and differentials

4.6.1 Distributors' discounts: It means price deductions that systematically make the net price vary according to buyer's position in the chain of distribution. These discounts are given to various distributors in the trade channel e.g., wholesalers, dealers and retailers.

4.6.2 Quantity discounts: Quantity discounts are price reductions related to the quantities purchased. It may take several forms. It may be related to the size of the order which is being measured in terms of physical units of a particular commodity.

4.6.3 Cash Discounts: Cash discounts are price reductions based on promptness of payment. It is a convenient device to identify and overcome

Advanced Management Accounting

bad credit risks.

4.6.4 Time differentials: Charging different prices on the basis of time is another kind of price discrimination.

Time differentials can be classified under the following heads.

- (i) **Clock-time differentials:** The price differentials are known as clock-time differentials when different prices are charged for the same service or commodity at different times within a 24 hour period.
- (ii) **Calendar-time differentials:** Here price differences are based on a period longer than 24 hours.
- iii) **Geographical price differentials:** It refers to price differentials based on buyers location.
- (iv) **Consumer category price differentials:** Price discriminations is frequently practised according to consumer categories in the case of public utilities,

4.7 Price Discrimination: Price discrimination means charging different prices and it takes various forms according to whether the basis is customer, product, place or time. These are illustrated as under:

4.7.1 Price discrimination on the basis of customer: In this case, the same product is charged at different prices to different customers. It is, however, potentially disruptive of customer relations.

4.7.2 Price discrimination based on product version: In this case, a slightly different product is charged at a different price regardless of its cost-price relationship. If, for example, a table with wooden top can be sold at Rs. 400, a table with sunmica top costing Rs. 175 extra is sold at Rs. 575. The higher premium in the latter case does not necessarily reflect the higher production cost.

4.7.3 Price discrimination based on place: An example of this method is the seats in cinema theatre where the front seats are charged at lower rates than the back seats.

4.7.4 Price discrimination based on time: An example of this method is the practice of giving off-season concession in sale of fans or refrigerators just after the summer season.

4.8 Geographic Pricing Strategies:

In pricing, a seller must consider the costs of shipping goods to the buyer. These

costs grow in importance as freight becomes a larger part of total variable costs. It includes:

- 4.8.1 Point-of-Production Pricing:** In a widely used geographic pricing strategy, the seller quotes the selling price at the point of production and the buyer selects the mode of transportation and pays all freight costs.
- 4.8.2 Uniform Delivered Pricing:** Under uniform delivered pricing, the same delivered price is quoted to all buyers regardless of their locations.
- 4.8.3 Zone-Delivered Pricing:** Zone-delivered pricing divides a seller's market into a limited number of broad geographic zones and then sets a uniform delivered price for each zone.
- 4.8.4 Freight-Absorption Pricing:** Under freight-absorption pricing, a manufacturer will quote to the customer a delivered price equal to its factory price *plus* the freight costs that would be charged by a competitive seller located near that customer.

4.9 Pareto Analysis

Pareto Analysis is a rule that recommends focus on the most important aspects of the decision making in order to simplify the process of decision making. It is based on the 80: 20 rule that was a phenomenon first observed by Vilfredo Pareto, a nineteenth century Italian economist. He noticed that 80% of the wealth of Milan was owned by 20% of its citizens. The management can use it in a number of different circumstances to direct management attention to the key control mechanism or planning aspects.

4.9.1 Usefulness of Pareto Analysis: Pareto analysis is useful to:

- Prioritize problems, goals, and objectives Identify root causes .
- Select and define key quality improvement programs Select key customer relations and service programs Select key employee relations improvement programs.
- Select and define key performance improvement programs Maximize research and product development time.
- Verify operating procedures and manufacturing processes.
- Product or services sales and distribution.
- Allocate physical, financial and human resources.

Advanced Management Accounting

Question 1

What is Penetration pricing? What are the circumstances in which this policy can be adopted?

Answer

Penetration pricing: This pricing policy is in favour of using a low price as the principal instrument for penetrating mass markets early. It is opposite to skimming pricing. The low pricing policy is introduced for the sake of long-term survival and profitability and hence it has to receive careful consideration before implementation. It needs an analysis of the scope for market expansion and hence considerable amount of research and forecasting are necessary before determining the price.

Penetration pricing means a price suitable for penetrating mass market as quickly as possible through lower price offers. This method is also used for pricing a new product. In order to popularize a new product penetrating pricing policy is used initially. The company may not earn profit by resorting to this policy during the initial stage. Later on, the price may be increased as and when the demand picks up. Penetrating pricing policy can also be adopted at any stage of the product life cycle for products whose market is approached with low initial price. The use of this policy by the existing concerns will discourage the new concerns to enter the market. This pricing policy is also known as “stay-out-pricing”.

Circumstances for adoption:

The three circumstances in which penetrating pricing policy can be adopted are as under:

- (i) When demand of the product is elastic to price. In other words, the demand of the product increases when price is low.
- (ii) When there are substantial savings on large-scale production, here increase in demand is sustained by the adoption of low pricing policy.
- (iii) When there is threat of competition. The prices fixed at a low level act as an entry barrier to the prospective competitions.

Question 2

C Ltd. and Indian company, ahs entered into an agreement of strategic alliance with Z Inc. of United States of America for the manufacture of personal computers in India. Broadly, the terms of agreement are:

- (i) *Z will provide C with kits in a dismantled condition. These will be used in the manufacture of the personal computer in India. On a value basis, the supply, in terms of the FOB price will be 50% thereof.*
- (ii) *C will procure the balance of materials in India.*

- (iii) Z will provide to C with designs and drawings in regard to the materials and supplies to be procured in India. For this, C will pay Z a technology fee of Rs.3 crores.
- (iv) Z will also be entitled total royalty at 10% of the selling price of the computers fixed for sales in India as reduced by the cost of standard items procured in India and also the cost of imported kits from Z.
- (v) C will furnish to Z detailed quarterly returns.

Other information available:

- (i) FOB price agreed \$510.
Exchange rate to be adopted \$1 = Rs.47.059
[Note: In making calculations, the final sum may be rounded to the next rupees]
- (ii) Insurance and freight – Rs.500 per imported kit;
- (iii) Customs duty leviable is 150% of the CIF prices; but as a concession, the actual rate leviable has been fixed at 30% of CIF.
- (iv) The technology agreement expires with the production of 2,00,000 computers;
- (v) The quoted price on kits includes a 20% margin of profits on cost to Z.
- (vi) The estimated cost of materials and supplies to be obtained in India will be 140% of the cost of supplies made by Z.
- (vii) 48% of the value in rupees of the locally procured goods represent cost of the standard items.
- (viii) Cost of assembly and other overheads in India will be Rs.2,000 per personal computer.

Required: Calculate the selling price, of a personal computer in India bearing in mind that C has targeted a profit of 20% to itself on the selling price.

Answer

Working Notes:

1. FOB price of dismantled kit:

FOB price of dismantled kit (in\$)	510	
FOB price of dismantled kit (in Rs.)		24,000
(\$510 × Rs.47.059)		
2. Cost of a dismantled kit to Z Inc.

Advanced Management Accounting

If Rs.120 is the S. P. of kit to Z Inc. then its C Rs.100

$$\text{Re 1} = \frac{\text{Rs.100}}{\text{Rs.120}}$$

$$\begin{aligned} \text{If Rs.24,000 is the S. P. then C. P. is} &= \frac{\text{Rs.100}}{\text{Rs.120}} \times \text{Rs.24,000} \\ &= \text{Rs.20,000} \end{aligned}$$

3. Cost of local procurements:

140% of the supplies made by Z Inc. or $140\% \times \text{Rs.10,000}^* = \text{Rs.14,000}$

*Being 50% of cost of a dismantled kit to Z Inc.

4. Landed cost of a dismantled kit:

	Rs.
FOB price	12,000
(50% × Rs.24,000) (Refer to working note 1)	
Add: Insurance & freight	<u>500</u>
CIF price	12,500
Add: Customs duty	3,750
(30% × Rs.12,500)	
Landed cost of a dismantled kit	<u>16,250</u>

5. Cost of the standard items procured locally:

48% of the cost of locally procured goods

$$= 48\% \times \text{Rs.14,000}$$

$$= \text{Rs.6,720}$$

6. Royalty payment per computer:

Let x = Selling price per unit of personal computer

y = Royalty paid per computer

Since 20% is the margin of profit on S.P. it main a margin of 25% on C.P.

Therefore we have

$$X = 1.25 (\text{Rs. } 32,250 + \text{Rs. } 150 + y)$$

$$Y = 10\% \{x - (\text{Rs. } 6,720 + \text{Rs. } 16,250)\}$$

On solving the above equations we get:

$$X = \text{Rs. } 43,000$$

$$Y = \text{Rs. } 2003.43 \text{ or Rs. } 2,000 \text{ (Approx)}$$

Statement showing the selling price of a personal computer in India Rs.

A.	Landed cost of a dismantled kit (Refer to working note 4)	16,250
B.	Cost of local procurement (Refer to working note 3)	4,000
C.	Cost of assembly and other overheads per computer	<u>2,000</u>
D.	Total cost of manufacture: (A+ B + C)	33,250
E.	Technology fee per computer (Rs. 3,00,00,000 / 2,00,000 computer)	150
F.	Royalty payment per unit (Refer to working note 6)	
G.	Total cost (D + E+ F)	34,400
H.	Profit (20% on selling price of 25% o total cost)	<u>8,600</u>
I.	Selling price (per computer)	<u>43,000</u>

Question 3

Explain Skimming pricing strategy.

Answer

Skimming pricing

It is a policy where the prices are kept high during the early period of a product's existence. This can be synchronised with high promotional expenditure and in the latter years the prices can be gradually reduced. The reasons for following such a policy are as follows:

- (1) The demand is likely to be inelastic in the earlier stages till the product is established in the market.
- (2) The gradual reduction in price in the latter years will tend to increase the sales.
- (3) This method is preferred in the beginning because in the initial periods when the demand for the product is not known the price covers the initial cost of production.

Advanced Management Accounting

- (4) High initial capital outlays needed for manufacture, results in high cost of production. In addition to this, the producer has to incur huge promotional activities resulting in increased costs. High initial prices will be able to finance the cost of production particularly when uncertainties block the usual sources of capital.

Question 4

How Pareto analysis is helpful in pricing of product in the case of firm dealing with multi-products?

Answer

In the case of firm dealing with multi products, it would not be possible for it to analyse price-volume relationship for all of them. Pareto Analysis is used for analysing the firm's estimated sales revenue from various products and it might indicate that approximately 80% of its total sales revenue is earned from about 20% of its products. Such analysis helps the top management to delegate the pricing decision for approximately 80% of its product to the lower level of management, thus freeing them to concentrate on the pricing decisions for products approximately 20% of which is essential for the company's survival. Thus, a firm can adopt more sophisticated pricing methods for small proportion of products that jointly account for 80% of total sales revenue. For the remaining 80% products, which account for 20% of the total sales value the firm may use cost based pricing method.

Question 5

An organisation manufactures a product, particulars of which are detailed below:

<i>Annual Production (Units)</i>	<i>20,000</i>
<i>Cost per annum (Rs.)</i>	
<i>Material</i>	<i>50,000</i>
<i>Other variable cost</i>	<i>60,000</i>
<i>Fixed cost</i>	<u><i>40,000</i></u>
<i>Apportioned Investment (Rs.)</i>	<u><i>1,50,000</i></u>

Determine the unit selling price under two strategies mentioned below. Assume that the organisation's Tax rate is 40%—

- (a) 20% return on investment.
 (b) 6% profit on list sales, when trade discount is 40%.

Answer**(i) Selling price to yield 20% return on investment:**

	Rs.
Investment	1,50,000
After tax required ROI 20%	30,000
Tax 40%	
After tax profit $100 - 40 = 60\%$	
Pre tax profit (return) $(30,000 \div 60) \times 100$	50,000
Sales = cost + return or $1,50,000 + 50,000$	2,00,000
Number of units produced	20,000
Selling price $\text{Rs. } 2,00,000 \div 20,000 = \text{Rs. } 10$ per unit	

Alternative solution

$$(\text{Sales} - \text{cost}) (1 - \text{Tax}) = \text{ROI}$$

$$(\text{Sales} - 1,50,000) (1 - 0.40) = 1,50,000 \times 20\%$$

$$(0.60 \text{ Sales} - 90,000) = 30,000$$

$$0.60 \text{ Sales} = 1,20,000$$

$$\text{Sales} = 1,20,000 \div 0.60 = \text{Rs. } 2,00,000$$

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

$$\text{Selling price} = \text{Rs. } 2,00,000 \div 20,000 = \text{Rs. } 10.$$

(ii) Selling price to yield 6% profit on list price.

	Rs.	Rs.
Investment		1,50,000
Let the list price be	100	
Desired after tax profit of 6%	6	
Pre-tax profit $(1 - 0.40) = 0.60 = (6 \div 0.60) =$	10	
List price		100
Discount		40
Net price		60
Profit desired		10

Advanced Management Accounting

Cost

50

Cost of 50% = Rs. 1,50,000

Sales = (Rs.1,50,000 ÷ 50) × 100 = Rs. 3,00,000

Number of units 20,000

List selling price (3,00,000 ÷ 20,000) = Rs. 15

Discount 40%

Net price (15 × 60%) Rs. 9 per unit

Alternative solution

Let s be the list sales

[List Sales (1 – tax discount) – cost] (1 – Tax rate) = 0.60s

[s (1 – .40) – 1, 50,000] (1 – 0.40) = .06s

s = Rs. 3, 00,000

List sales price per unit is Rs. $15 \left(\frac{3,00,000}{20,000} \right)$

Net selling price per unit is Rs. 9 (Rs. 15 – 40% of 15%).

Question 6*Outline the features of penetration pricing strategy***Answer**

- (i) Penetration Pricing: It is a policy of using a low price as the principal instrument for penetrating mass markets early.
- (ii) This method is used for pricing a new product and to popularize it initially.
- (iii) Profits may not be earned in the initial stages. However, prices may be increased as and when the product is established and its demand picks up.
- (iv) The low price policy is introduced for the sake of long term survival and profitability and hence it has to receive careful consideration before implementation. It needs an analysis of the scope for market expansion and hence considerable amount of research and forecasting are necessary before determining the price.
- (v) The circumstances in which penetrating pricing can be adopted are:

Elastic demand: The demand of the product is high when price is low. Hence, lower prices mean large volumes and hence more profits.

Mass Production: When there are substantial savings in large-scale production, increase in demand is sustained by the adoption of low pricing policy.

Frighten off competition: The prices fixed at a low-level acts as an entry barrier to the prospective competitors. The use of this policy by existing concerns will discourage the new concerns to enter the market. This pricing policy is also known as “stay-out-pricing”.

Question 7

S Limited is engaged in manufacturing activities. It has received a request from one of its important customers to supply a product which will require conversion of material ‘M’, which is a non-moving item.

The following details are available:

<i>Book value of material M</i>	<i>Rs. 60</i>
<i>Realisable value of material M</i>	<i>Rs. 80</i>
<i>Replacement cost of material M</i>	<i>Rs. 100</i>

It is estimated that conversion of one unit of ‘M’ into one unit of the finished product will require one labour hour. At present, labour is paid at the rate of Rs. 20 per hour. Other costs are as follows:

<i>Out-of-pocket expenses</i>	<i>Rs. 30 per unit</i>
<i>Allocated overheads</i>	<i>Rs. 10 per unit</i>

The labour will be re-deployed from other activities. It is estimated that the temporary redeployment will not result in loss of contribution. The employees to be re-deployed are permanent employees of the company.

Required:

Estimate the minimum price to be charged from the customer so that the company is not worse off by executing the order.

Answer

Relevant costs of producing one unit of the finished product

	<i>Rs.</i>
Cost of material ‘M’ (realisable value)	80
Cost of labour (Being sunk cost)	0
Out-of-pocket expenses	<u>30</u>
	<u>110</u>

Advanced Management Accounting

Allocated overhead is not relevant for the decision. The customer should be charged Rs. 110 per unit.

Question 8

What is Pareto Analysis? Name some applications.

Answer

Vilfredo Pareto, an Italian economist, observed that about 70 – 80% of value was represented by 30 – 20% of volume. This observation was found to exist in many business solutions.

Analysing and focusing on the 80% value relating to 20% volume helps business in the following areas.

- (i) Pricing of a product (in a multi-product company)
- (ii) Customer profitability.
- (iii) Stock control.
- (iv) Activity Based Costing (20% cost drivers are responsible for 80% of total cost)
- (v) Quality Control.

Question 9

State the general guidelines to be used in adopting a pricing policy in a manufacturing organization.

Answer

The general guidelines to be used in adopting a pricing policy are as under:

- (i) The pricing policy should encourage optimum utilization of resources.
- (ii) The pricing policy should work towards a better balance between demand and supply.
- (iii) The pricing policy should promote exports.
- (iv) The pricing policy should serve as an incentive to the manufacturers to maximize production by adopting improved technology.
- (v) The pricing policy should avoid adverse effects on the rest of the economy.

Question 10

Enumerate the uses of Pareto Analysis.

Answer

Pareto analysis is useful to:

- (i) Prioritize problems, goals and objectives.
- (ii) Identify the root causes.
- (iii) Select and define the key quality improvement programs, key employee relations improvement programs etc.
- (iv) Verify the operating procedures and manufacturing processes.
- (v) Allocate physical, financial and human resources effectively.
- (vi) Maximise research and product development time.

Question 11

Briefly explain skimming pricing and penetration pricing policies.

Answer

Skimming prices: Policy of highly pricing a product at the entry level into the market and reducing it later.

For example: Electronic goods, mobile phone, Flat, TVs, etc.

It is used when market is price insensitive, demand inelastic or to recover high promotional costs.

Penetration Pricing: Policy of entering the market with a low price, then establishing the product and then increasing the price.

This is also used by companies with established markets, when products are in any stage of their life cycle, to avoid competition. This is also known as “stay-out pricing”.

For example, entry of a new model small segment car into the market.

Question 12

Hind Metals Manufactures an alloy product ‘Incop’ by using iron and Copper. The metals pass through two plants, X and Y. The company gives you the following details for the manufacture of one unit of Incop:

Materials

Iron: 10 kgs @ Rs.5 per kg.

Cooper: 5 kg @ Rs.8 per kg.

Wages

3 hours @ Rs.15 per hour in Plant X

5 hours @ Rs.12 per hour in Plant Y

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Overhead recovery *On the basis of direct labour hours*

Fixed overhead *Rs.8 per hour in Plant X*

Rs.5 per hour in Plant Y

Variable overhead *Rs.8 per hour in Plant X*

Rs.5 per hour in Plant Y

Selling overhead: *(fully variable) – Rs.20 per unit*

- (i) Find out the minimum price to be fixed for the alloy, when the alloy is new to the market. Briefly explain this pricing strategy.
- (ii) After the alloy is well established in the market. What should be the minimum selling price? Why?

Answer

		Rs./u of alloy
Materials:		
Iron 10kg @ Rs.5/-	50	
Copper 5 kg @ Rs.8/-	<u>40</u>	90
Wages		
X: 3 hrs @ 15 Rs./Hr.	45	
Y: 5 hrs @ 12 Rs./Hr	<u>60</u>	105
Variable OH (Production)		
X: 8 hrs × 3 hrs	24	
Y: 5 hrs × 5 hrs	<u>25</u>	49
Variable OH – Selling		<u>20</u>
Total Variable Cost		264
Fixed Off:		
X: 8/hrs × 3 hrs.	24	
Y: 5/hrs × 5 hrs	<u>25</u>	<u>49</u>
Total Cost		<u>313</u>

- (i) If pricing strategy is to penetrate the market, the minimum price for a new product should be the variable cost i.e. Rs.264/-. In some circumstances, it can also be sold below the variable cost, if it is expected to quickly penetrate the market and later absorb a price increase. Total Variable Cost is the penetration price.

- (ii) When the alloy is well established, the minimum selling price will be the total cost – including the fixed cost i.e. Rs.313 per unit. Long run costs should cover at least the total cost.

Question 13

What is penetrating pricing? What are the circumstances in which this policy can be adopted?

Answer

The penetration pricing policy implies charging a low price to deter entry of competitors and to expand market share. Circumstances of penetration policy:

- The short run price elasticity of demand is high. By charging a low price, the first entrant is able to establish a market.
- Economies of scale are significant. By entering at a large scale the first firm can both enjoy low average cost and impose a cost penalty on any small scale subsequent entrant.
- Exploitation of established reputation / sales, marketing, distribution strengths. Create platform form for continued sale of related products.
- When there is a threat of competition. It depicted at maturity stage of a product in its life-cycle.

Question 14

A company had nearly completed a job relating to construction of a specialised equipment, when it discovered that the customer had gone out of business. At this stage, the position if the job was as under:

	Rs.
Original cost estimate	1,75,200
Costs incurred so far	1,48,500
Costs to be incurred	29,700
Progress payment received from original customer	1,00,000

After searches, a new customer for the equipment has been found. He is interested to take the equipment, if certain modifications are carried out. The new customer wanted the equipment in its original condition, but without its control device and with certain other modifications. The costs of these additions and modifications are estimated as under:

Direct materials (at cost)	Rs.1,050
----------------------------	----------

Advanced Management Accounting

Direct Wages Dept.:	A	15 man days
Dept.:	B	25 man days
Variable overheads		25% of direct wages in each dept.
Delivery costs		Rs.1,350

Fixed overheads will be absorbed at 50% of direct wages in each department.

The following additional information is available:

- (1) The direct materials required for the modification are in stock and if not used for modification of this order, they will be used in another job in place of materials that will now cost Rs.2,250.
- (2) Department A is working normally and hence any engagement of labour will have to be paid at the direct wage rate of Rs.120 per man day.
- (3) Department B is extremely busy. Its direct wages rate is Rs.100 per man day and it is currently yielding a contribution of Rs.3.20 per rupee of direct wages.
- (4) Supervisory overtime payable for the modification is Rs.1,050.
- (5) The cost of the control device that the new customer does not require is Rs.13,500. If it is taken out, it can be used in another job in place of a different mechanism. The latter mechanism has otherwise to be bought for Rs.10,500. The dismantling and removal of the control mechanism will take one man day in department A.
- (6) If the convention is not carried out, some of the materials in the original equipment can be used in another contract in place of materials that would have cost Rs.12,000. It would have taken 2 man days of work in department A to make them suitable for this purpose. The remaining materials will realize Rs.11,400 as scrap. The drawings, which are included as part for the job can be sold for Rs.1,500.

You are required to calculate the minimum price, which the company can afford to quote for the new customer as stated above.

Answer

**Statement of minimum price which the company can afford to
quote for the new customer
(based on relevant cost)**

	<i>Rs.</i>
Cost to be incurred to bring the equipment in its original condition.	29,700
Opportunity cost of the direct material	2,250
Direct wages:	
Dept. A: 15 man days × Rs.120	1,800
Dept. B: 25 man days × Rs.100	2,500
Opportunity cost of contribution lost by department B (Rs.2,500 × Rs.2.30)	8,000
Variable overheads	1,075
25% × (Rs.1,800 + Rs.2,500)	
Delivery costs	1,350
Supervisory overtime payable for modification	1,050
Control device to be used in another job (Refer to working note 1)	(10,350)
Net loss on material cost savings, in the original equipment (Refer to working note)	11,700
Opportunity cost of remaining materials which can be sold as scrap	11,400
Opportunity cost of sale drawings	<u>1,500</u>
Total minimum price which may be quoted	<u>61,975</u>

Working notes:**1. Cost of control device to be used in another job:**

	<i>Rs.</i>
Cost of control device	10,500
Less: Dismantling & removal cost of control mechanism (1 man day × Rs.120)	120
Less: Variable cost)25% × Rs.120)	<u>30</u>
Balance cost of control device	10,350

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2. Net loss on material cost saving of equipment:

Loss on material cost saving of equipment	12,000
Less: Conversion cost	
(2 man days × Rs.120)	240
Less: Variable overheads (25% × Rs.240)	<u>60</u>
Net loss on material cost saving of equipment	<u>11,700</u>

Question 15

Determine the selling price per unit to earn a return of 12% net on capital employed (net of Tax @ 40%).

The cost of production and sales of 80,000 units per annum are:

Material	Rs. 4,80,000	Labour	Rs. 1,60,000
Variable overhead	Rs. 3,20,000	Fixed overhead	Rs. 5,00,000

The fixed portion of capital employed is Rs. 12 lacs and the varying portion is 50% of sales turnover. .

Answer

Return of 12% net (after tax of 40%) on capital employed is equivalent to $12\% \div (1 - 0.4) = 20\%$ (gross) on capital employed

Let selling price per unit to be 'x'

Since Total sales = Total cost + profit

i.e. $80,000 \times x = 14,60,000 + 20\% (12,00,000 + 0.5 \times 80,000x)$

or, $80,000 \times x = 14,60,000 + 2,40,000 + 8,000x$

or, $72,000 \times x = 17,00,000$

or, $'x' = \frac{17,00,000}{72,000} = \text{Rs. } 23.61$

Hence selling price per unit will be Rs. 23.61

EXERCISE**Question 1**

Name the pricing policy which aims at high selling price in the beginning of a product's, life cycle?

Answer

Refer to Chapter 4: Paragraph:4.7.1

Question 2

What is meant by Cost-plus pricing?

Answer

Refer to Chapter 4: Paragraph: 4.6.1

Question 3

Enumerate the circumstances which are favourable for the adoption of a penetrating pricing policy

Answer

Refer to Chapter 4: Paragraph: 4.7.1

Question 4

Chum-Chum Ltd. is about to introduce a new product with the following estimates:

<i>Price per unit (in rupees)</i>	<i>Demand (in thousand units)</i>
30-00	400
31-50	380
33-00	360
34.50	340
36-00	315
37-50	280
39-00	240

Costs:

<i>Direct material</i>	<i>Rs.12 per unit</i>
<i>Direct labour</i>	<i>Rs.3 per unit</i>
<i>Variable overhead</i>	<i>Rs.3 per unit</i>

Advanced Management Accounting

<i>Selling expenses</i>	<i>10% on sales</i>
<i>Fixed production overheads</i>	<i>Rs.14,40,000</i>
<i>Administration expenses</i>	<i>Rs.10,80,000</i>

Judging from the estimates, determine the tentative price of the new product to earn maximum profits.

Answer

Maximum profit = Rs.20,16,000

Question 5

Explain the concept of cost plus pricing. What are its advantages and disadvantages?

Answer

Refer to Chapter 4: Paragraph: 4.6.1

Question 6

P. W. Perfume Company manufactures various qualities of perfumes and colognes. One popular line of colognes includes three products that result from a joint production process. Below are data from the most recent month of production:

<i>Product</i>	<i>Sales Price</i>	<i>Quantity</i>	<i>Joint cost</i>	<i>Cost after split off</i>	<i>Total cost</i>
<i>Evergreen</i>	<i>Rs.40</i>	<i>10,000</i>	<i>Rs.28</i>	<i>Rs.20</i>	<i>Rs.48</i>
<i>Morning Flower</i>	<i>Rs.100</i>	<i>6,000</i>	<i>Rs.28</i>	<i>Rs.40</i>	<i>Rs.68</i>
<i>Evening Flower</i>	<i>Rs.150</i>	<i>4,000</i>	<i>Rs.28</i>	<i>Rs.50</i>	<i>Rs.78</i>

As the Controller, you are called into the Presidents Office with the Director of Marketing. The President says, "I don't understand your product cost report. Either, we are selling our largest-volume product at a loss or the product cost data are all wrong. Now what is it?"

Required:

- (i) Respond to the Presidents question.*
- (ii) Another company has just introduced a product that competes directly with Morning Flower to compete successfully with the other company's product, the price of Morning Flower cologne must be reduced to Rs.60. Should the company do so and sell below cost?*

- (iii) If P. W. Perfume Company has a policy of maintaining a gross margin of 20 per cent on sales, what would your answer be in response to the price reduction in part (ii)?
- (iv) What is the minimum price for which Morning Flower can sell and still meet the 20 per cent product gross margin for the group of products?

Answer

	<i>Evergreen</i>	<i>Morning Flower</i>	<i>Evening Flower</i>	<i>Total</i>
Profit	83,333	1,50,000	1,66,667	4,00,000

	<i>Evergreen</i>	<i>Morning Flower</i>	<i>Evening Flower</i>
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>
Joint cost per unit	11,666	35	58.33

If the company sell Morning Flower Cologne below cost, it will still contribute Rs.20 per unit (Rs.60 – Rs.40) towards joint cost and profit. On a volume of 6,000 units it will contribute Rs.1,20,000 in total. Hence the company should do so and go ahead to sell Morning Flower below cost.

Minimum price per unit: Rs. 83.33

BUDGET & BUDGETARY CONTROL

BASIC CONCEPTS AND FORMULAE

Basic Concepts

- 5.1 Strategic Planning:** Strategic planning is concerned with preparing long-term action plans to attain the organization's objectives by considering the changes at horizon.
- 5.2 Budgetary Planning:** Budgetary planning is mainly concerned with preparing the short to medium term plan of the organisation. It will be carried out within the framework of the strategic plan as already set. An organization's annual budget is considered as an intermediary step towards achieving the strategic plan.
- 5.3 Operational Planning:** It concerns with the short-term or day-to-day planning process. It plans the utilisation of resources and will be carried out within the framework of the budget. Each step in the operational planning process is an interim step towards achieving the budget.
- 5.4 Preparation of Budgets :** The process of preparing and using budgets will differ from organisation to organisation. However, there are a number of key requirements in the design of a budgetary planning and control process.

5.4.1 Co-ordination: The budget committee:

Budgets provide a **means of co-ordination** of the business as a whole. In the process of establishing budgets, the various factors like production capacity, sales possibilities, and procurement of material, labour, etc. are balanced and co-ordinates so that all the activities proceed according to the objective.

5.4.2 Participative budgeting:

CIMA defines participative budgeting as: A budgeting system in which all budget committee members are given the opportunity to apply their own budgets in practice.

5.4.3 Budget Manual:

A budget manual is a collection of documents that contains key information for those involved in the planning process.

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5.4.4 Identification of the principal budget factor:

The principal budget factor is the factor that limits the activities of functional budgets of the organization. The early identification of this factor is important in the budgetary planning process because it indicates which budget should be prepared first.

5.5 Zero Base Budgeting (ZBB)

ZBB is defined as 'a method of budgeting which requires each cost element to be specifically justified, as though the activities to which the budget relates were being undertaken for the first time. ZBB is prepared and justified from zero, instead of simply using last year's budget as a base.

5.6 Traditional Budgeting vs Zero-based budgeting.

Traditional budgeting	Zero Based Budgeting
Accounting Oriented	Responsibility Accounting oriented
Reference is past budget. Some managers only inflate them.	Fresh approach without any previous reference. Nothing is taken into account without justification.
Routine Approach	Investigative approach

5.7 Performance Budgeting (PB)

Performance Budgeting provides a meaningful relationship between estimated inputs and expected outputs as an integral part of the budgeting system. 'A performance budget is one which presents the purposes and objectives for which funds are required, the costs of the programmes proposed for achieving those objectives, and quantities data measuring the accomplishments and work performed under each programme.

5.8 Traditional budgeting vs. Performance budgeting

1. The traditional budgeting (TB) gives more emphasis on the financial aspect than the physical aspects or performance. PB aims at establishing a relationship between the inputs and the outputs.
2. Traditional budgets are generally prepared with the main basis towards the objects or items of expenditure i.e. it highlights the items of expenditure, namely, salaries, stores and materials, rates rents and taxes and so on. In the PB latter the emphasis is more on the functions of the organisation, the programmes to discharge these function and the activities which will be involved in undertaking these programmes.

5.9 Budget Ratio

These ratios provide information about the performance level, i.e., the extent of deviation of actual performance from the budgeted performance and whether the actual performance is favourable or unfavorable. If the ratio is 100% or more, the performance is considered as favourable and if ratios is less than 100% the performance is considered as unfavourable.

Basic Formulas

- i) Efficiency Ratio = $(\text{Standard hours} \div \text{Actual hours}) \times 100$
- ii). Activity Ratio = $(\text{Standard hours} \div \text{Budgeted hours}) \times 100$
- iii) Calendar Ratio = $(\text{Available working days} \div \text{budgeted working days}) \times 100$
- iv) Standard Capacity Usage Ratio = $(\text{Budgeted hours} \div \text{Max. possible hours in the budgeted period}) \times 100$
- v). Actual Capacity Usage Ratio = $(\text{Actual hours worked} \div \text{Maximum possible working hours in a period}) \times 100$
- vi). Actual Usage of Budgeted Capacity Ratio = $(\text{Actual working hours} \div \text{Budgeted hours}) \times 100$

Question 1

A company manufactures two products X and Y. Product X requires 8 hours to produce while Y requires 12 hours. In April, 2004, of 22 effective working days of 8 hours a day, 1,200 units of X and 800 units of Y were produced. The company employs 100 workers in production department to produce X and Y. The budgeted hours are 1,86,000 for the year. Calculate Capacity, Activity and Efficiency ratio and establish their relationship.

Answer

	Standard hours produced		
	Product X	Product Y	Total
Out put (units)	1,200	800	
Hours per unit	8	12	
Standard hours	9,600	9,600	19,200

Actual hours worked

100 workers $\times$ 8 hours $\times$ 22 days = 17,600

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Budgeted hours per month

$$1,86,000/12 = 15,500$$

$$\text{Capacity Ratio} = \frac{\text{actual hours}}{\text{Budgeted hours}} \times 100 = \frac{17,600}{15,500} = 113.55 \%$$

$$\text{Efficiency Ratio} = \frac{\text{Standard Hours Produced}}{\text{Actual hours}} \times 100 = \frac{19,200}{17,600} \times 100 = 109.09\%$$

$$\text{Activity Ratio} = \frac{\text{Standard Hours Produced}}{\text{Budget hours}} \times 100 = \frac{19,200}{15,500} \times 100 = 123.87\%$$

Relationship : Activity Ratio = Efficiency Ratio $\times$ Capacity Ratio

$$\text{or} \quad 123.87 = \frac{109.09 \times 113.55}{100}$$

Question 2

Kitchen King Company makes a high-end kitchen range hood 'Maharaja'. The company presents the data for the year 2003 and 2004:

	2003	2004
1. Units or maharaja produced and sold	40,000	42,000
2. Selling Price per unit in Rs.	1,000	1,100
3. Total Direct Material (Square feet)	1,20,000	1,23,000
4. Direct material cost per square feet in Rs.	100	110
5. Manufacturing Capacity (in units)	50,000	50,000
6. Total Conversion cost in Rs.	1,00,00,000	1,10,00,000
7. Conversion cost per unit of capacity (6)/(5)	200	220
8. Selling and customer service capacity	300 customer	290 customer
9. Total selling and customer service cost in Rs.	72,00,000	72,50,000
10. Cost per customer of selling and customer service capacity (9)/(8)	24,000	25,000

Kitchen King produces no defective units, but it reduces direct material used per unit in 2004. Conversion cost in each year depends on production capacity defined in terms of Maharaja units that can be produced. Selling and Customer service cost depends on the number of customers that the selling and service functions are designed to support. Kitchen King has 230 customers in 2003 and 250 customers in 2004.

You are required

1. Describe briefly key elements that would include in Kitchen King's Balance Score Card.
2. Calculate the Growth, Price-recovery and productivity component that explain the change in operating income from 2003 to 2004.

Answer

Kitchen King's Score card should describe its product differentiation strategy. The key points that should be included in its balance score card are

- Financial Perspective – Increase in operating income by charging higher margins on Maharaja.
- Customer Perspective – Market share in high-end kitchen range market and customer satisfaction.
- Internal business Perspectives: Manufacturing quality, order delivery time, on time delivery and new product feature added.
- Learning and Growth Perspective: Development time for designing new end product and improvement in manufacturing process.

Operative Income:

(Amount in 000 Rs.)

	2003	2004
Revenue (40000×1000; 42000×1100)	40000	46200
Direct Material	12000	13530
Conversion cost	10000	11000
Selling and Customer service	7200	7250
Total cost	29200	31780
Operative Income	10800	14420

Change in operating Income 36, 20,000 (F)

A. Growth Component

- (a) Revenue effect = Output Price in 2003{Actual units sold in 04 – Actual units sold in 03}

$$= \text{Rs}1,000 (42,000 \text{ units} - 40,000 \text{ units}) = \text{Rs}20,00,000 \text{ (F)}$$

- (b) The cost effect = Input price in 2003{Actual units of input to produce 2003

Advanced Management Accounting

output less Actual units of input which would have been used to produce year 2004 output on the basis of 2003}

$$(i) \quad \text{Direct Material} = \text{Rs}100 \left[1, 20,000\text{sqft} - 1, 20,000\text{sqft} \times \frac{42,000 \text{ units}}{40,000 \text{ units}} \right]$$

$$= \text{Rs}6, 00,000 \text{ (A)}$$

- (ii) Conversion cost and selling and customer service will not change since adequate capacity exists in 2003 to support 2004 output and customers. Hence variance

$$\text{Conversion cost} = 200(50000 - 50000) = 0$$

$$\text{S \& Customer Service} = 25000 (300 - 300) = 0$$

Increase in operating effect of Growth component is Rs14, 00,000 (F)

B Price recovery Component:

$$(i) \quad \text{Revenue effect} = \text{Actual output in 2004} [\text{Selling price per unit in 2004 less Selling price per unit in 2003}]$$

$$= 42,000\text{units} (\text{Rs}1, 100 - \text{Rs}1, 000) = \text{Rs}42, 00,000 \text{ (F)}$$

- (ii) Cost effect = Unit of input based on 2003 actual that would have been used to produce 2004 output {Input prices per unit in 2003 less Input prices per unit in 2004}

$$(a) \quad \text{Direct material} = 1, 26,000\text{sqft} (\text{Rs}100/\text{sqft} - \text{Rs}110/\text{sqft}) = \text{Rs}12, 60,000 \text{ (A)}$$

$$(b) \quad \text{Conversion Cost} = 50,000 \text{ units} (\text{Rs}200/\text{unit} - \text{Rs}220/\text{unit})$$

$$= \text{Rs}10, 00,000 \text{ (A)}$$

$$(c) \quad \text{S \& Custr Service} = 300 \text{ customers} (\text{Rs}24, 000 - \text{Rs}25,000)$$

$$= \text{Rs}3,00,000 \text{ (A)} = \text{Rs} 25, 60,000 \text{ (A)}$$

Increase in Operating income due to Price Recovery is Rs16, 40,000 (F)
{Rs42, 00,000 – Rs25, 60,000}

C Productivity Component

Productivity component = Input Prices in 04{Actual units of input which would have been used to produce year 2004 output on the basis of 2003 actual less Actual Input

$$(i) \quad \text{Direct Material: Rs}110/\text{sqft} (1, 26,000 \text{ units} - 1, 23,000 \text{ units}) = \text{Rs}3, 30,000 \text{ (F)}$$

$$(ii) \quad \text{Conversion Cost: Rs}200/\text{unit} (50,000 \text{ units} - 50,000 \text{ units}) = 0$$

Budget & Budgetary Control

- (iii) Selling & Customer = Rs25, 000 (300 customers–290 customers)= Rs2,50,000 (F)
= Rs 5,80,000 (F)

The change in operating income from 2003 to 2004 is analysed as follows:

	(Amount in 000 Rs.)				
	2003	Growth component	Price recovery	Cost effect of productivity component	2004
Revenue	40000	2000 (F)	4200 (F)	-----	46200
Cost	29200	600 (A)	2560 (A)	580 (F)	31780
Operating Income	10800	1400(F)	1640 (F)	580 (F)	14420

Question 3

Explain briefly the major components of a balanced score card.

Answer

An ideal Balanced score card combines financial measures of past performance with measures of the firm's drivers of future performance. The following perspectives are evaluated:

- (i) Customer perspective – Measures of price / delivery / quality / support.
- (ii) Internal perspective – Measures of efficiency / sales penetration and new product introduction.
- (iii) Innovation and learning perspective – Measures of technology / cost leadership.
- (iv) Financial perspective – Sales / Cost of sales / Return on capital employed etc.

Question 4

Describe the process of zero-base budgeting.

Answer

The zero Base Budgeting involves the following steps:

- (i) Corporate objectives should be established and laid down in details.
- (ii) Decide about the techniques of ZBB to be applied.
- (iii) Identify those areas where decisions are required to be taken.
- (iv) Develop decision programmes and rank them in order of preferences.

Advanced Management Accounting

- (v) Preparation of budget, that is translating decision packages into practicable units/items and allocating financial resources.

Question 5

“In many organisations, initiatives to introduce balanced score card failed because efforts were made to negotiate targets rather than to build consensus.”

Required:

Elucidate the above statement.

Answer

Balanced score card is a set of financial and non-financial measures relating to a company's critical success factors. It is an approach which provides information to management to assist in strategy implementation. Therefore, the components to be included in the balanced score card must flow from strategy. The targets should be measurable and must flow from strategy and corporate plan of the company. It is necessary that managers should agree to the components and targets because in absence of a consensus, managers may not commit to the targets established by the top management / the board of directors. Moreover, the functions are interdependent and results in one functional area/perspective (e.g. innovation and learning) have direct bearing on the results in other functional area / perspective (e.g. customer perspective). Therefore, it is not sufficient that individual managers agree to their targets. Successful implementation requires that the top management builds an overall consensus on the components and targets of the balanced score card. Negotiation undermines the fundamental principle that the components and targets should flow from strategy. As a result, an approach to establish targets through negotiation defeats the very purpose of balanced score card.

Question 6

What do you mean by a flexible budget? Give an example of an industry where this type of budget is typically needed?

Answer

A flexible budget is a budget which, by recognizing the difference between fixed, semi-variable and variable costs, is designed to change in relation to the level of activity attained.

E.g. seasonal products – e.g. soft drink industry

industries in make to order business like ship building

industries influenced by change in fashion.

Industries which keep on introducing new products / new designs.

Question 7

Describe the four types of bench marking of critical success factors.

Answer

The Benchmarking is of following types:

- (i) **Competitive benchmarking:** It involves the comparison of competitors products, processes and business results with own.
- (ii) **Strategic benchmarking:** It is similar to the process benchmarking in nature but differs in its scope and depth.
- (iii) **Global benchmarking:** It is a benchmarking through which distinction in international culture, business processes and trade practices across companies are bridged and their ramification for business process improvement are understood and utilized.
- (iv) **Process benchmarking:** It involves the comparison of an organisation critical business processes and operations against best practice organization that performs similar work or deliver similar services.
- (v) **Functional Benchmarking or Generic Benchmarking:** This type of benchmarking is used when organisations look to benchmark with partners drawn from different business sectors or areas of activity to find ways of improving similar functions or work processes.
- (vi) **Internal Benchmarking:** It involves seeking partners from within the same organization, for example, from business units located in different areas.
- (vii) **External Benchmarking:** It involves seeking help of outside organisations that are known to be best in class. External benchmarking provides opportunities of learning from those who are at the leading edge, although it must be remembered that not every best practice solution can be transferred to others.

Question 8

- (a) *What are the advantages and limitations of Zero base Budgeting?*
- (b) *What are benchmarking code of conduct?*
- (c) *A Company manufactures two Products A and B by making use of two types of materials, viz., X and Y. Product A requires 10 units of X and 3 units of Y. Product B requires 5 units of X and 2 units of Y. The price of X is Rs. 2 per unit and that of Y is Rs. 3 per unit. Standard hours allowed per product are 4 and 3, respectively. Budgeted wages rate is Rs. 8 per hour. Overtime premium is 50% and is payable, if a worker works for more than 40 hours a week. There are 150 workers.*

Advanced Management Accounting

The Sales Manager has estimated the sales of Product A to be 5,000 units and Product B 10,000 units. The target productivity ratio (or efficiency ratio) for the productive hours worked by the direct worker in actually manufacturing the product is 80%, in addition, the non-productive downtime is budgeted at 20% of the productive hours worked. There are twelve 5-day weeks in the budget period and it is anticipated that sales and production will occur evenly throughout the whole period.

It is anticipated that stock at the beginning of the period will be:

Product A 800 units; Product B 1,680 units. The targeted closing stock expressed in terms of anticipated activity during the budget period are Product A 12 days sales; Product B 18 days sales. The opening and closing stock of raw material of X and Y will be maintained according to requirement of stock position for Product A and B.

You are required to prepare the following for the next period:

- (i) Material usage and Material purchase budget in terms of quantities and values.*
- (ii) Production budget.*
- (iii) Wages budget for the direct workers.*

Answer

(a) Advantage of ZBB

- (i) It provides a systematic approach for evaluation of different activities and ranks them in order of preference for allocation of scarce resource.
- (ii) It ensures that the various functions undertaken by the organisation are critical for the achievement of its objectives and are being performed in the best way.
- (iii) It provides an opportunity to the management to allocate resources for various activities only after having a thorough cost-benefit analysis.
- (iv) The area of wasteful expenditure can be easily identified and eliminated.
- (v) Departmental budgets are closely linked with corporate objectives.
- (vi) The technique can also be used for the introduction and implementation of the system of 'management by objective'.

Limitations of ZBB

- (i) Various operational problems are likely to be faced in implementing the technique.
- (ii) The full support of top management is required.

- (iii) It is time consuming as well as costly.
- (iv) It requires proper trained managerial staff.

(b) Benchmarking code of conduct

Benchmarking is the process of identifying and learning from the best practices anywhere in the world. It is a powerful tool for continuous improvement. To contribute to efficient, effective and ethical benchmarking, individuals agree for themselves and their organisation to be abided by the following principles for the benchmarking with other organisations.

Suggested benchmarking code of conduct:

- (i) Principle of legality
- (ii) Principle of exchange
- (iii) Principle of confidentiality
- (iv) Principle of use
- (v) Principle of first party contact
- (vi) Principle of third party contact
- (vii) Principle of preparation

(c) (i) Material usage budget

	<i>Products A (units)</i>	<i>Products B (units)</i>	<i>Total material usage units</i>	<i>Cost per unit (Rs)</i>	<i>Total cost of materials (Rs)</i>
Estimated sales	5,000	10,000			
Material X : 10 units per product A and 5 units per product B	50,000	50,000	1,00,000	2	2,00,000
Material Y : 3 units per product A and 2 units per product B	15,000	20,000	35,000	3	1,05,000
Total	65,000	70,000	1,35,000		3,05,000

Advanced Management Accounting**Material Purchase Budget**

	<i>X Units</i>	<i>Y Units</i>	<i>Total</i>
Required for sales	1,00,000	35,000	
Add: desired closing stock			
Product A:			
1,000 units (A) $\times$ 10 units (X) = 10,000 units of X	25,000		
3,000 units (B) $\times$ 5 units (X) = 15,000 units of X.			
Product B:		9,000	
1,000 units (A) $\times$ 3 units (Y) = 3000 units of Y			
3,000 units (B) $\times$ 2 units (Y) = 6,000 units of Y.			
	1,25,000	44,000	
Less: Opening stock			
Product A:			
800 units (A) $\times$ 10 units (X) = 8,000 units of X			
1,680 units (B) $\times$ 5 units (X) = 8,400 units of X	16,400		
Product B			
800 units (A) $\times$ 3 units (Y) = 2,400 units of Y		5,760	
1,680 units (B) $\times$ 2 units (Y) = 3,360 units of Y.			
Units to be purchased	1,08,600	38,240	1,46,840
Cost per unit	Rs.2	Rs.3	
Cost of purchase (Rs.)	2,17,200	1,14,720	3,31,920

(ii) Production Budget

	<i>Product A</i>	<i>Product B</i>
	<i>Units</i>	<i>Units</i>
Sales	5,000	10,000
Add: Closing stock**	1,000	3,000
	6,000	13,000
Less: Opening stock	800	1,680
Production	5,200	11,320

**Calculation of closing stock:

Budgeted period is 12 weeks of 5 days each =60 days.

$$\text{Product A} = \frac{5,000 \times 12}{60} = 1,000 \text{ units}$$

$$\text{Product B} = \frac{10,000 \times 18}{60} = 3,000 \text{ units}$$

(iii) Wages budget for direct workers

	<i>Product A</i>	<i>Product B</i>	<i>Total</i>
	<i>(hrs)</i>	<i>(hrs)</i>	<i>(hrs.)</i>
Standard hours (budgeted)			
5,200 units (A) × 4 hours per unit and 11,320 units (B) × 3 hours per unit.	20,800	33,960	54,760
Standard hours at 80% efficiency ratio			68,450
Add: non productive time (20% of 68,450)			13,690
			82,140
Labour hours required (150 workers × 8 hours per day × 60 days)			72,000
Overtime			10,140
Wages for normal hours (72,000 × 8)	= Rs 5,76,000		
Wages for overtime (10,140 × 8 × 1.5)	= Rs 1,21,680		
Total wages	= Rs 6,97,680		

Advanced Management Accounting

Question 9

The budgeted and actual cost data of M Ltd. for 6 months from April to September, 2008 are as under:

	Budget	Actual
Production units	16,000	14,000
Material cost	Rs. 25,60,000 (1,600 MT @ Rs. 1,600)	Rs. 41,60,000 (at Rs. 1,650)
Labour cost	Rs. 16,00,000 (at Rs. 40 per hour)	Rs. 15,99,840 (@ Rs. 44 per hour)
Variable overhead	Rs. 3,00,000	Rs. 2,76,000
Fixed overhead	Rs. 4,60,000	Rs. 5,80,000

In the first half of financial year 2009-10, production is budgeted for 30,000 units, material cost per tonne will increase from last year's actual by Rs. 150, but it is proposed to maintain the consumption efficiency of 2008 as budgeted. Labour efficiency will be lower by 1% and labour rate will be Rs. 44 per hour. Variable and fixed overheads will go up by 20% over 2008 actuals.

Prepare the Production Cost budget for the period April-September, 2009 giving all the workings.

Answer

Production Cost Budget (for 6 months ending 30th September, 2009)

	30,000 units Cost per unit	Total
	Rs.	Rs.
Material cost	180	54,00,000
Labour cost	115.21	34,56,420
Variable overhead	23.65	7,09,500
Fixed overhead	<u>23.2</u>	<u>6,96,000</u>
	<u>342.06</u>	<u>1,02,61,920</u>

Assumption: Here, difference in actual and standard time is also considered for calculating the lower efficiency i.e. $3.74\% + 1\% = 4.74\%$

Working Notes:

I. Material cost

$$\text{Material consumption per unit} = \frac{1,600 \text{ MT}}{16,000} = 0.10 \text{ MT}$$

Consumption for 30,000 units = 3,000 MT.

Cost of 3,000 MT @ Rs. 1,800 per MT = Rs. 54,00,000.

II. Labour cost can be calculated as follows:

$$\text{Time required for 30,000 units} = 75,000 \text{ hours}$$

$$\text{Add: } *(3.74\% + 1\%) = 4.74\% \text{ for lower efficiency} = \underline{3,555} \text{ hours}$$

$$= \underline{78,555} \text{ hours}$$

$$*3.74\% = \frac{\text{Difference in actual and standard hours}}{\text{Actual hours}} \times 100 = \frac{1,360 \text{ hours}}{36,360 \text{ hours}}$$

$$\text{Labour cost} = 78,555 \text{ hours} \times 44 \text{ per hour} = 34,56,420.$$

III. Variable overhead

$$\text{Actual rate} = \frac{\text{Rs. } 2,76,000}{14,000 \text{ units}} = 19.71 \text{ per unit}$$

$$\text{Add: } 20 = \underline{3.94}$$

$$\text{New rate} = \underline{23.65}$$

$$\text{Total variable overhead} = 30,000 \times 23.65 = \text{Rs. } 7,09,500$$

IV. Fixed overhead

$$\text{Actual} = \text{Rs. } 5,80,000$$

$$\text{Add: } 20\% = \text{Rs. } \underline{1,16,000}$$

$$= \text{Rs. } \underline{6,96,000}$$

According to above the production cost budget will be as follows:

Alternative

Production Cost Budget
(for 6 months ending 30th September, 2009)

	30,000 units	
	Cost per unit	Total

Advanced Management Accounting

	Rs.	Rs.
Material cost	180	54,00,000
Labour cost	111.1	33,33,000
Variable overhead	23.65	7,09,500
Fixed overhead	<u>23.2</u>	<u>6,96,000</u>
	<u>337.95</u>	<u>1,01,38,500</u>

Working Notes:

I. Material cost

$$\text{Material consumption per unit} = \frac{1,600 \text{ MT}}{16,000} = 0.10 \text{ MT}$$

Consumption for 30,000 units = 3,000 MT.

Cost of 3,000 MT @ Rs. 1,800 per MT = Rs. 54,00,000.

II. Labour Cost:

$$2008 - \text{Total Budgeted Hour} = \frac{16,00,000}{40} = 40,000 \text{ hours}$$

$$\text{Labour hour budget for each unit} = \frac{40,000}{16,000} = 2.5$$

$$\text{Actual time paid} = \frac{15,99,840}{44} = 36,360 \text{ hours}$$

Less: Standard labour hours for 14,000 units (i.e. $14,000 \times 2.5$) = 35,000 hours

$$\text{Difference in actual and standard hours} = \underline{\underline{1,360}}$$

Time required for 30,000 units ($30,000 \times 2.5$) = 75,000, hours

Add: 1% for lower efficiency = 750 hours

$$= \underline{\underline{75,750 \text{ hours}}}$$

Labour cost = 75,750 hours $\times$ 44 per hour = 33,33,000

III. Variable overhead

$$\text{Actual rate} = \frac{\text{Rs. } 2,76,000}{14,000 \text{ units}} = 19.71 \text{ per unit}$$

$$\text{Add: } 20 = \underline{\underline{3.94}}$$

New rate 23.65

Total variable overhead = $30,000 \times 23.65$ = Rs. 7,09,500

IV. Fixed overhead

Actual = Rs. 5,80,000

Add: 20% = Rs. 1,16,000

= Rs. 6,96,000

Question 10

What are the various formulae used in calculating budget ratios?

Answer

Type of budgeted ratio used are:

1. Efficiency Ratio = $(\text{Standard hours} + \text{Actual hours}) \times 100$
2. Activity Ratio = $(\text{Standard hours} + \text{Budgeted hours}) \times 100$
3. Calendar Ratio = $(\text{Available working days} \div \text{budgeted working days}) \times 100$
4. Standard Capacity Usage Ratio = $(\text{Budgeted hours} \div \text{Max. possible hours in the budgeted period}) \times 100$
5. Actual Capacity Usage Ratio = $(\text{Actual hours worked} + \text{Maximum possible working hours in a period}) \times 100$
6. Actual usage of Budgeted Capacity Ratio = $(\text{Actual working hours} \div \text{Budgeted hours}) \times 100$.

Question 11

Explain goals and performance measure for each perspective of Balance Score Card.

Answer

Goals and performance measures for each perspective of balance scorecard.

Customer Perspective

Goals	Performance Measures
Price	Competitive price
Delivery	Number of on time delivery, lead time from receipt of order to delivery to customer.

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Quality	Own quality relative to industry standards, number of defects or defect level.
Support	Response time, customer satisfaction survey.

Internal Business Perspective

Goals	Performance Measures
Efficiency of manufacturing process	Manufacturing cycle time
Sales penetration	Sales plan, Increase in number of customer in a unit of time.
New Product introduction	Rate of new product introduction.

Innovation and Learning Perspective

Goals	Performance Measures
Technology leadership	Performance of product, use of technology
Cost leadership	Manufacture overhead per quarter
Market leadership	Market share in all major markets
Research and development	Number of new products, Patents

Financial Perspective

Goals	Performance Measures
Sales	Revenue and profit growth
Cost of Sales	Extent in remain fixed or decreased each year
Profitability	Return on capital employed
Prosperity	Cash flows

Question 12

JBC Limited, a manufacturing company having a capacity of 60,000 units has prepared a following cost sheet:

<i>Direct material (per unit)</i>	<i>Rs.12.50</i>
<i>Direct wages (per unit)</i>	<i>Rs.5.00</i>
<i>Semi-variable cost</i>	<i>Rs.30,000 fixed plus 0.50 per unit</i>
<i>Factory overhead (per unit)</i>	<i>Rs.10.00 (50% fixed)</i>

Selling and administration overhead (per unit) Rs.8.00 (25% variable)

Selling price (per unit) Rs.40

During the year 2008, the sales volume achieved by the company was 50,000 units.

The company has launched an expansion program as under

- (a) The capacity will be increased to 1,00,000 units.
- (b) The cost of investment on expansion is Rs.5 lakhs which is proposed to be financed through financial institution at 12 per cent per annum.
- (c) The depreciation rate on new investment is 10 per cent based on straight line.
- (d) The additional fixed overheads will amount to Rs.2.00 lakhs up to 80,000 units and will increase by Rs.80,000 more beyond 80,000 units.

After the expansion, the company has two alternatives for operating the expanded plant as under:

- (i) Sales can be increased up to 80,000 units by spending Rs. 50,000 on special advertisement campaign to explore new market.
- (ii) Sales can be increased up to 1,00,000 units subject to the following:
 - (a) Reduction of selling price by Rs.4 per unit on all the units sold.
 - (b) The direct material cost would go down by 4 per cent due to discount on bulk buying.
 - (c) By increasing the variable selling and administration expenses by 4 per cent.

Required.

- (i) Construct a flexible budget at the level 50,000 units, 80,000 units and 1,00,000 units of production and select best profitable level of operation.
- (ii) Calculate break even point both before and after expansion.

Answer

Flexible Budget

Output level (units)	50,000 (Rs. in lakhs)	80,000 (Rs. in lakhs)	1,00,000 (Rs. in lakhs)
Sales	20.00	32.00	36.00
Direct Material 12.5 per unit (reduction	6.25	10.00	12.00

Advanced Management Accounting

for 1,00,000 units by Rs.0.50)			
Direct wages (5.00 per unit)	2.50	4.00	5.00
Semi variable cost (variable)	0.25	0.40	0.50
Factory overhead (V) Rs.5 per unit)	2.50	4.00	5.00
Selling and Adm. (25% variable)	<u>1.00</u>	<u>1.60</u>	<u>2.08</u>
Total variable cost	<u>12.50</u>	<u>20.00</u>	<u>24.58</u>
Contribution	<u>7.50</u>	<u>12.00</u>	<u>11.42</u>
Fixed factory overheads (5×60,000)	3.00	3.00	3.00
Selling and adm. (6 × 60,000)	3.60	3.60	3.60
Semi variable fixed part	.30	.30	.30
Increase due to expansion		2.00	2.80
Interest		.60	.60
Depreciation		.50	.50
Special Advertisement exp.	<u>—</u>	<u>.50</u>	<u>—</u>
Total fixed costs	<u>6.90</u>	<u>10.50</u>	<u>10.80</u>
	<u>0.60</u>	<u>1.50</u>	<u>0.62</u>

Therefore activity level 80,000 units is most profitable level.

Calculation of Break even point

P/V ratio

$7.5/20.00 \times 100 = 37.5\%$, $12.00/32.00 \times 100 = 37.5\%$, $11.42/36.00 \times 100 = 31.72\%$ BEP (value)

$= 6.90/37.5\% = \text{Rs.}18,40,000$, $10.50/37.5\% = \text{Rs.}28,00,000$, $10.80/31.72\% = 34,04,792$

BEP (Units)

<u>6.90 lakhs</u>	<u>10.50 lakhs</u>	<u>10.80 lakhs</u>
Rs.15	Rs.15	Rs.15
= 46,000 units	= 70,000 units	= 94,571 units

Alternative Solution (BEP in Sales)

Break Even Point in value of sales: $(F \times S) / (S - V)$

At 50000 units' level : $(6,90,000 \times 20,00,000)/7,50,000 = \text{Rs. } 18,40,000$

At 80000 units' level : $(10,50,000 \times 32,00,000)/12,00,000 = \text{Rs. } 28,00,000$

At 100000 units' level : $(10,80,000 \times 36,00,000)/11,42,000 = \text{Rs. } 34,04,553$

Question 13

Explain briefly stages involved in the process of Bench marking.

Answer

Process of Benchmarking: The process of benchmarking requires a Company to identify the areas i.e. processes, activity etc. which are central to its business and then selects the top-performing companies in those areas.

The benchmarking process is comprised of following stages. These stages are:

1. Planning:

- (i) **Determination of benchmarking goal statement:** This requires identification of areas to be benchmarked. In practice, one should start with the identification of those areas which have to be really good to be really successful.
- (ii) **Identification of best performance:** Once the benchmarked goal statement are defined, the step is seeking the best of the breed or best of the best.
- (iii) **Establishment of the benchmarking or process improvement team:** Ideally this should include the persons who are most knowledgeable about the internal operations and will be directly affected by changes due to benchmarking.
- (iv) **Defining the relevant benchmarking measurement:** Relevant measures will not include the measures used by the organisation today but they will be refined measures that comprehend the true performance differences.

2. Collection of data and information:

The data gathering for benchmarking could be done through national/international clearing houses, mail surveys, suppliers, company visits, telephone, interviews etc. In recent years national and international clearing houses have been set up.

3. Analysing the findings: The analysing of findings of step (2) requires following:

- (i) Review the findings and produce tables, charts and graphs to support the analysts.
- (ii) Identify gaps in performance between our organisation and better performers.
- (iii) Seek explanations for the gaps in performance. The performance gaps can be positive, negative or zero.
- (iv) Ensure that comparisons are meaningful and credible.

Advanced Management Accounting

(v) Communicate the findings to those who are affected.

(vi) Identify realistic opportunities for improvements.

4. **Recommendations: This involves:**

Making recommendation: This requires:

(i) Deciding the feasibility of making the improvements in the light of the conditions that apply within own organisation.

(ii) Agreement of the improvements that are likely to be feasible.

(iii) Producing a report on the Benchmarking in which the recommendations are included.

(iv) Obtaining the support of key stakeholder groups for making the changes needed.

(v) Developing action plan(s) for implementation.

5. **Monitoring and reviewing: This involves:**

(i) Evaluating the benchmarking process undertaken and the results of the improvements against objectives and success criteria plus overall efficiency and effectiveness.

(ii) Documenting the lessons learnt and make them available to others.

(iii) Periodically re-considering the benchmarks

EXERCISE**Question 1**

A company manufactures two products X and Y. Product X requires 5 hours to produce while Y requires 10 hours. In July, 1996, of 25 effective working days of 8 hours a day, 1,000 units of X and 600 units of Y were produced. The company employs 50 workers in the production department to produce X and Y. The budgeted hours are 1,02,000 for the year.

Calculate capacity ratio, activity ratio and efficiency ratio. Also establish their inter-relationship.

Answer

Inter-relationship:

Capacity ratio ÷ Efficiency ratio = Activity ratio

$117.65\% \times 110\% = 129.41\%$

Question 2

The Financial controller of ACE Ltd. has prepared the following estimates of working results for the year ending 31st March, 1999:

		Year ending 31.3.1999
Direct Material	Rs. / unit	16.00
Direct wages	Rs. / unit	40.00
Variable Overheads	Rs. / unit	12.00
Selling Price	Rs. / unit	125.00
Fixed Expenses	Rs.	6,75,000 per annum
Sales	Rs.	25,00,000 per annum

During the 1999-2000, it is expected that the material prices and variable overheads will go up by 10% and 5 % respectively. As a result of re-engineering of business processes, the overall direct labour efficiency will increase by 12%, but the wage rate will go up by 5%. The fixed overheads are also expected to increase by Rs.1,25,000.

The Vice-President-Manufacturing states that the same level of output as obtained in 1998-1999 should be maintained in 1999-2000 also and efforts should be made to maintain the same level of profit by suitably increasing the selling price.

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The Vice President-Marketing states that the market will not absorb any increase in the selling price. On the other hand, he proposes that publicity involving advertisement expenses as given below will increase the quantity of sales as under:

Advertisement Expenses (Rs.)	80,000	1,94,000	3,20,000	4,60,000
Additional units of Sales	2,000	4,000	6,000	8,000

Required:

Present an Income Statement for 1999-2000.

Find the revised price and the percentage of increase in the price for 1999-2000, if the views of the Vice-President. Manufacturing are accepted.

Evaluate the four alternative proposals put forth by the Vice-President – Marketing Determine the best output level to the budgeted and prepare an overall Income Statement for 1999-2000 at that level of output.

Answer

Additional units of sales	2,000	4,000	6,000	8,000
	Rs.	Rs.	Rs.	Rs.
Additional Profit/ (Loss)	34,600	35,200	23,800	(1,600)

Evaluation of four alternatives: Since the additional profit is maximum at the additional sales of 4,000 units, therefore the second alternative is adjudged as the best out of the four alternatives proposed by the Vice President of Marketing. Hence the concern should produce and sell 24,000 units during the year 1999-2000.

Question 3

A Company is engaged in manufacturing two products 'X' and 'Y'. Product X uses one unit of component 'P' and two units of component 'Q'. Product 'Y' uses two units of component 'P', one unit of component 'Q' and two units of component 'R'. Component 'R' which is assembled in the factory uses one unit of component 'Q'.

Component 'P' and 'Q' are purchased from the market. The company has prepared the following forecast of sales and inventory for the next year:

	Product 'X'	Product 'Y'
Sales (in units)	80,000	1,50,000
At the end of the year	10,000	20,000
At the beginning of the year	30,000	50,000

The production of both the products and the assembling of the component 'R' will be spread out uniformly throughout the year. The company at present orders its inventory of 'P' and 'Q' in quantities equivalent to 3 months production. The company has compiled the following data related to two components:

	P	Q
Price per unit (Rs.)	20	8
Order placing cost per order (Rs.)	1,500	1,500
Carrying cost per annum	20%	20%

Required:

- (a) Prepare a Budget of production and requirements of components during next year.
- (b) Suggest the optimal order quantity of components 'P' and 'Q'.

Answer

- (a) Budgeted requirements of components P, Q and R are 3,00,000, 4,80,000 and 24,000 respectively.
- (b) EOQ: P = 15,000 components and Q = 30,000 components

STANDARD COSTING

BASIC CONCEPTS AND FORMULAE

Basic Concepts

6.1 Meaning of Variance Analysis

Variance analysis is the analysis of the cost variances into its component parts with appropriate justification of such variances, so that we can approach for corrective measures

6.2 Variances of Efficiency

Variances due to the effective or ineffective use of materials quantities, labour hours, once actual quantities are compared with the predetermined standards.

6.3 Variances of Price Rates

Variances arising due to change in unit material prices, standard labour hour rates and standard allowances for indirect costs.

6.4 Variances Due to Volume

Variance due to the effect of difference between actual activity and the level of activity assumed when the standard was set.

6.5 Purpose of Standard Costing

Standard Costing main purpose is to

- Investigate the reasons
- Identify the problems
- Take corrective action.

6.6 Reasons for Each Type Of Variances And The Suggested Course Of Action

Type of Variance	Reasons of Variance	Suggestive Course of Action
MATERIAL		
Material	• Change in Basic Price	• Departmental head should take necessary action to

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Price	• Fail to purchase the anticipated standard quantities at appropriate price	• purchase at right point of time • Cash discount or interest rate for payment of purchase should be consider at the time of such payment • Price check on the purchase of standard quality materials
Material Usage	• Use of sub-standard material • Ineffective use of materials • Pilferage • Non standardised mix	• Regular Inspection of quality of materials • Proper training of operators • Ensure best utilisation of resources
LABOUR		
Labour Efficiency	• Change in design and quality standard • Poor working conditions • Improper scheduling	• Proper planning • Proper training • Healthy working environment • Timelines for achieving set targets
Labour Rate	• Improper placement of labour • Increments / high labour wages • Overtime	• Time Scheduling for work performance • Proper job allocation according to capabilities of workers
OVERHEADS		
Manufacturing	• Improper planning • Under or over absorption of fixed overheads • Reduction of sales • Breakdowns • Power failure • Labour Trouble	• Efficient planning for better Capacity utilization • Check on expenditure
Selling and Distribution	• Increase in delivery cost • Increase in stock holding period	• Sales quotas • Sale Targets

	• Overtime	
Administrative	• Over expenditure	• Comparison of budgets with actuals • Introduction of Operating costing • Introduction of cost ratios
SALES		
Sales Value	• Change in Price • Change in Market Size • Change in Market Share	• Better Price Decision • Improved Strategic Planning

Basic Formulas

1. Material Variance

1.1 Material costs variance = (Standard quantity x Standard Price) – (Actual quantity x Actual price)

$$MCV = (SQ \times SP) - (AQ \times AP)$$

1.2 Material price variance = Actual quantity x (Standard price – Actual price)

$$MPV = AQ \times (SP - AP)$$

1.3 Material usage variance = Standard price (Standard quantity – Actual quantity)

$$MUV = SP \times (SQ - AQ)$$

Check:

1.4 Material cost variance = Material usage variance + Material price variance

$$MCV = MUV + MPV$$

Classification of Material Usage Variance

Material usage variance is further sub-divided into:

i) Material mix variance

ii) Material yield variance. (Or Material sub-usage variance)

1.5 Material mix variance = (Revised standard quantity – Actual quantity) x Standard price

$$MMV = (RSQ - AQ) \times SP$$

Where

Revised standard quantity =

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$$\frac{\text{Standard quantity of one material}}{\text{Total of standard quantities of all materials}} \times \text{Total of actual quantities of all materials}$$

1.6 Material revised usage variance = $\frac{\text{Standard quantity} - \text{Revised standard quantity}}{\text{Standard price}} \times \text{Standard price}$

$$\text{MRUV} = (\text{SQ} - \text{RSQ}) \times \text{SP}$$

1.7 Material yield variance = $(\text{Actual yield} - \text{Standard yield}) \times \text{Standard output price}$

$$\text{MYV} = (\text{AY} - \text{SY}) \times \text{SOP}$$

Check:

Material usage variance = Material mix variance + Material yield variance

$$\text{MUV} = \text{MMV} + \text{MYV}$$

Or

1.8 Material usage variance = Material mix variance + Material revised usage variance

$$\text{MUV} = \text{MMV} + \text{MRUV}$$

Note: Material revised usage variance is also known as material sub – usage variance.

In each case there will be only one variance either material yield or material revised usage variance.

2. Labour Variance

2.1 Labour Cost variance = $(\text{Std. hours for actual output} \times \text{Std. rate per hour}) - (\text{Actual hours} \times \text{Actual rate per hour})$

$$\text{LCV} = (\text{SH} \times \text{SR}) - (\text{AH} \times \text{AR})$$

2.2 Labour rate variance = $\text{Actual time} (\text{Std. rate} - \text{Actual rate})$

$$\text{LRV} = \text{AH} \times (\text{SR} - \text{AR})$$

2.3 Labour efficiency (or time) variance = $\text{Std. rate} (\text{Std. hours for actual output} - \text{Actual hours})$

$$\text{LEV} = \text{SR} \times (\text{SH} - \text{AH})$$

Check:

Labour cost variance = Labour efficiency variance + Labour rate variance

$$\text{LCV} = \text{LEV} + \text{LRV}$$

2.4 Classification of Labour Efficiency Variance

Labour efficiency variance is further divided into the following variances:

(i) Idle time variance

(ii) Labour mix variance

(iii) Labour yield variance (or Labour revised-efficiency variance)

2.5 Idle time variance = Idle hours x Standard rate

$$\text{ITV} = \text{IH} \times \text{SR}$$

2.6 Labour mix variance = (Revised std. hours – Actual hours) x Standard rate

$$\text{LMV} = (\text{RSH} - \text{AH}) \times \text{SR}$$

2.7 Labour revised efficiency variance = (Std. hours for actual output – Revised std. hours) x Standard rate

$$\text{LREV} = (\text{SH} - \text{RSH}) \times \text{SR}$$

2.8 Labour yield variance = (Actual yield – Std. yield from actual input) x Std. labour cost per unit of output

$$\text{LYV} = (\text{AY} - \text{SY}) \times \text{SLC}$$

Check:

Labour efficiency variance = Idle time variance + Labour mix variance + Labour yield variance
(or labour revised efficiency variance)

$$\text{LEV} = \text{ITV} + \text{LMV} + \text{LYV} \text{ (or LREV)}$$

3. Overhead Variance

Basic terms used in the computation of overhead variance

Standard overhead rate (per hour) = $\frac{\text{Budgeted overhead}}{\text{Budgeted hours}}$

Or

Standard overhead rate (per unit) = $\frac{\text{Budgeted Overhead}}{\text{Budgeted output in units}}$

Note: Separate overhead rates will be computed for fixed and variable overheads.

Basic calculations before the computation of overhead variances:

The following basic calculation should be made before computing variances.

(i) **When overhead rate per hour is used:**

(a) **Standard hours for actual output (SHAO)**

$$\text{SHAO} = \frac{\text{Budgeted hours}}{\text{Budgeted output}} \times \text{Actual output}$$

Advanced Management Accounting

(b) **Absorbed (or Recovered) overhead** = Std. hours for actual output × Std. overhead rate per hour

(c) **Standard overhead** = Actual hours × Std. overhead rate per hour

(d) **Budgeted overhead** = Budgeted hours × Std. overhead rate per hour

(e) **Actual overhead** = Actual hours × Actual overhead rate per hour

(ii) **When overhead rate per unit is used**

(a) **Standard output for actual hours (SOAH)**

$$\text{SOAH} = \frac{\text{Budgeted output (in units)}}{\text{Budgeted hours}} \times \text{Actual hours}$$

(b) **Absorbed overhead** = Actual output × Std. overhead rate per unit

(c) **Standard overhead** = Std. output for actual time × Std. overhead rate per unit

(d) **Budgeted overhead** = Budgeted output × Std. overhead rate per unit

(e) **Actual overhead** = Actual output × Actual overhead rate per unit

Overhead cost variance = Absorbed overhead – Actual overhead

$$\text{OCV} = (\text{Std. hours for actual output} \times \text{Std. overhead rate}) - \text{Actual overhead}$$

Overhead cost variance is divided into two categories:

(i) Variable overhead (VO) variances

(ii) Fixed overhead (FO) variances

3.1 Variable Overhead (VO) Variances

V. O. cost variance = (Absorbed variable overhead – Actual variable overhead)

$$= (\text{Std. hours for actual output} \times \text{Std. variable overhead Rate}) - \text{Actual overhead cost}$$

This variance is sub-divided into the following two variances:

(a) Variable overhead expenditure variance or spending variance or budget variance

(b) Variable overhead efficiency variance

3.2 V. O. expenditure variance = (Standard variable overhead – Actual variable overhead)

$$= (\text{Actual hours} \times \text{Std. variable overhead rate}) - \text{Actual overhead cost}$$

3.3 V.O. efficiency variance = (Absorbed variable overhead – Standard variable overhead)

$$= (\text{Std. hours for actual output} - \text{Actual hours}) \times \text{Std. variable overhead rate}$$

Check:

V. O. cost variance = V.O. expenditure variance + V. O. efficiency variance

Fixed Overhead (FO) Variances

3.4 F.O cost variance = (Absorbed overhead – Actual overhead)

= (Std. hours for actual output × Std. fixed overhead rate) – Actual fixed overhead

Fixed overhead cost variance is further divided into the following two variances:

(a) Fixed overhead expenditure variance

(b) Fixed overhead volume variance

3.5 F.O. expenditure variance = (Budgeted fixed overhead – Actual fixed overhead)

= (Budgeted hours × Std. fixed overhead rate) – Actual fixed overhead

3.6 F.O volume variance = (Absorbed overhead – Budgeted overhead)

= (Std. hours for actual output – Budgeted hours) × Std. fixed overhead rate

Check:

F.O. cost variance = F.O. expenditure variance + F.O. volume variance

Fixed overhead volume variance is further divided into the following variances:

(a) Efficiency variance

(b) Capacity variance

(c) Calendar variance

3.7 Efficiency variance = (Absorbed fixed overhead – Standard fixed overhead)

= (Std. hours for actual output – Actual hours) × Std. fixed overhead rate

3.8 Capacity variance = (Standard fixed overhead – Budgeted overhead)

= (Actual hours – Budgeted hours) × Std. fixed overhead rate

3.9 Calendar variance = (Actual No. of working days – Std. No. of working days) × Std. fixed rate per day

Or = (Revised budgeted hours – Budgeted hours) × Std. fixed rate per hour

Where,

Revised budgeted hours = $\frac{\text{Budgeted hours}}{\text{Budgeted days}} \times \text{Actual days}$

Advanced Management Accounting

Note: When calendar variance is computed, there will be a modification in the capacity variance. In that case revised capacity variance will be calculated and the formula is:

Revised capacity variance = (Actual hours – Revised budgeted hours) × Std. fixed rate per hour

Check: F. O. volume variance = Efficiency Variance + Capacity variance + Calendar variance

4. Sales Variance

The sales variances can be computed in two ways. They are:

- (a) Sales turnover or value method.
- (b) Profit or sales margin method.

(a) Sales turnover or sales value method: It includes the following:

4.1 Sales value variance: (Budgeted sales - Actual sales)

The variance can be bifurcated into sales price variance and sales volume variance.

4.2 Sales price variance:

Actual quantity of Sales (Actual price – Budgeted price)

or

(Actual sales - Actual quantity at budgeted prices)

4.3 Sales volume variances:

Budgeted price (Actual quantity – Budgeted quantity)

or

(Actual quantity at budgeted price - budgeted sales)

Check: Sales value variance = Sales price variance + Sales volume variances

Sales volume variance can be sub-divided into two parts:

- (i) Sales mix variance
- (ii) Sales quantity variance

4.4 Sales mix variance

Total actual sales quantity (Budgeted price per unit of actual mix – Budgeted price per unit of budgeted mix)

4.5 Sales quantity variance:

Budgeted price per unit of budgeted mix (Actual total sales qty. – Budgeted total sales qty.)

Check: Sales volume variance = Sales mix variance + Sales quantity variance

(b) Profit or sales margin method

4.6 Total Sales Margin Variance (TSMV):

(Budgeted margin - Actual margin)

4.7 Sales Margin Price Variance (SMPV):

SMPV = Actual quantity (Actual margin per unit – Budgeted margin per unit).

4.8 Sales Margin Volume Variance (SMVV):

SMVV = Budgeted margin per unit (Actual units – Budgeted units)

This can be further sub-divided into the following two variances:

4.9 Sales Margin Quantity Variance (SMQV):

(Budgeted total quantity - Actual total quantity) Budgeted margin per unit of budgeted mix.

4.10 Sales Margin Mix Variance (SMMV):

SMMV = Total actual quantity sold × (Budgeted margin per unit of actual mix - Budgeted margin per unit of budgeted mix).

Check: Sales Margin Volume Variance = Sales Margin Quantity Variance + Sales Margin Mix Variance

Question 1

(a) State the features of Partial plan of Standard Cost Accounting procedure.

(b) The following is the Operating Statement of a company for April 2001:

		Rs.	
Budgeted Profit		1,00,000	
Variances:		Favourable Rs.	Adverse Rs.
Sales Volume			4,000
	Price	9,600	
Direct Material	Price		4,960
	Usage		6,400
Direct Labour	Rate		3,600
	Efficiency	3,600	
Fixed	Efficiency	2,400	

Advanced Management Accounting

*Overheads**Capacity*

4,000

Expense

1,400

17,000

22,960

5,960 (A)

Actual profit

94,040

*Additional information is as under:**Budget for the year*

1,20,000 units

Budgeted fixed overheads

Rs.4,80,000 per annum

*Standard cost of one unit of product is:**Direct Materials*

5 kg.@ Rs.4 per kg.

Direct Labour

2 hours @ Rs.3 per hour

*Fixed overheads are absorbed on direct labour hour basis.**Profit*

25% on sales

*You are required to prepare the Annual Financial Profit / Loss Statement for April, 2001 in the following format:**Account**Qty./ Hours**Rate / Price**Actual Value Rs.**Sales**Direct Materials**Direct Labour**Fixed Overheads**Total Costs**Profit***Answer****(a)** Features of Partial Plan of Standard Cost Accounting procedure:

Standard cost operations can be recorded in the books of account by using partial plan, Features of partial plan of standard costing procedure are as follows:

- (i) Partial plan system uses current standards in which the inventory will be valued at current standard cost figure.
- (ii) Under this method WIP account is charged at the actual cost of production for the month and is credited with the standard cost of the month's

production of finished product.

- (iii) The closing balance of WIP is also shown at standard cost. The balance after making the credit entries represent the variance from standard for the month.
- (iv) The analysis of variance is done after the end of the month.

(b) Working notes:

1. (a) Budgeted fixed overhead per unit:

$$= (\text{Budgeted fixed overheads p.a} / \text{Budgeted output for the year})$$

$$= \text{Rs.4,80,000 p.a.} / 1,20,000 \text{ units} = \text{Rs.4 per unit.}$$
- (b) Budgeted fixed overhead hour:

$$= \text{Budgeted fixed overhead per unit} / \text{Standard labour hours per unit}$$

$$= \text{Rs.4} / 2 \text{ hours} = \text{Rs.2 per hour}$$
2. (a) Standard cost per unit:

	Rs.
Direct material	20
(5 kg × Rs.4/- per kg)	
Direct labour	6
(2 hours × Rs.3/- per hour)	
Fixed overhead	4
(2 hours × Rs.2)	
Total standard cost (per unit)	30
(b) Budgeted selling price per unit	
Standard cost per unit	30
Standard profit per unit	10
(25% on sales or 33 – 1/3% of standard cost)	
Budgeted selling price per unit	40

- 3 (a) Actual output units for April, 2001:
 Fixed overhead volume Variance

$$= \text{Efficiency variance} + \text{Capacity variance}$$

Advanced Management Accounting

or (Budgeted output units – Actual output units) Budgeted fixed overhead p.u.

Rs.2,400 (Favourable) + Rs.4,000 (Adverse) = Rs.1,600 (Adverse)

or (10,000 units – x units) Rs.4 – Rs.1,600 (Adverse)

or (10,000 units – 400 units) = x (Actual output units)

or Actual output units = 9,600 units

(b) Actual fixed overhead expenses:

(budgeted fixed overhead – Actual fixed overhead) = Fixed overhead expenses variance

or (Rs.40,000 – x) = Rs.1,400 (Favourable)

or x = Rs.40,000 – Rs.1,400

= Rs.38,600

4. (a) Actual sales quantity units: Sales volume variance

$$= \text{Budgeted margin per unit} \left(\frac{\text{Actual sales quantity units} - \text{Budgeted quantity units}}{\text{quantity units}} \right)$$

= Rs.4,000 (Adverse) = Rs.10 (x – 10,000 units)

or 400 units = x – 10,000 units

or x (Actual sales quantity) = 9,600 units

(b) Actual selling price per units

$$\text{Sales price variance} = \left(\frac{\text{Actual Selling price per unit} - \text{Budgeted selling price per unit}}{\text{price per unit}} \right) \text{Actual Sales units}$$

or Rs.9,600 (Fav.) = (x – Rs.40) × 9,600 units

or Actual selling price per unit = Rs.41/-

5. (a) Actual quantity of material consumed:

$$\text{Material usage variance} = \left(\frac{\text{Standard quantity} - \text{Actual quantity}}{\text{quantity}} \right) \text{Standard price per unit}$$

or 6,400 (Adv.) = (9,600 units × 5 kgs.) Rs.4

or x kgs. = 49,600 kgs.

(actual quantity of material consumed)

(b) Actual price per kg:

Actual price per kg.:

Material price variance = $\frac{\text{Standard price per kg} - \text{Actual price per kg}}{\text{Actual quantity of material consumed}}$

-Rs.4,960 = (Rs.4 – Rs. y per kg.) 49,600 kg.

-0.1 = (Rs.4 – Rs. y per kg)

or y = Rs.4.10 per kg.

6. (a) Actual direct labour hour used:

Labour efficiency variance = $\frac{\text{Standard hours} - \text{Actual hours}}{\text{Standard rate per hour}}$

Rs.3,600 (Favourable) = $\frac{(9,600 \text{ units} \times 2 \text{ hours} - p \text{ hours})}{\text{Rs.3}}$

Rs.3,600 (Favourable) = $\frac{(19,200 \text{ hours} - p \text{ hours})}{\text{Rs.3}}$

P hours = $\frac{(19,200 \text{ hours} - 1,200 \text{ hours})}{18,000 \text{ hours (Actual direct labour hours)}}$

(b) Actual direct labour hour rate:

Labour rate variance = $\left(\frac{\text{Standard rate per hour} - \text{Actual rate per hour}}{\text{Actual Direct labour hours}} \right)$

Rs.3,600 (Adverse) = $(\text{Rs.3 per hour} - t \text{ per hour}) 18,000 \text{ hours}$

or t = $\text{Rs.3} + \text{Rs.0.20} - \text{Rs.3.20 per hour}$
(actual direct labour hour rate)

7. Actual fixed overheads:

Fixed overhead expense variance = Budgeted fixed overhead – Actual fixed overhead

or Rs.1,400 (Favourable) = $10,000 \text{ units} \times \text{Rs.4 p.u.} - \text{Actual fixed overhead}$

or Actual fixed overhead = $\text{Rs.40,000} - \text{Rs.1,400}$

or Actual fixed overhead = Rs.38,600

Advanced Management Accounting**Annual financial Profit /Loss Statement****(for April, 2001)**

<i>Account</i>	<i>Qty./ Hours</i>	<i>Rate/Price</i>	<i>Actual/ Value</i>
<i>(a)</i>	<i>(b)</i>	<i>(c)</i>	<i>(d)=(b)×(c)</i>
Sales: (A)	9,600 units	41	3,93,600
(Refer to working note 4)			
Direct Materials	49,600 kgs.	4.10 per kg.	2,03,360
(Refer to working note 5)			
Direct labour	18,000 hours	3.20 per hour	57,600
(Refer to working note 6)			
Fixed Overheads	18,000 hours	2.14444 per hour	38,600
(Refer to working note 6 (a) and 7)			
(Rs.38,600/18,000 hours)			
(absorbed on direct labour hour basis)			
Total costs: (B)			2,99,560
Profit: [(A) – (B)]			94,040

Question 2

C Preserves produces Jams, Marmalade and Preserves. All the products are produced in a similar fashion; the fruits are cooked at low temperature in a vacuum process and then blended with glucose syrup with added citric acid and pectin to help setting.

Margins are tight and the firm operates, a system of standard costing for each batch of Jam.

The standard cost data for a batch of raspberry jam are

<i>Fruits extract</i>	<i>400 kgs @ Rs. 16 per kg.</i>
<i>Glucose syrup</i>	<i>700 kgs @ Rs. 10 per kg.</i>
<i>Pectin</i>	<i>99 kgs. @ 33.2 per kg.</i>
<i>Citric acid</i>	<i>1 kg at Rs. 200 per kg.</i>
<i>Labour</i>	<i>18 hours @ Rs. 32.50 per hour.</i>
<i>Standard processing loss 3%.</i>	

The climate conditions proved disastrous for the raspberry crop. As a consequence, normal prices in the trade were Rs. 19 per kg for fruits abstract although good buying could achieve some savings. The impact of exchange rates for imported sugar plus the minimum price fixed for sugarcane, caused the price of syrup to increase by 20%.

The retail results for the batch were –

Fruit extract	428 kgs at Rs. 18 per kg.
Glucose syrup	742 kgs at Rs. 12 per kg.
Pectin	125 kgs at Rs 32.8 per kg.
Citric acid	1 kg at Rs. 95 per kg.
Labour	20 hrs. at Rs. 30 per hour.

Actual output was 1,164 kgs of raspberry jam.

You are required to:

- Calculate the ingredients planning variances that are deemed uncontrollable.
- Calculate the ingredients operating variances that are deemed controllable.
- Calculate the mixture and yield variances.
- Calculate the total variances for the batch.

Answer

Details of original and revised standards and actual achieved

	Original standards		Revised standards		Actual	
Fruit	400 Kgs × Rs16	Rs6,400	400 Kgs × 19	Rs7,600	428 Kgs× 18	Rs7,70 4
Glucose	700 Kgs × Rs10	Rs7,000	700 Kgs × Rs12	Rs 8,400	742 Kgs × Rs 12	Rs 8,904
Pectin	99 Kgs × Rs 33.2	Rs 3286.8	99 Kgs × Rs 33.2	Rs 3286.8	125Kgs×Rs 32.8	Rs 4,100
Citric acid	1 Kg× Rs 200	Rs 200	1 Kg× Rs 200	Rs 200	1 Kg× Rs 95	Rs 95
	1,200 kgs	Rs16,886. 8	1,200 kgs	Rs19,48 6.8	1,296 kgs	Rs20,8 03
Labour		Rs 585.0		Rs 585.0		Rs 600
	1,200 kgs	17,471.8	1,200 kgs	20,071.8	1,296 kgs	21,403

Advanced Management Accounting

Loss	36 kgs		36kgs		132	
	1,164kgs	Rs	1,164kgs	Rs	1,164 Kgs	Rs
		17,471.8		20,071.8		21,403

(i) Planning variances

* Fruit extract (6,400 less 7,600)	Rs 1,200(Adverse)
Glucose syrup (7,000 less 8,400)	Rs1,400(Adverse)
Total	Rs 2,600(Adverse)

* (Std qty × Std price less Std qty × Revised Std price)

(ii) Ingredients operating variances

Total (19,486.8 less 20,803) = Rs 1,316.2(Adverse)

Ingredients Price variance

(Revised Material Price – Actual Material Price) × (Actual Qty Consumed)

		Variance in Rs
Fruit extract	$(19 - 18) \times 428$	428(F)
Glucose syrup		Nil
Pectin	$(33.2 - 32.8) \times 125$	50(F)
Citric acid	$(200 - 95) \times 1$	105(F)
		583(F)

Usage variance

(Std Qty on Actual Production less Actual Qty on Actual Production) × Revised Std Price/Unit

	Rs	Variance in Rs
Fruit extract	$(400 - 428) \times 19$	532(A)
Glucose syrup	$(700 - 742) \times 12$	504(A)
Pectin	$(99 - 125) \times 33.2$	863.2(A)
Citric acid		Nil
		1,899.2(A)

(iii) Mix Variance

(Actual usage in std mix less Actual usage in actual mix) × std price

		Variance in Rs
Fruit extract	$(432 - 428) \times 19$	76(F)
Glucose syrup	$(756 - 742) \times 12$	168 (F)
Pectin	$(106.92 - 125) \times 33.2$	600.3(A)
Citric acid	$(1.08 - 1) \times 200$	16(F)
		340.3 (A)

Yield variance

(Actual yield – Std yield from actual output) $\times$ Std cost per unit of output

$$= (1,164 - 1,296 \times 0.97) \times \frac{19486.8}{1164} = 1,558.9(\text{A})$$

Labour operating variance

$$585 - 600 = 15(\text{A})$$

- (iv) Total variance = Planning variance + Usage Variance + Price Variance + labour operating Variance.

$$\text{Or Total Variance} = (2,600) + (1,899.2) + 583 + (15) = 3931.2 (\text{A}).$$

Question 3

Rainbow Ltd. manufactures paint in batches. The company uses standard costing system and the variances are reported weekly. You have taken the account sheet for study for variance analysis discussion. While working coffee was spilled on these sheets and only following could have been retrieved:

Dr.		Cr.
	Raw Material -1	
Beg. Balance	0	18,000
	Closing Balance	6,000
	Raw Material -2	
Beg. Balance	18,000	
	Closing Balance	41,400
	Work in Progress	
Beg. Balance	0	
Raw Material -2	72,000	Closing Balance 0

Advanced Management Accounting

<i>Sundry Creditors</i>	1,27,200
<i>Wages outstanding</i>	
51,750	
<i>Quantity Variance-Material-1</i>	
1,200	
<i>Price Variance-Material-2</i>	
	6,600
<i>Efficiency Variance-Labour</i>	
	7,200

Other information's are: standard cost of Material – 2 is Rs180 per litre and standard quantity is 5 litres. Standard wages rate is Rs24 per hour and a total 2,300 hours were worked during the week. 1,000 kg of Material -1 and 550 litres of Material-2 were purchased. Sundry creditors are for material acquisition, and wages outstanding pertain to direct labour.

You are required to compute Material-1 Rate Variance, Material-2 Quantity Variance & Labour Spending Variance, Standard hours allowed for production and purchase value of Material-1 for variance analysis discussion.

Answer

Material – 1 Rate Variance	= Standard cost of material purchased – Actual cost = Rs24, 000 – Rs21, 600 = Rs2, 400 (F)
Material – 2 Quantity Variance	= SR × SQ – SR × AQ = Rs900 × 80 units – Rs75, 600 = Rs3, 600 (A)
Labour Spending Variance	= SR × AH – AR × AH = Rs24/per hour × 2300 hours – Rs51, 750 = Rs3, 450 (A)
Labour Efficiency Variance	= SR × (SH – AH) – 7200 = 24 (SH – 2300) SH = 2000 Hrs.

	Rs
Total Cost of material purchased	1,27,200
Less Purchase Value of Material – 2	1,05,600
Cost of material –1	21,600

Working Notes:

- (1) Standard Cost of Material – 2 actually consumed in production = Rs72, 000 (Given)
 Standard cost of Material – 2 per unit: 5 litres × Rs180 = Rs900
 $\therefore$ No of units produced = Rs72, 000 / Rs900 = 80 units
 Total material – 1 used in production = Rs18, 000 (Given)
 Add Closing Inventory = Rs6, 000 (Given)
 Less Opening Inventory = 0
 Hence Standard Cost of Material – 1 purchased = Rs24, 000
- (2) Standard Rate of Material -1 = Rs24, 000 / 1,000kg = Rs24 per kg
 Standard Cost of Material – 1 = Rs18, 000
 Add favourable Quantity Variance = Rs1, 200
 Material – 1 allowed = Rs19, 200
 Standard quantity of Material – 1 allowed = Rs19, 200/Rs24= 800 Kg.
 Standard quantity per unit = 800kg/80units = 10 kg
 Standard purchase price for Material – 2 = (550liters × Rs180)= Rs99, 000
 Add unfavourable Rate Variance = Rs6, 600
 Actual cost Price of Material – 2 = Rs1, 05, 600
- (3) Opening balance of Material – 2 = Rs18, 000
 Add Standard Cost of Purchase (550 litres × Rs180) = Rs99, 000
 Less Closing Balance = Rs41, 400
 Material-2 Consumed at Standard cost = Rs75, 600

Advanced Management Accounting

Question 4

“Overhead variances should be viewed as interdependent rather than independent”. Explain.

Answer

The operations of a firm are so inter linked that the level of performance in one area of operation will affect the performance in other areas. Improvements in one area may lead to improvements in other areas. A sub-standard performance in one area may be compensated by a favourable performance in another area. Because of such interdependency among activities in the firm, the managers should not jump to conclusions merely based on the label of variances namely favourable or unfavourable. They should remember that there is a room for trade off amongst variances. Hence, variances need to be viewed as ‘attention directors’ rather than problem solvers. Thus, a better picture will be captured when overhead variance are not viewed in isolation but in an integrated manner.

Question 5

A company following standard marginal costing system has the following interim trading statement for the quarter ending 30th June, 2005, which reveals a loss of Rs. 17,000, detailed below:

	Rs.
Sales	4,99,200
Closing stock (at prime cost)	<u>18,000</u>
	5,17,200
Costs:	
Direct material	1,68,000
Direct labour	1,05,000
Variable overhead	<u>42,000</u>
	3,15,000
Fixed overhead	1,20,000
Fixed Admn. Overhead	40,000
Variable distribution Overhead	19,200
Fixed selling Overhead	<u>40,000</u>
	<u>2,19,200</u>

Standard Costing

Total costs	<u>5,34,000</u>
Loss	<u>17,000</u>

Additional information is as follows:

- (i) Sales for the quarter were 1,200 units. Production was 1,400 units, of which 100 units were scrapped after complete manufacture. The factory capacity is estimated at 2,000 units.
- (ii) Because of low production, labour efficiency during the quarter is estimated to be 20% below normal level.

You are required to analyse the above and report to the management giving the reasons for the loss.

Answer

(i)

	Details	Working	Amount (Rs.)
(1)	Selling price at cost	<u>4,99,200</u>	416
		1,200	
(2)	Raw materials	<u>148,000</u>	120
		1,400	
	Labour	<u>105,000</u>	60
		1,750	
	[Equivalent units (1,400/80%)]		
	Factory overhead	<u>42,000</u>	
		1,400	30
	Total manufacturing cost		210
	Distribution overheads	<u>19,200</u>	16
		1,200	
	Total cost		226
	Contribution		190
	Total fixed cost: factory	1,20,000	
	Administration	40,000	
	Selling	40,000	2,00,000

Advanced Management Accounting

(ii) Standard Profit for 1,200 units sold:

	Rs.	
Contribution	$1,200 \times 190$	2,28,000
Less: Fixed costs		<u>2,00,000</u>
Profit		<u>28,000</u>

(iii) Reconciliation

	Rs.	
Budgeted profit	$(2,000 \times 190 - 2,00,000)$	1,80,000
Less: Volume variance	800×190	1,62,000
Standard profit		28,000
<i>Factors causing loss:</i>		
Units scrapped	100×210	21,000
Labour inefficiency	350×60	21,000
Undervaluation of closing stock	$100 \times (210 - 180)$	3,000
Actual profit		<u>-17,000</u>

Question 6

The following figures are available. Find out the missing figures, giving appropriate formulae:

	Rs.
Budgeted profit	15,000
<i>Less: Adverse variances:</i>	
Contribution price variance	10,600
Direct materials variance	1,000
Fixed overhead variance	<u>600</u>
	<u>(12,200)</u>
	2,800
<i>Add: Favourable variances</i>	
Contribution quantity variance	1,800

Standard Costing

Direct wages variance	600	
Variable overhead variance	<u>1,800</u>	<u>4,200</u>
Actual profit		<u>7,000</u>

There is no inventory

Production units = Sales units for both actual and budget.

Standard selling price	Rs. 18/unit
Standard variable cost	Rs. 15/unit
Standard contribution	Rs. 3/unit
Actual selling price	Rs. 17/unit
Budgeted sales	10,000 units

Standard material cost p.u. = Re. 1 (which is 5 kg. @ Rs. 20 Paise/kg.).

Material usage variance = 400 (Adv.)

Actual labour hours @ actual rate = Rs. 63,000

Actual labour hours @ standard rate = Rs. 61,950

Variable overhead standard rate = Rs. 2

Standard hours of production = 4 per unit

Variable overhead at standard rate = Rs. 84,800.

Variable overhead expenditure variance = 400 (A).

Budgeted fixed overhead = Rs. 15,000.

Find out the following:

- (i) Actual sales units
 - (ii) Actual sales rupees
 - (iii) Actual quantity of raw materials used
 - (iv) Labour efficiency variance
 - (v) Actual variable overhead in rupees
 - (vi) Variable overhead efficiency variance
 - (vii) Actual fixed overheads
 - (viii) Operating profit variance.
-

Advanced Management Accounting

Answer

		Rs.
(1)	Budgeted contribution = Budgeted Profit + Budgeted Fixed Cost	15,000 + 15,000 = 30,000
	Plus Contribution quantity variance	1,800
	Total Standard contribution	31,800
	Standard Contribution per unit	3
	Actual Sales Volume	10,600 units
(2)	Actual Sales Volume 10,600 × 17	1,80,200
(3)	Actual quantity of Raw Materials used	
	Standard consumption 10,600 × 5	2,000 Kgs.
	Add: Material Usage Variance $\frac{400}{.2}$	2,000 kgs.
	Actual consumption	55,000 Kgs.
(4)	Labour Efficiency variance	
	Standard labour cost for Standard hours (63,000 + 600)	63,600
	Standard labour cost for actual hours	61,950
	Labour efficiency variance	1,650 F
(5)	Actual variable overhead	
	Selling Overhead variance – Variable overhead	Rs. 84,800 – Rs. 1,800 = Rs. 83,000
(6)	Variable Overhead efficiency variance	
	Actual hours (AH)	61950/15 41,300 hours
	Standard hours (SH)	60,600 × 4 42,400 hours
	Standard rate per hour (SR)	63600/(10600x4) Rs. 1.5
	Efficiency variance SR (SH– AH) = 2 (42,400 – 41,300) = 2,200F	
(7)	Actual fixed overheads: Budgeted Overhead + Fixed Overhead variance = 15,000 + 600 = Rs. 15,600.	
(8)	Operating profit variance	
	If budgeted profit is considered (15,000 – 7,000) = Rs. 8,000 adverse	
	If standard profit is considered (16,800 – 7,000) = Rs. 9,800 adverse	

Question 7

Under the single plan, record the journal entries giving appropriate narration, with indication of amounts of debits or credits alongside the entries, for the following transactions using the respective control A/c.

- (i) *Material price variance (on purchase of materials)*
- (ii) *Material usage variance (on consumption)*
- (iii) *Labour rate variance.*

Answer

- (i) Dr. Material Control A/c
Dr. or Cr. Material Price Variance A/c
Cr. Creditors A/c
(Being price variance during purchase of materials)
- (ii) Dr. WIP Control A/c
Dr. or Cr. Material Usage Variance A/c
Cr. Material Control A/c
(Being recording of usage variance at Standard cost of excess/under utilized quantity)
- (iii) Dr. Wages Control A/c
Dr. or Cr. Labour Rate Variance A/c
Cr. Cash
(Being entry to record wages at standard rate)

Question 8

A company produces a product X, using raw materials A and B. The standard mix of A and B is 1: 1 and the standard loss is 10% of input.

You are required to compute the missing information indicated by “?” based on the data given below:

	A	B	Total
Standard price of raw material (Rs./kg.)	24	30	
Actual input (kg.)	<u>?</u>	70	
Actual output (kg.)			<u>?</u>

Advanced Management Accounting

Actual price Rs./kg.	30	?	
Standard input quantity (kg.)	?	?	
Yield variance (sub usage)	?	?	270(A)
Mix variance	?	?	?
Usage variance	?	?	?
Price variance	?	?	?
Cost variance	0	?	1300(A)

Answer

Computation of Yield Variance for 'A' and 'B'

DM yield variance for 'A' =

$$\text{DM yield variance for 'A'} = \left[\frac{\text{Std qty of all DM allowed for actual output} - \text{Actual total qty of all DM used}}{\text{all DM}} \right] \times \text{Std Mix \%age of 'A'} \times \text{Std price of 'A'}$$

$$= [SQ_A - RSQ_A] \times \text{Std price of 'A'}$$

Where RSQ_A = Revised Standard Quantity of 'A' = (Actual total qty of all DM used) $\times$ Std Mix %age of 'A' and

SQ_A = Standard Quantity of DM 'A' for Actual Production = Standard quantity of all DM allowed for actual output $\times$ Std Mix %age of 'A'

$$\text{DM yield variance for 'B'} = \left[\frac{\text{Std qty of all DM allowed for actual output} - \text{Actual total qty of all DM used}}{\text{all DM}} \right] \times \text{Std Mix \%age of 'B'} \times \text{Std price of 'B'}$$

$$= [SQ_B - RSQ_B] \times \text{Std price of 'B'}$$

Where RSQ_B = Revised Standard Quantity of 'B' = (Actual total qty of all DM used) $\times$ Standard Mix %age of 'B' and

SQ_B = Standard quantity of DM 'B' for Actual Production = Standard quantity of all DM allowed for actual output $\times$ Standard Mix %age of 'B'

Since Standard Mix %age is the same for both 'A' and 'B' (1:1) we have,

Total Yield variance for 'A' and 'B' = $T \times (\text{Std price of 'A'} + \text{Std price of 'B'})$

Where $T = (\text{Std qty of all DM allowed for actual output} - \text{Actual total qty of all DM used}) \times 0.5$

As Total Yield variance for 'A' and 'B' is given as – Rs 270, we have

$$- \text{Rs } 270 = T \times \text{Rs } 24 + T \times \text{Rs } 30$$

$$\text{Or } T = - 5$$

Hence Yield Variance for 'A' = $- 5 \times 24 = - \text{Rs } 120$ and

Yield variance for 'B' = $- 5 \times 30 = - \text{Rs } 150$.

Also

$$(\text{SQ}_A - \text{RSQ}_A) \times 24 = - 120 \text{ or } \text{SQ}_A - \text{RSQ}_A = - 5$$

Similarly

$$(\text{SQ}_B - \text{RSQ}_B) \times 30 = - 150 \text{ or } \text{SQ}_B - \text{RSQ}_B = - 5$$

Alternative 1

Let total actual quantity consumed; X kg.

Then, Quantity of A = $X - 70$

$$\text{RSQ} = \frac{X}{2} \text{ of A \& } \frac{X}{2} \text{ of B. (Since the Mix ratio is 1:1)}$$

The Standard input for both 'A' and 'B' will be $0.5X - 5$

Since Cost Variance for 'A' is given to be nil, we have,

$$(\text{SP}_A \times \text{SQ}_A) - (\text{AQ}_A \times \text{AP}_A) = 0$$

$$\text{i.e. } 24 \times (0.5X - 5) - (X - 70) \times 30 = 0$$

$$\text{or } X = 110 \text{ Kgs}$$

Therefore Actual Input for 'A' = $110 - 70 = 40 \text{ Kgs}$

Also, Standard Input for 'A' and 'B' will be $\left(\frac{110}{2} - 5\right) = 50 \text{ Kgs}$. Using this quantity in the

Cost Variance of 'B', the actual price per kg of 'B' (AP_B) will be ,

$$50 \times 30 - 70 \times \text{AP}_B = -1,300$$

$$\text{Or } \text{AP}_B = \text{Rs } 40.$$

Alternative 2

Let the standard input of 'A' = X kg. Therefore, the total standard input for 'A' + 'B' = $2X$

Advanced Management Accounting

Actual input = $(2X + 10)$ Kgs. $\therefore$ Actual input for 'A' = $(2X + 10 - 70) = (2X - 60)$ Kgs

Forming the equation for nil cost variance of 'A'.

$$\text{Rs. } 24 \times X - \text{Rs. } 30 \times (2X - 60) = 0$$

Or $X = 50$ Kgs. Using this quantity in the Cost Variance of 'B', the actual price per kg. of 'B' (AP_B) will be ,

$$50 \times 30 - 70 \times AP_B = -1,300$$

Or $AP_B = \text{Rs. } 40$.

Alternative 3

Let the actual input of 'A' = X

Then the total actual input = $(X + 70)$. Therefore, RSQ of 'A' and 'B' each = $0.5X + 35$ and Standard Input of 'A' and 'B' each = $0.5X + 30$.

Forming the equation for nil cost variance of 'A', we have,

$$24 \times (0.5X + 30) - 30 \times X = 0$$

Or $X = 40$ Kgs.

$\therefore$ Standard Input will be 50 Kgs. Using this, quantity in the Cost Variance of 'B', the actual price per kg. of 'B' (AP_B) will be,

$$50 \times 30 - 70 \times AP_B = -1,300$$

Or $AP_B = \text{Rs. } 40$.

Substituting various values for quantity and price, we get the following table.

	(1)	(2)	(3)	(4)	
	Std. Price $\times$ SQ	Std. Price $\times$ RSQ	Std. Price $\times$ Actual Qty.	Actual Price $\times$ Actual Qty.	
A	$24 \times 50 = 1200$	$24 \times 55 = 1320$	$24 \times 40 = 960$	$30 \times 40 = 1200$	
B	$30 \times 50 = 1500$	$30 \times 55 = 1650$	$30 \times 70 = 2100$	$40 \times 70 = 2800$	
	<u>2700</u>	<u>2970</u>	<u>3060</u>	<u>4000</u>	
	(1) – (2)	(2) – (3)	(1) – (3)	(3) – (4)	(1) – (4)
	Yld variance	Mix variance	Usage variance	Price variance	Cost variance
A	$1200 - 1320 = 120(A)$	$1320 - 960 = 360(F)$	$1200 - 960 = 240(F)$	$960 - 1200 = 240(A)$	$1200 - 1200 = 0$

Standard Costing

B	1500 – 1650 =	1650 – 2100 =	1500 – 2100 =	2100 – 2800	1500 – 2800
	150(A)	450(A)	600(A)	= 700(A)	= 1300(A)
	<u>270A)</u>	<u>90A)</u>	<u>360A)</u>	<u>940A)</u>	<u>1300A)</u>

Actual Output = 90 Kgs.

(Actual output and standard output are always equal numerically in any material variance analysis)

Standard output = Standard input – Standard loss or 100 – 10 = 90 Kgs.

Question 9

The working results of a Software Company for two corresponding years are shown below:

	Amount (Rs. in lakhs)	
	Year 2005	Year 2006
Sales (A)	600	770
Cost of Sales:		
Direct materials	300	324
Direct wages and variable overheads	180	206
Fixed overheads	<u>80</u>	<u>150</u>
Total (B)	<u>560</u>	<u>680</u>
Profit (A – B)	<u>40</u>	<u>90</u>

In year 2006, there has been an increase in the selling price by 10 per cent. Following are the details of material consumption and utilization of direct labour hours during the two years:

	Year 2005	Year 2006
Direct material consumption (M. tons)	5,00,000	5,40,000
Direct labour hours	75,00,000	80,00,000

Required:

- Taking year 2005 as base year, analyse the variances of year 2006 and also workout the amount which each variance has contributed to change in profit.
- Find out the breakeven sales for both years.

Advanced Management Accounting

- (iii) Calculate the percentage increase in selling price in the year 2006 that would be needed over the sale value of year 2006 to earn margin of safety of 45 per cent.

Answer**Working Notes:**

- (i) Budgeted sales in year 2006 = $(100/110) \times 770$ = Rs. 700 lakhs
(ii) Budgeted direct material cost = $(300/600) \times 700$ = Rs. 350 lakhs
(iii) Budgeted direct wages and variable overheads = $(180/600) \times 700$ = Rs. 210 lakhs
(iv) Rate per M. ton of direct material: Year 2005 = $(300/5)$ = Rs. 60
: Year 2006 = $(324/5.40)$ = Rs. 60
(v) Material usage budget for the year 2006 = $(5/600) \times 700$ = 5.83333 lakhs
(vi) Direct labour hours budget for the year 2006 = $(75/600) \times 700$ = 87.50 lakhs
(vii) Direct labour and variable overheads rate per hour: Year 2005 = $(180/75)$ = Rs. 2.40
Year 2006 = $(206/80)$ = Rs. 2.575
(viii) Material price variance = $(\text{Rs. } 60 - \text{Rs. } 60) \times 5,40,000$ = zero
(ix) Material usage variance = $(5.83333 - 5.40) \times \text{Rs. } 60$ = Rs. 26 lakhs (F)
(x) Labour and variable overheads rate variance = $(2.40 - 2.575) \times 80$ = Rs.14 lakhs (A)
(xi) Labour and variable overheads efficiency variance = $(87.50 - 80.00) \times \text{Rs. } 2.40$
= Rs. 18 lakhs (F)
(xii) Fixed overheads expenditure variance = $(150 - 80)$ = Rs. 70 lakhs (A)

(xiii) **Statement of working results of the company**

	Amount Rs. in lakhs		
	Actuals	Budget	Variance
	2006	2006	
Sales	<u>770</u>	<u>700</u>	<u>70(F)</u>
Less: Direct material	324	350	26(F)
Direct wages and variable overheads	<u>206</u>	<u>210</u>	<u>4(F)</u>
Contribution	240	140	100(F)
Less: Fixed overheads	<u>150</u>	<u>80</u>	<u>70(A)</u>
Profit	<u>90</u>	<u>60</u>	<u>30(F)</u>

I Reconciliation statement showing variances contribution to change in profit (Rs. in lakhs)

	<i>Favourable</i>	<i>Adverse</i>
Increase in contribution due to volume	20	—
Sales price variance	70	—
Material usage variance	26	—
Material price variance	—	—
Direct labour and variable overheads rate variance	—	14
Direct labour and variable overheads efficiency variance	18	—
Fixed overheads expenditure variance	<u>—</u>	<u>70</u>
	<u>134</u>	<u>84</u>
Total change in profit (increase)	<u>50</u>	

II Break-even point

Year 2005: $(80/120) \times 600 = \text{Rs. } 400 \text{ lakhs}$

Year 2006: $(150/240) \times 770 = \text{Rs. } 481.25 \text{ lakhs}$

III Required percentage increase in selling price in the year 2006 to earn a margin of safety of 45%.

Break-even sales = $(1 - 0.45)$ or 55 per cent of total sales.

Contribution at 55% sales = Fixed overheads = Rs. 150 lakhs.

Required contribution at total sales = $\text{Rs. } 150 / 0.55 = \text{Rs. } 272.73 \text{ lakhs}$

Additional contribution required = $(272.73 - 240) = \text{Rs. } 32.73 \text{ lakhs}$

Percentage increase in selling price required = $(32.73/770) \times 100 = 4.25\%$.

Question 10

The following information has been extracted from the books of Goru Enterprises which is using standard costing system:

Actual output = 9,000 units

Direct wages paid = 1,10,000 hours at Rs.22 per hour, of which 5,000 hours, being idle time, were not recorded in production

Advanced Management Accounting

Standard hours = 10 hours per unit

Labour efficiency variance = Rs. 3,75,000 (A)

Standard variable Overhead = Rs. 150 per unit

Actual variable Overhead = Rs. 16,00,000

You are required to calculate:

- (i) Idle time variance
- (ii) Total variable overhead variance
- (iii) Variable overhead expenditure variance
- (iv) Variable overhead efficiency variance.

Answer

Actual output = 9,000 units

Idle time = 5,000 hours

Production time (Actual) = 1,05,000 hours

Standard hours for actual production = 10 hours / unit $\times$ 9,000 units = 90,000 hours.

Labour efficiency variance = 3,75,000 (A)

i.e. Standard rate $\times$ (Standard Production time – Actual production time) = 3,75,000(A).

SR (90,000 – 1,05,000) = – 3,75,000

$$SR = \frac{-3,75,000}{-15,000} = \text{Rs. } 25$$

(i) Idle time variance = 5,000 hours $\times$ 25 Rs. / hour = 1,25,000. (A)

(ii) Standard Variable Overhead = Rs. 150 / unit

Standard hours = 10 hours / unit

Standard Variable Overhead rate / hour = 150 / 10 = Rs. 15 / hour

Total Variable Overhead variance = Standard Variable Overhead – Actual
Variable Overhead

= Standard Rate $\times$ Standard hours – Actual
rate $\times$ Actual hours

= (15) $\times$ (10 $\times$ 9,000) – 16,00,000

= 13,50,000 – 16,00,000

Total Variable Overhead Variance = 2,50,000 (A)

- (iii) Variable Overhead Expenditure Variance = (Standard Rate × Actual Hours) – (Actual Rate × Actual Hours)
- $$= (15 \times 1,05,000) - 16,00,000$$
- $$= 15,75,000 - 16,00,000$$
- $$= 25,000 \text{ (A)}$$
- (iv) Variable Overhead Efficiency Variance = Standard Rate × (Standard Hours for actual output – Actual hours for Actual output)
- $$= 15 (90,000 - 1,05,000)$$
- $$= 15 (-15,000)$$
- $$= 2,25,000 \text{ (A)}$$

Alternative Solution

Actual Output = 9,000 Units

Idle time = 5,000 hrs

Direct Wages Paid = 1,10,000 hours @ Rs. 22 out of which 5,000 hours being idle, were not recorded in production.

Standard hours = 10 per unit.

Labour efficiency variance = Rs. 3,75,000 (A)

or

Standard Rate (Standard Time – Actual Time) = – 3,75,000

Or $(90,000 - 1,05,000) = \frac{-3,75,000}{\text{Standard Rate}}$

Or Standard Rate = Rs 25/-

(i) Idle time variance = Standard Rate × Idle time

$25 \times 5,000 = \text{Rs } 1,25,000 \text{ (A)}$

(ii) Standard Variable Overhead / unit = 150

Standard Rate = $\frac{150}{10} = \text{Rs. } 15/\text{hour}$

Standard Quantity = 10 hours

Advanced Management Accounting

Actual Variable Overhead = 16,00,000

Standard Variable Overhead = $150 \times 9,000$ = 13,50,000

Actual Variable Overhead = 16,00,000

Total Variable Overhead Variance = 2,50,000 (A)

- (iii) Variable Overhead expenditure Variance = Standard Variable Overhead for actual hours – Actual Variable Overhead
- $$= (150 \times 1,05,000) - 16,00,000$$
- $$= 15,75,000 - 16,00,000$$
- $$= 25,000 \text{ (A)}$$
- (iv) Variable overhead efficiency variance = Standard Variable Overhead for actual output – Standard Variable Overhead for Actual hours
- $$= 15 (10 \text{ hours} \times 90,000 \text{ units} - 1,05,000)$$
- $$= 15 (90,000 - 1,05,000)$$
- $$= 15 (-15,000)$$
- $$= 2,25,000 \text{ (A)}$$

Question 11

A manufacturing company has furnished the following financial data relating to the actual output of 9,600 units produced in the last quarter:

		Rs.
Sales		4,45,500
Costs:		
Direct Materials	59,400	
Direct Wages	89,400	
Variable Overheads	1,45,500	
Fixed Overheads	<u>78,000</u>	<u>3,72,300</u>
Profit		<u>73,200</u>

The standard wage rate is Rs. 4.50 per hour and the standard variable overhead rate is Rs. 7.50 per hour. The company uses a JIT system and the budgeted production and sales quantity is 10,000 units.

Standard Costing

The following are the variances from standard costs recorded during the last quarter:

		Rs.
Direct materials	Price V	600 A
	Usage V	1,200 A
Direct Wages	Rate V	1,500 F
	Efficiency V	4,500 A
Variable Overheads	Expense V	6,000 F
	Efficiency V	7,500 A
Fixed Overheads	Expense V	3,000 A
Sales	Price V	13,500 F

You are required to:

- (i) Prepare the Original budget and Standard cost sheet per unit of output;
- (ii) Produce a statement reconciling the budgeted profit with actual profit.

Answer

Direct Materials:

SQ	AQ	SP	$SQ \times SP$	$AQ \times SP$	AP	$AQ \times AP$
						59,400
			Usage variance	Price variance		
			1200 A	600 A		

$AQ \times SP = 58,800^1$

$SQ \times SP = 57,600^2$

Standard cost of materials for actual output of 9,600 units = Rs. 57,600.

Hence, standard cost per unit is $57,600 / 9,600 = \text{Rs. } 6$.

Direct Labour:

SH	AH	SR	$SH \times SR$	$AH \times SR$	AR	$AH \times AR$
						89,400
			Efficiency variance	Rate variance		
			4500 A	1500 F		

$$SH \times SR = 86,400^4$$

Standard wage rate is Rs. 4.50.

Standard time per unit is $9/4.5 = 2$ hours.

Standard rate is Rs. 7.50 per hour

Standard cost per unit is 2 hours $\times$ Rs. 7.50 = Rs. 15.

Actual units	9,600
Standard time / unit 2 hours	
Standard hours produced	$9,600 \times 2 = 19,200$ hours
Actual overheads	78,000
Expense variance	3,000 A
Budgeted overheads	75,000
Budgeted units	10,000
Fixed overheads per unit	Rs. 7.50.
Charged to Production:	$9,600 \times 7.50 = \text{Rs. } 72,000$
Budgeted overheads	Rs. 75,000
Volume variance	Rs. 3,000 (A)

SQ	AQ	SP	SQ × SP	AQ × SP	AP	AQ × AP	
							4,45,500
						Price variance	13,500 F

$$AO \times SP = 4,32,000^5$$

Actual units = 9,600

Standard price is $4,32,000 / 9,600 = \text{Rs. } 45$ per unit.

Standard Costing

Original Budget and Standard Cost Sheet:

	<i>Budget</i>	<i>Standard Cost</i>
Units budgeted	10,000	
Sales	<u>4,50,000</u>	<u>45.00</u>
Direct materials @ Rs. 6 per unit	60,000	6.00
Direct Wages	90,000	9.00
Variable Overheads @ Rs. 15 per unit	1,50,000	15.00
Fixed overheads @ Rs. 7.50 per unit	<u>75,000</u>	<u>7.50</u>
Total costs	<u>3,75,000</u>	<u>37.50</u>
Profit	<u>75,000</u>	<u>7.50</u>

Sales volume variance is $(9,600 - 10,000) \times 7.50 = \text{Rs. } 3,000 \text{ A}$

Reconciliation Statement:

Budgeted Profit	75,000
Sales volume variance	3,000 A
Standard profit	72,000
Sales price variance	13,500 F
Total	85,500

Cost variances:

		F	A	
Materials:	Price		600	
	Usage		1,200	
Direct Labour:	Rate	1,500		
	Efficiency		4,500	
Variable Overhead:	Efficiency		7,500	
	Expense	6,000		
Fixed Overhead:	Volume		3,000	
	Expense	_____	<u>3,000</u>	
Total variances		<u>7,500</u>	<u>19,800</u>	12,300 A
Actual profit				73,200

Advanced Management Accounting

Working Notes:

- (1) Price Variance = $[SP - AP] \times AQ$
 600 (A) = $[SP \times AQ - 59,400]$
 $SP \times AQ = 58,800$.
- (2) Usage Variance = $[SQ \times SP] - [AQ \times SP]$
 1200 (A) = $SQ \times SP - 58,800$
 $SQ \times SP = 57,600$.
- (3) Rate Variance = $[SR - AR] \times AH$
 1500 (F) = $SR \times AH - 89,400$
 $SR \times AH = 90,900$.
- (4) Efficiency Variance = $[SH - AH] \times SR$
 4500 (A) = $SH \times SR - 90,900$
 $SH \times SR = 86,400$.
- (5) Price Variance = $(AP - SP) \times AQ$
 13500 (F) = $SP \times AQ - 4,45,500$
 $SP \times AQ = 4,59,000$.

Question 12

The following profit reconciliation statement has been prepared by the Cost Accountant of RSQ Ltd. for March, 2008:

	Rs.	
Budget profit	2,40,000	
Sales price variance	51,000	(F)
Sales volume profit variance	<u>42,000</u>	(A)
	2,49,000	
Material price variance	15,880	(A)
Material usage variance	3,200	(F)
Labour rate variance	78,400	(F)
Labour efficiency variance	32,000	(A)
Variable overhead expenditure variance	8,000	(F)

Standard Costing

Variable overhead efficiency variance	12,000	(A)
Fixed overhead volume variance	1,96,000	(A)
Fixed overhead expenditure variance	<u>4,000</u>	(F)
Actual profit	<u>86,720</u>	

Budgeted production and sales volumes for Mach, 2008 were equal and the level of finished goods stock was unchanged, but the stock of raw materials decreased by 6,400 kg (valued at standard price) during the month.

The standard cost card is as under:

Material 4 kg @ Rs. 2.00	8.00
Labour 4 hours @ Rs. 32.00	128.00
Variable overhead	
4 hours @ Rs. 12.00	48.00
Fixed overheads	
4 hours @ Rs. 28.00	<u>112.00</u>
	296.00
Standard profit	<u>24.00</u>
Standard selling price	<u>320.00</u>

The actual labour rate was Rs. 2.24 lower than the standard hourly rate.

You are required to calculate:

- (i) Actual quantity of material purchased
- (ii) Actual production and sales volume
- (iii) Actual number of hours worked
- (iv) Actual variable and fixed overhead cost incurred.

Answer

$$\begin{aligned}
 \text{(i) Budgeted volume} &= \frac{\text{Budgeted profit}}{\text{Budgeted profit per unit}} \\
 &= \frac{2,40,000}{24.00} \\
 &= 10,000 \text{ units}
 \end{aligned}$$

Advanced Management Accounting

$$\begin{aligned}\text{Difference between actual and budgeted volume} &= \frac{\text{Fixed overhead volume variance}}{\text{Standard fixed overhead rate}} \\ &= \frac{1,96,000}{112} \\ &= 1,750 \text{ units}\end{aligned}$$

$$\begin{aligned}\text{Actual Production} &= \text{Budgeted volume} - \text{Difference between actual and budget volume} \\ &= 10,000 - 1,750 \\ &= 8,250 \text{ units}\end{aligned}$$

(ii) Actual production = 8,250 units

$$\text{Material quantity} = 4 \text{ kg.} \times 8,250 = 33,000 \text{ kg.}$$

Less: Difference in material use

$$\text{Material} = \frac{\text{Usage variance}}{\text{Standard price}} = \frac{3,200}{2.00} = 1,600 \text{ kg.}$$

$$\text{Actual usages} \quad \quad \quad 31,400 \text{ kg.}$$

$$\text{Less: Decrease in stock} \quad \quad \quad \underline{6,400 \text{ kg.}}$$

$$\text{Actual purchases} \quad \quad \quad \underline{25,000 \text{ kg.}}$$

(iii) Actual hours

$$8,250 \text{ units} \times 4 \text{ hours} = 33,000 \text{ hours}$$

Difference in actual and standard

$$\frac{\text{Efficiency variance}}{\text{Standard rate}} = \frac{32,000 \text{ (A)}}{32.00} = 1,000 \text{ (A) hours}$$

$$\text{Actual hours} \quad \quad \quad \underline{34,000 \text{ hours}}$$

(iv) Actual variable overhead incurred:

$$\text{Standard cost of variable overhead} = 8,250 \times 48 = \text{Rs. } 3,96,000$$

$$\text{Total variable overhead cost variance [8,000 (F) + 12,000 (A)]} = \underline{\text{Rs. } 4,000 \text{ (A)}}$$

$$\text{Actual variable overhead} = \underline{\text{Rs. } 4,00,000}$$

(v) Actual fixed overhead:

Budgeted fixed overhead =

$$\text{Budgeted units} \times \text{Budgeted rate}$$

$$= 10,000 \times 112 = \text{Rs. } 11,20,000$$

Expenditure variance = Rs. 4,000 (F)

Actual fixed overhead = Rs. 11,16,000

It can also be calculated as below:

Actual fixed overhead:

Standard fixed overhead = (Actual output × Standard fixed overhead rate per unit) $8,250 \times 112$ = Rs. 9,24,000

Total fixed overhead variance [1,96,000 (A) + 4,000 (F)] = Rs. 1,92,000 (A)

Actual fixed overhead = Rs. 11,16,000

(vi) Actual sales volume:

Sales volume variance = Standard profit per unit (Actual quantity of sales – Standard quantity of sales)

42,000 (A) = 24 (Actual Quantity of sales – 10,000)

Actual quantity of sales = 8,250 units

Alternative for (iv) and (v) points

(1) Variable overhead cost variance = (Standard hours for actual output × Standard variable overhead rate per hour) – Actual variable overhead cost

4,000 (A) = $(4 \times 8,250 \times 12)$ – Actual variable overhead

Actual variable overhead = Rs. 4,00,000.

(2) Fixed overhead cost variance = (Standard hours for actual output × Standard fixed overhead rate per hour) – Actual fixed overheads

1,92,000 (A) = $(4 \times 8,250 \times 28)$ – Actual fixed overheads.

Actual fixed overhead = Rs. 11,16,000.

Question 13

The CEO of your company has been given the following statement showing the results for a recent month:

Particulars	Master Budget	Actual
Units produced & sold	10,000	9,000
	Rs.	Rs.
Sales	8,00,000	7,00,000

Advanced Management Accounting

<i>Direct material</i>	<i>2,00,000</i>	<i>1,84,000</i>
<i>Direct Wages</i>	<i>3,00,000</i>	<i>2,62,000</i>
<i>Variable overhead</i>	<i>1,00,000</i>	<i>94,000</i>
<i>Fixed overhead</i>	<i>1,00,000</i>	<i>98,000</i>
<i>Total Cost</i>	<i>7,00,000</i>	<i>6,38,000</i>
<i>Net Surplus</i>	<i>1,00,000</i>	<i>62,000</i>

The standard cost of the product is as follows:

Direct material (1 kg @ Rs. 20/kg) Rs. 20.00 per unit

Direct Wages (1 hour @ Rs. 30/hour) Rs. 30.00 per unit

Variable overhead (1 hour @ Rs. 10/hour) Rs. 10.00 per unit

Actual results for the month revealed that 9,800 kg. of material was used and 8,800 labour hours were recorded.

(i) *Prepare a flexible budget for the month and compare with the actual results.*

(ii) *Calculate material volume and variable overhead efficiency variances.*

Answer

(i)

Particular	Master Budget		Flexible Budget	Actual	Variance	
Units	10,000		9,000	9,000		
	(Rs.) Total	(Rs.) Per Unit	(Rs.)	(Rs.)		
Sales	8,00,000	80	7,20,000	7,00,000	20,000	(A)
Direct Material	2,00,000	20	1,80,000	1,84,000	4,000	(A)
Direct Wages	3,00,000	30	2,70,000	2,62,000	8,000	(F)
Variable Overhead	1,00,000	10	90,000	94,000	4,000	(A)
Total Variable Cost	6,00,000	60	5,40,000	5,40,000	-	
Contribution	2,00,000	20	1,80,000	1,60,000	20,000	(A)
Fixed Overhead	1,00,000	10	1,00,000	98,000	2,000	(F)
Net Profit	1,00,000	10	80,000	62,000	18,000	(A)

(ii) Calculation of Variances:

Material Volume Variance: $SP (SQ - AQ) = 20 (9,000 - 9,800) = 16,000 (A)$

Variable Overhead efficiency variance $SR (SH - AR) = 10 (9,000 - 8,800) = 2,000 (F)$

Question 14

The following information relates to labour of x Ltd.

Type of Labour	Skilled	Semi Skilled	Unskilled	Total
No. of workers in standard gang	4	3	2	9
Standard rate per hour (Rs)	6	3	1	-
Number of workers in actual gang				
Actual rate per hour (Rs.)	7	2	2	-

In a 40 hours week, the gang produced 270 standard hours.

The actual number of semi-skilled workers is two times the actual number of unskilled workers. The rate variance of semi-skilled workers is Rs.160 (F).

Find the following:

- (i) The number of workers in each category
- (ii) Total gang variance
- (iii) Total Sub-efficiency variance
- (iv) Total labour rate variance
- (v) Total labour cost variance

Answer

	SR	SH		SR	RSH		SR	AH		AR	AH	
Skill	6×	120	720	6×	960	160	6×	120	120	7×	120	840
Semi-Skill	3×	90	270	3×	360	120	3×	160	480	2×	160	320
Unskilled	1×	60	<u>60</u>	1×	<u>80</u>	80	1×	80	<u>80</u>	2×	80	<u>160</u>
			<u>1050</u>		<u>1400</u>				<u>1280</u>			<u>1320</u>
	Sub-efficiency Variance					Gang Variance				Rate Variance		
	350 (A)					120 (F)				40 (A)		
	Cost Variance = 270 (A)											

Advanced Management Accounting**Workings Note:**

Standard hours produced = 270

Standard Mix: $270 \div 9 = 30$

	<i>Skill</i>	<i>Semi-Skill</i>	<i>Unskilled</i>
Ratio	4:	3:	2:
Hrs.	120	90	60

Actual hrs = $40 \times 9 = 360$ hrs.

Actual hrs in Standard Ratio = 360

4:	3:	2:
$\frac{360}{9} \times 4 = 160$	$\frac{360}{9} \times 3 = 120$	$\frac{360}{9} \times 2 = 80$

[(Standard Rate = Actual Rate) Actual hrs.] = Rate Variance

Semi-skilled = 160

$(3 - 2)$ Actual hrs = 160

Actual hrs = 160 (for semi-skilled)

Actual Semi-skilled = 2 (Unskilled actual)

$160 = 2$ (Unskilled)

Unskilled hrs (actual) = $\frac{160}{2} = 80$

Total Actual = 360

$\therefore$ Actual hrs – skilled = $360 - (160 + 80)$
 $= 360 - 240 = 120$

Actual Hrs.	Skilled	Semi-skilled	Unskilled
	120	160	80
40 hr week			
$\therefore$	$\frac{120}{40} = 3$	$\frac{160}{40} = 4$	$\frac{80}{40} = 2$
No. of Workers			
(i)	3	4	2

- (ii) Gang Variance:

$$= (\text{Actual Hrs in Standard Ratio} - \text{Actual Hrs in Actual Ratio}) \times \text{Standard Rate}$$

$$= 1400 - 1280 = 120 \text{ (F)}$$
- (iii) Sub-efficiency Variance:

$$= \text{Standard Rate} (\text{Standard Hrs} - \text{Actual Hrs in Standard Ratio})$$

$$= 1050 - 1400 = 350 \text{ (A)}$$
- (iv) Total Labour Rate Variance:

$$= \text{Actual Hrs} (\text{Standard Rate} - \text{Actual Rate})$$

$$= 1280 - 1320 = 40 \text{ (A)}$$
- (v) Labour Cost Variance:

$$= (\text{Standard Rate} \times \text{Standard Hrs} - \text{Actual Rate} \times \text{Actual Hrs.})$$

$$= 1050 - 1320 = 270 \text{ (A)}$$

Question 15

Global Limited uses standard and marginal costing system. It provides the following details for the year 2007-08 relating to its production, cost and sales:

Particulars	Budget	Actual
Sales units	24,000	25,600
Sales value	6,000	6,784
Materials	960	1,080
Labour	1,440	1,664
Variable overheads	2,400	2,592
Total variable cost	4,800	5,336

The sales budget is based on the expectation of the company's estimate of market share of 12%. The entire industry's sales of the same product for the year 2007-08 is 2,40,000 units. Further details are as follows:

(In Rs.)

Particulars	Standard	Actual
Material price per kg.	8.00	7.50
Labour rate per hour	6.00	6.40

Advanced Management Accounting

You are required to:

- Prepare a statement reconciling the budgeted contribution with actual contribution on the basis of important material variances, labour variances, variable overhead variances and sales variances.
- Compute market size variance and market share variance.

Answer

Sales variances

Budgeted Sales Rs.6000

Budgeted sales quantity 24000

Budgeted selling price $6000/24000 = \text{Rs.}0.25$

Actual industry sales in units 240000

Budgeted market share 12%

Hence market share required: $240000 \times 12\% = 28800$ units

SQ	RSQ	AQ	SP	SQ × SP	RSQ × SP	AQ × SP	AQ×AP
24000	28800	25600	0.25	6000	7200	6400	6784

Sales Market Size variance $6000-7200 = \text{Rs.}1200$ F

Sales Market Share Variance: $7200-6400 = \text{Rs. } 800$ A

Sales Volume Variance: $6000-6400 = \text{Rs. } 400$ F

Sales Price variance $6400-6784 = \text{Rs. } 384$ F

Budgeted contribution:

Sales Rs.6000

Variable costs Rs.4800

Contribution Rs.1200

Units 24000

Contribution/unit: Rs.0.05

($1200/24000$)

SQ	RSQ	AQ	SP	SQ × SP	RSQ × SP	AQ × SP
24000	28800	25600	0.05	1200	1440	1280

Sales Market Size variance: $1200 - 1440 = \text{Rs.}240 \text{ F}$

Sales Market Share Variance: $1440 - 1280 = \text{Rs.}160 \text{ A}$

Sales Volume Variance $1200 - 1280 = \text{Rs } 80 \text{ F}$

As per the requirement of the question (b)

Sales Market Size variance is Rs.1200 F

Sales Market Share variance is Rs.800 A

Sales Variances:

Sales Gross Margin Market Size variance $\text{Rs.}240 \text{ F}$

Sales Gross Margin Market Share variance $\text{Rs.}160 \text{ A}$

Sales Gross Margin Volume Variance: $\text{Rs. } 80 \text{ F}$

Sales Price Variance $\text{Rs.}384 \text{ F}$

Direct materials:

Budgeted Material costs $\text{Rs.}960$

Budgeted units 24000

Budgeted material cost per 100 units: $= \text{Rs.}4.00$

$(960/24000) \times 100$

Standard price of Material/ kg $= \text{Rs.}8$

Standard requirement of materials per 100 units of output: $4/8 = 0.50 \text{ kg}$

Actual output: $= 25600$

Standard requirement for actual output $= 128 \text{ kg}$

$(25600 \times 0.50)/100$

Actual material cost: $= \text{Rs.}1080$

Actual price/kg $= \text{Rs.}7.50$

Actual quantity of materials consumed: $= 144 \text{ kg}$

$(1080/7.50)$

SQ	AQ	SP	SQ $\times$ SP	AQ $\times$ SP	AP	AQ $\times$ AP
128	144	8	1024	1152	7.50	1080

Usage Variance $1024 - 1152 = \text{Rs.}128 \text{ A}$

Price Variance $1152 - 1080 = \text{Rs. } 72 \text{ F}$

Advanced Management Accounting

Direct Labour:

Budgeted Labour costs Rs.1440

Budgeted units 24000

Budgeted Labour cost per 100 units: = Rs.6.00

 $(1440/24000) \times 100$

Standard Labour hour rate/hour = Rs.6

Standard requirement of labour hours per 100 units of output: $6/6 = 1.00$ hour

Actual output = 25600

Standard hours required for actual output: $(25600 \times 1)/100 = 256$ hours

Actual labour cost: = Rs.1664

Actual direct labour hour rate = Rs.6.40

Actual hours worked $(1664/6.40) = 260$ hoursBudgeted direct labour $(1440/6) = 240$ hours

SH	AH	SR	SH×SR	AH×SR	AR	AH×AR
256	260	6	1536	1560	6.40	1664

Efficiency Variance $1536 - 1560 = \text{Rs. } 24 \text{ A}$ Labour Rate Variance $1560 - 1664 = \text{Rs. } 104 \text{ A}$

Variable Overheads:

Budgeted variable overheads Rs. 2400

Budgeted direct labour hours 240

Budgeted variable overhead rate per direct labour hour: $2400/240 = \text{Rs. } 10$ A. Charged to production: $256 \text{ hours} \times 10 = \text{Rs. } 2560$ B. Standard cost of actual hours: $260 \times 10 = \text{Rs. } 2600$

C. Actual overheads Rs.2592

Efficiency Variance $2560 - 2600 = \text{Rs. } 40 \text{ A}$ Expense variance $2600 - 2592 = \text{Rs. } 8 \text{ F}$

Contribution analysis:

Budget	Actual
Rs.	Rs

Standard Costing

Sales	6000	6784
Variable costs	4800	5336
Contribution	1200	1448

Statement of Reconciliation between Budgeted and Actual Contribution

			Rs
Budgeted Contribution			1200
Gross Margin Sales Volume Variance			80 F
Standard Contribution			1280
Sales Price Variance			384 F
Total contribution			1664
Cost Variances:			
	F	A	
Material Usage Variance		128	
Material Price Variance	72		
Labour Efficiency Variance		24	
Labour Rate Variance		104	
Variable OH Efficiency Variance		40	
Variable OH Expense Variance	<u>8</u>	<u>—</u>	<u>216</u> A
Actual Contribution			<u>1448</u>

Question 16

The following information relates to a manufacturing concern:

Standard	Rs.
Material A 24,000 kgs @ Rs.3 per kg.	72,000
Material B 12,000 kgs @ Rs.4 per kg	48,000
Wages 60,000 hours @ Rs.4 per hour	2,40,000
Variable overheads 60,000 hours @ Re.1 per hour	60,000
Fixed overheads 60,000 hours @ Rs.2 per hour	1,20,000
Total Cost	5,40,000
Budgeted profit	60,000

Advanced Management Accounting

<i>Budgeted sales</i>	6,00,000
<i>Budgeted production (units)</i>	12,000
<i>Actual</i>	<i>Rs.</i>
<i>Sales (9,000 units)</i>	4,57,500
<i>Material A consumed 22,275 kgs.</i>	62,370
<i>Material B consumed 10,890 kgs.</i>	44,649
<i>Wages paid (48,000 hours)</i>	1,91,250
<i>Fixed Overhead</i>	1,20,900
<i>Variable overhead</i>	45,000
<i>Labour hours worked</i>	47,700
<i>Closing work in progress</i>	900 units
<i>Degree of completion:</i>	
<i>Material A and B</i>	100%
<i>Wage and overheads</i>	50%

You are required to:

- Calculate all the material and labour variances.
- Calculate variable overhead expenditure and efficiency variances, fixed overhead expenditure and volume variances and sales price and sales volume variances.

Answer**(i) Statement of Equivalent Production in Units**

<i>Particulars</i>	<i>Materials</i>		<i>Wages & Overheads</i>	
	<i>% age</i>	<i>Units</i>	<i>% age</i>	<i>Units</i>
Units Completed	100%	9000	100%	9000
Closing W.I.P.	100%	900	50%	450
Equivalent Units		9900		9450

Material Variances

<i>Standard qty for actual output ** x std price</i>			<i>Actual qty X actual price</i>	
Material A	19,800 @ 3	= 59,400	22,275@2.8*	= 62,370

Material B	9,900 @ 4	= 39,600	10,889 @4.1*	= 44,649
	29,700	99,000	33,165	1,07,019

*Actual Cost / Actual Quantity

** Standard Quantity for actual output = (std qty/ budgeted prod) x actual output

MCV = TSC – TAC

= 99,000 – 1,07,019 = 8,019 (A)

MPV = AQ (SP – AP)

A = 22,275 (3 – 2.80) = 4,455 (F)

B = 10,890 (4 – 4.10) = 1,089 (A)

3,366 (F)

MUV = SP (SQ – AQ)

A = 3 (19,800 – 22,275) = 7,425 (A)

B = 4 (9,900 – 10,890) = 3,960 (A)

11,385 (A)

MMV = SP (RSQ – AQ)

A = 3 {19,800 ÷ 29,700 × 33,165 – 22,275} = 495 (A)

B = 4 {9,900 ÷ 29,700 × 3,165 – 10,890} = 660 (F)

165 (F)

MYV = S. C Per Unit (S. O. For Actual Mix – A. O.)

= 99,000 ÷ 9,900 {9,900 ÷ 29,700 × 33,165 – 9,900}

= 10 (11.055 – 9,900) = 11,550 (A)

Labour Variances:

LCV = TSC – TAC

= 2,40,000 ÷ 12,000 × 9,450 – 1,91,250 = 2,250 (A)

LRV = AH (SR – AR)

= 48,000 {4 – (1,91,250 ÷ 48,000)} = 750 (F)

LITV = No. of Idle hours × SR

= 48,000 – (47,500 ÷ 4) = 1,200 (A)

LEV = SR (SH – AH)

Advanced Management Accounting

$$= 4 \{(60,000 \div 12,000) \times 9,450 - 47,700\} = 1,800 \text{ (A)}$$

(ii) Variable Overhead Variances

$$\text{VOC} = \text{Recovered Overheads} - \text{Actual Overheads}$$

$$= 9,450 \times 5 - 45,000 = 2,250 \text{ (F)}$$

$$\text{V.O (Exp.) V} = \text{Standard V.O.} - \text{Actual V.O.}$$

$$= 47,700 \times 1 - 45,000 = 2,700 \text{ (F)}$$

$$\text{V.O. (Eff.) V} = \text{Recovered Overheads} - \text{Standard Overheads}$$

$$= 9,450 \times 5 - 47,700 = 450 \text{ (A)}$$

Fixed Overheads Variances

$$\text{FOCV} = \text{Recovered Overheads} - \text{Actual Overheads}$$

$$= (1,20,000 \div 12,000) \times 9,450 - 1,20,900 = 94,500 - 1,20,900$$

$$= 26,400 \text{ (A)}$$

$$\text{F.O.(Exp.) V} = \text{Budgeted Overheads} - \text{Actual Overheads}$$

$$= 1,20,000 - 1,20,900 = 900 \text{ (A)}$$

$$\text{FOVV} = \text{Recovered Overheads} - \text{Budgeted Overheads}$$

$$= 95,500 - 1,20,000 = 25,500 \text{ (A)}$$

Sales Variances

$$\text{Sales Price Variance} = \text{Actual Unit Sold (SP - AP)}$$

$$= 9,000 \{50 - (4,57,500 \div 9,000)\} = 7,500 \text{ (F)}$$

$$\text{Sales Volume Variance (Contribution Loss)}$$

$$= \text{S. R. of Profit (Budgeted Qty. - Actual Qty.)}$$

$$= (60,000 \div 12,000) (12,000 - 9,000) = 15,000 \text{ (A)}$$

Question 17

How are cost variances disposed off in a standard costing system? Explain.

Answer

There is no unanimity of opinion among Cost Accountants regarding the disposition of variances. The following are commonly used methods for their disposition.

1. Transfer all variances to Profit and Loss Account. Under this method, stock of work-in-progress, finished stock and cost of sales are maintained at standard cost and variances arising are transferred to profit and loss account.
2. Distributing variances on pro-rata basis over the cost of sales, work-in-progress and finished goods stocks by using suitable basis.
3. Write off quantity variance to profit and loss account and spread price variance over to cost of sales, work in progress and finished goods. The reason behind apportioning variance to inventories and cost of sales is that they represent costs although they are derived as variances.

Question 18

“Calculation of variances in standard costing is not an end in itself, but a means to an end.” Discuss.

Answer

The crux of standard costing lies in variance analysis. Standard costing is the technique whereby standard costs are predetermined and subsequently compared with the recorded actual costs. It is a technique of cost ascertainment and cost control. It establishes predetermined estimates of the cost of products and services based on management's standards of efficient operation. It thus lays emphasis on “what the cost should be”. These should be costs are when compared with the actual costs. The difference between standard cost and actual cost of actual output is defined as the variance.

The variance in other words in the difference between the actual performance and the standard performance. The calculations of variances are simple. A variance may be favourable or unfavourable. If the actual cost is less than the standard cost, the variance is favourable but if the actual cost is more than the standard cost, the variance will be unfavourable. They are easily expressible and do not provide detailed analysis to enable management of exercise control over them. It is not enough to know the figures of these variances from month to month. We infact are required to trace their origin and causes of occurrence for taking necessary remedial steps to reduce / eliminate them.

A detailed probe into the variance particularly the controllable variances helps the management to ascertain:

- (i) the amount of variance
- (ii) the factors or causes of their occurrence
- (iii) the responsibility to be laid on executives and departments and
- (iv) corrective actions which should be taken to obviate or reduce the variances.

Advanced Management Accounting

Mere calculation and analysis of variances is of no use. The success of variance analysis depends upon how quickly and effectively the corrective actions can be taken on the analysed variances. In fact variance gives information. The manager needs to act on the information provided for taking corrective action. Information is the means and action taken on it is the end. In other words, the calculation of variances in standard costing is not an end in itself, but a means to an end.

Question 19

Describe three distinct groups of variances that arise in standard costing.

Answer

The three distinct groups of variances that arise in standard costing are:

The three distinct groups of variances that arise in standard costing are:

- (i) Variances of efficiency. These are the variance, which arise due to efficiency or inefficiency in use of material, labour etc.
- (ii) Variances of prices and rates: These are the variances, which arise due to changes in procurement price and standard price.
- (iii) Variances due to volume: These represent the effect of difference between actual activity and standard level of activity. These can be summarized as under:

<i>Element of cost</i>	<i>Variance of Efficiency</i>	<i>Variance of price</i>	<i>Variance of volume</i>
Material	Usage, Mixture, Yield	Price	Revision
Labour	Efficiency, idle time	Rate of pay	--
- Variable	Efficiency	Expenditure	Revision
- Fixed	Efficiency	Expenditure	Revision
			Capacity
			Calendar

Question 20

“Standard costing variances centre around comparison of actual Performance with the standard and the standards or plans are normally based on the environment anticipated when the targets are set and if the current environment is different from that anticipated, such analysis cannot measure managerial performance”. Comment on the statement and how will you deal with the situation with reference to material, labour and sales variances.

Answer

- (a) The statement give in the question highlights practical difficulties faced by our industries today.

When the current environmental conditions are different from the anticipated environmental conditions (prevailing at the time of setting standard or plans) the use of routine analysis of variance for measuring managerial performance is not desirable / suitable.

The variance analysis can be useful for measuring managerial performance if the variances computed are determined on the basis of revised targets / standards based on current actual environmental conditions. In order to deal with the above situation i.e. to measure managerial performance with reference to material, labour and sales variances, it is necessary to proceed and compute the following variances.

Material variances:

In the case of material purchase price variance, suppose the standard price of raw material determined was Rs.5 per unit, the general market price per unit at the time of purchase was Rs.5.20 and actual price paid per unit was Rs.5.18 on the purchase of say 10,000 units of raw material.

In this case the variances to be computed should be:

Uncontrollable material purchase price planning variance:

= (Standard price p.u. – General market price p.u.) Actual quantity purchased

= (Rs.5 – Rs.5.20) 10,000 units = Rs.2,000 (Adverse)

Controllable material purchase price efficiency variance:

= (General market price p.u. – Actual price paid p.u.) Actual quantity purchased

= (Rs.5.20 – 5.18) 10,000 units

= Rs.200 (Fav.)

In the case of material usage variance, suppose the standard quantity per unit be 5 kgs, actual production units be 250 and actual quantity of material used is 1,450 kgs. Standard cost of material per kg. was Re.1. Because of shortage of skilled labour it was felt necessary to use unskilled labour and that increased material usage by 20%. The variances to be computed to deal with the current environmental conditions will be: Uncontrollable material usage planning variances:

Advanced Management Accounting

= (Original std. quantity in kgs. – Revised std. quantity in kgs.) Standard price per kg.

= (1,250 kgs. – 1,500 kgs) Re.1

= Rs.250 (Adverse)

Controllable material usage efficiency variance:

= (Revised standard quantity in kgs. Actual quantity used in kgs.) Standard price per kg.

= (1,500 kgs. – 1,450 kgs.) Re.1

= Rs.50 (Favourable)

Labour variances:

Like material variances, here also labour efficiency and wage rate variances should also be adjusted to reflect changes in environmental conditions that prevailed during the period. The labour efficiency variances would be equivalent to the following two variances.

(a) Uncontrollable labour efficiency planning variance

(b) Controllable labour efficiency variance

The above variances would arise when unskilled labour is substituted for skilled labour.

Similarly, one uncontrollable and other controllable variance would arise in the case of wage rate variance as well under current environmental conditions.

Sales variances:

The conventional sales volume variance reports the difference between actual and budgeted sales, priced at the budgeted contribution per unit. The variance merely indicates whether sales volume is greater or less than expected. It does not indicate how well sales management actual sales volume should be compared with an expert estimate that reflects the market conditions prevailing during that period.

Total sales margin variance (planning element):

= {Expert's budgeted sales volume × (Expert's selling price – Standard cost) – Original budgeted sales volume × (Budgeted selling price – Standard cost)}

Total sales margin variance (appraisal element):

= {Actual sales volume × (Actual selling price – Standard cost)}

= Expert's budgeted sales volume × (Expert's selling price – Standard cost)}

The figure of "Expert's budgeted sales volume" for a particular product can be determined by estimating the total market sales volume for the period and then multiplying the estimate by the target percentage of market share.

EXERCISE**Question 1**

Super Computers manufactures and sells three related PC models:

- (1) PC = Sold mostly to college students.
- (2) Portable PC = Smaller version of PC positioned as home computer
- (3) Super PC = Sold mostly to business executives.

Budgeted and actual data for 1995 is as follows:

Budget for 1995

	Selling Price per Unit	Variable Cost per Unit	Contribution margin per Unit	Sales Volume in Units
	Rs.	Rs.	Rs.	Rs.
PC	24,000	14,000	10,000	7,000
Portable PC	16,000	10,000	6,000	1,000
Super PC	1,00,000	60,000	40,000	2,000
				10,000

Actual for 1995

	Selling Price per Unit	Variable Cost per Unit	Contribution margin per Unit	Sales Volume in Units
	Rs.	Rs.	Rs.	Rs.
PC	22,000	10,000	12,000	8,250
Portable PC	13,000	8,000	5,000	1,650
Super PC	70,000	50,000	20,000	1,100
				11,000

Super computers derived its total unit sales budget for 1995 from the internal management estimate of a 20% market share and an industry sales forecast by computer manufactures association of 50,000 units. At the end of the year the association reported actual industry sales of 68,750 units.

Required:

- (i) Compute the individual product and total sales volume variance.
- (ii) Compute total sales quantity variance.

Advanced Management Accounting

- (iii) Compute the market size and market share variance.
- (iv) Compute individual product and total sales mix variances.
- (v) Comment on your results.

Answer

- (i) Total Sales Volume Variance = Rs.1,96,00,000 (Adv.)
 - (ii) Total sales quantity variance = Rs.1,56,00,000 (Fav.)
 - (iii) Market size variance = Rs.5,85,00,000 (Fav.)
 - (iv) Market share variance = Rs.4,29,00,000 (Adv.)
 - (iv) Computation of individual product and total sales mix variances
1. Individual product and total sales mix variance:
 Sales mix variance:
 PC = Rs.30,80,000 (Adv.)
 Super PC = Rs.2,68,40,000 (Adv.)
 2. Total sales mix variance = Rs.3,52,00,000 (Adv.)

Question 2

GLOBAL LTD. is engaged in marketing of wide range of consumer goods. A, B, C and D are the zonal sales officers for four zones. The company fixes annual sales target for them individually. You are furnished with the following:

- (1) The standard costs of sales target in respect of A, B, C and D are Rs.5,00,000, Rs.3,75,000, Rs.4,00,000 and Rs.4,25,000 respectively.
- (2) A, B, C and D respectively earned Rs.29,900, Rs.23,500, Rs.24,500 and Rs.25,800 as commission at 5% on actual sales effected by them during the previous year.
- (3) The relevant variances as computed by a qualified cost accountant are as follows:

	A	B	C	D
	Rs.	Rs.	Rs.	Rs.
Sales price variance	4,000 (F)	6,000 (A)	5,000 (A)	2,000 (A)
Sales volume variance	6,000 (A)	26,000 (F)	15,000 (F)	8,000 (F)
Sales margin mix variance	14,000 (A)	8,000 (F)	17,000 (F)	3,000 (A)

(A) = Adverse variance and (F) = Favourable variance.

You are required to:

- (1) Compute the amount of sales target fixed and the actual amount of contribution earned in case of each of the zonal sales officer.
- (2) Evaluate the overall performance of these zonal sales officers taking three relevant base factors and then recommend whose performance is the best.

Answer

	(Rs.'000)			
Zonal Sales Officers	A	B	C	D
Sales target / Budgeted sales	600	450	480	510
Standard cost of sales target	<u>500</u>	<u>375</u>	<u>400</u>	<u>425</u>
Standard margin/ Budgeted margin	100	75	80	85
Sales margin mix variance	14 (A)	8 (F)	17 (F)	3 (A)
Sales price variance	<u>4 (F)</u>	<u>6 (A)</u>	<u>5 (A)</u>	<u>2 (A)</u>
Actual margin	90	77	92	80

Question 3

The following information is available in respect of Y Ltd. for a week:

- (a) 400 kg of raw material were actually used in producing product 'EXE'. The purchase cost thereof being Rs.24,800. The standard price per kg of raw material is Rs.60. The expected output is 12 units of product 'EXE' from each kg of raw material. Raw material price variance and usage variance as computed by cost accountant are Rs.800 (adverse) and Rs.600 (adverse) respectively.
- (b) The week is of 40 hours. The standard time to produce one unit of 'EXE' is 30 minutes. The standard wage rate is Rs.5 per labour hour. The company employs 60 workers who have been paid hourly wage rate as under:

Number of workers	6	8	46
Hourly Wage Rate (Rs.)	4.80	5.20	5.00

- (c) Budgeted overheads for a four-weekly period is Rs.81,600. The actual fixed overheads spent during the said week are Rs.19,800.
- (d) Entire output of 'EXE' has been sold at its standard selling price of Rs.15 per unit.

You are required to:

- (i) Compute the variances relating to labour and overheads.

Advanced Management Accounting

- (ii) Prepare a statement showing total standard costs, standard profit, and actual profit for the week.

Answer

Labour cost variance = Rs. 316 (Adverse)

Labour Rate Variance = Rs.16 (Adv.)

Labour efficiency variance = Rs.300 (Adv.)

Total fixed overhead cost variance = Rs.90 (Fav.)

Fixed overhead volume variance = Rs.510 (Adv.)

Fixed overhead expenditure variance = Rs.600 (Fav.)

Actual Profit = Rs. 13,584

Question 4

The Standard Cost of producing one unit of Item 'Q' is as under:

Direct Material --	A – 12 Kg. @ Rs.10/-	= Rs.120
	B – 5 kg. @ Rs.6/-	= Rs.30
Direct Wages --	5 hrs. @ Rs.3/-	= Rs.15
Fixed Production Overheads		= Rs.35
Total Standard Cost:		= Rs.200
Standard Gross Profit		= Rs.50
Standard Sale Price		= Rs.250

Fixed Production overhead is absorbed on expected annual output of 13,200 units.

Actual result for the month of September, 1997 are under:

Actual Production:	1,000 units	Rs.
Sales	1,000 Units @ Rs.250	= 2,50,000
Direct Material --	A – 11,000 kg.	= 1,21,000
	B – 5,200 kg.	= 28,600
Direct wages	5,500 hrs.	= 17,500
Fixed Overheads		= 39,000
		= 2,06,100
	Gross profit	= 43,900

You are required to calculate all variances. Material price variance is taken out at the time of receipt of Material. Material purchases were:

12,000 kg. 'A' @ Rs.11 & 5,000 kg. of 'B' @ Rs.5.50

Answer

Material cost variance	= Rs.400 (Fav.)
Material price variance	= Rs.8,400 (Adv.)
Material usage variance	= Rs.8,800 (Fav.)
Material mix variance	= Rs.1,741.18 (Fav.)
Material yield variance	= Rs.7058.82 (Fav.)
Material purchase price variance	= Rs.9,500 (Adv.)
Labour cost variance	= Rs.2,500 (Adv.)
Labour rate variance	= Rs.1,000 (Adv.)
Labour efficiency variance	= Rs.1,500 (Adv.)
Total fixed overhead variance	= Rs.4,000 (Adv.)
Fixed overhead expenditure variance	= Rs.500 (Adv.)
Fixed overhead volume variance	= Rs.3,500 (Adv.)
Efficiency variance	= Rs.3,500 (Adv.)

Question 5

On 1st April, 1998, ZED Company began the manufacture of a new electronic gadget. The company installed a standard costing system to account for manufacturing costs.

The standard costs for a unit of the product are as under:

	Rs.
<i>Direct Material (3 kg at Rs.5 per kg.)</i>	<i>15.00</i>
<i>Direct Labour (0.5 hour at Rs.20 per hour)</i>	<i>10.00</i>
<i>Manufacturing Overhead (75% of direct labour cost)</i>	<i>7.50</i>
<i>Total Cost</i>	<i>32.50</i>

Advanced Management Accounting

The following data was obtained from ZED Company's records for April 1998:

	Debit	Credit
	Rs.	Rs.
Sales	--	1,25,000
Sundry Creditors (for purchase of direct materials in April 1998)	68,250	--
Direct Material Price Variance	3,250	--
Direct Labour Rate Variance	2,500	--
Direct Labour Rate Variance	1,900	--
Direct Labour Efficiency Variance	--	2,000

The Actual Production in April 1998 was 4,000 units of the gadget and the actual sales for the month was 2,500 units.

The amount shown above for direct materials price variance applies to materials purchase during April, 1998. There was no opening stock of raw materials on 1st April, 1998.

Required:

Calculate for April, 1998 the following:

- (i) Standard direct labour hours allowed for the actual output achieved.
- (ii) Actual direct labour hours worked.
- (iii) Actual direct labour rate.
- (iv) Standard quantity of direct materials allowed (in kgs.)
- (v) Actual quantity of direct materials used (in kgs.)
- (vi) Actual quantity of direct materials purchased (in kgs.)
- (vii) Actual direct materials price per kg.

Answer

- (i) Standard direct labour hours allowed for the actual output achieved = 2,000 hours.
- (ii) Actual direct labour hour worked = 1,900 hours.
- (iii) Actual direct labour rate = Rs.21
- (iv) Standard quantity of direct materials allowed (in kgs.) = 12,000 Kgs.
- (v) Actual quantity of direct materials used (in Kgs.)
or Actual qty. of direct materials used for actual output = 12,500 Kgs.

(vi) Actual quantity of direct materials purchased (in Kgs.) = Rs.13,000 Kgs.

(vii) Actual direct materials price per Kg.= Rs.5.25

Question 6

Despite the increase in the Sales price of its sole product to the extent of 20%, a company finds that it has incurred a loss during the year 1998-99 to the extent of Rs.4 lakhs as against a profit of Rs.5 lakhs made in 1997-98. This adverse situation is attributed mainly to the increase in prices of materials and overheads, the increase over the previous year being, on the average, 15% and 10% respectively.

The following figures are extracted from the books of the company.

	31..03.98	31.03.99
	Rs.	Rs.
Sales	1,20,00,000	1,29,60,000
Cost of Sales:		
Material	80,00,000	91,10,000
Variable Overhead	20,00,000	24,00,000
Fixed Overhead	15,00,000	18,50,000

Required:

Analyse the variances over the year in order to bring out the reasons for the fall in profit

Answer

Sales price variance	= Rs.21.60 (Lakhs) (Fav.)
Material price variance	= 11.88 (Lakhs) (Adv.)
Variable overhead expenditure variance	= Rs.2.18 (Lakhs) (Adv.)
Variable overhead efficiency variance	= Rs.3.62 (Lakhs) (Adv.)
Fixed overhead expenditure variance	= Rs.1.68 (Lakhs) (Adv.)
Fixed overhead volume variance	= Rs.1.82 (Lakhs) (Adv.)

Question 7

Following the standard cost card of a component:

Materials	2 units at Rs.15	Rs.30
Labour	3 Hours at Rs.20	Rs.60
Total overheads	3 Hours at Rs.10	Rs.30

Advanced Management Accounting

During a particular month 10,000 units of the component were produced and the same was found to be at 60% capacity of the budget. In preparing the variance report for the month, the cost accountant gathered the following information:

<i>Labour</i>	<i>Rs.6,50,000</i>
<i>Variable overheads</i>	<i>Rs.2,00,000</i>
<i>Fixed overheads</i>	<i>Rs.3,00,000</i>
<i>Material price variance</i>	<i>Rs.70,000 (A)</i>
<i>Material cost variance</i>	<i>Rs.50,000 (A)</i>
<i>Labour rate variance</i>	<i>Rs.50,000 (F)</i>
<i>Fixed overhead expenditure variance</i>	<i>Rs.50,000 (A)</i>

You are required to prepare from the above details:

- (1) Actual material cost incurred*
- (2) Standard cost of materials actually consumed*
- (3) Labour efficiency variance*
- (4) Variable OH efficiency variance*
- (5) Variable OH expenditure variance*
- (6) Fixed OH efficiency variance*
- (7) Fixed OH capacity variance*
- (8) Fixed OH volume variance*

Answer

- | | |
|--|----------------------|
| (1) Actual material cost incurred | = Rs. 3,50,000 |
| (2) Standard cost of materials actually consumed | = Rs.2,80,000 |
| (3) Labour efficiency variance | = Rs.1,00,000 (Adv.) |
| (4) Variable OH efficiency variance | = Rs.25,000 (Adv.) |
| (5) Variable OH expenditure variance | = Rs.25,000 (Adv.) |
| (6) Fixed OH efficiency variance | = Rs.25,000 (Adv.) |
| (7) Fixed OH capacity variance | = Rs.75,000 (Adv.) |
| (8) Fixed OH volume variance | = Rs.1,00,000 (Adv.) |

Question 8

F Manufacturing Ltd., uses the three variances method to analyse the manufacturing overhead variances for the fiscal year just ended were computed as follows:

<i>Spending</i>	<i>Rs.86,000</i>	<i>Adverse</i>
<i>Efficiency</i>	<i>Rs.36,000</i>	<i>Favourable</i>
<i>Volume</i>	<i>Rs.80,000</i>	<i>Favourable</i>

The manufacturing overhead application rate for the year was Rs.160 per machine hours of which Rs.60 per machine hour was the variable component. The year end balance the manufacturing overhead control account was Rs.16,50,000 and the standard machine hours for the year were 11,300.

From the above data compute:

- (i) Budgeted Machine Hours*
- (ii) Actual Machine Hours*
- (iii) Applied Manufacturing Overhead*
- (iv) Total Amount of Fixed Overhead Cost*

Answer

- (i) Budgeted Machine Hours = 10,500 hours
- (ii) Actual machine Hours = 10,700 hours.
- (iii) Applied Manufacturing Overhead = Rs.16,80,000
- (iv) Total Amount of Fixed Overhead Cost = Rs.9,22,000

COSTING OF SERVICE SECTOR

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Meaning of Costing of Service Sector

This is a method of ascertaining costs of providing or operating a service. This method of costing is applied by those undertakings which provide services rather than production of commodities.

2. Cost Units

(A) To External Customers	Cost Unit
(i) Hotel	Bed nights available, Bed night occupied
(ii) School	Student hours, Full time students
(iii) Hospital	Patient per day, Room per day
(iv) Accounting firm	Charged out client hours
(v) Transport	Passenger km., quintal km.
(B) Internal services	Cost Unit
(i) Staff canteen	Meals provided, No. of staff
(ii) Machine maintenance	Maintenance hours provided to user department
(iii) Computer department	Computer time provided to user department

3. Costing Methods Used In Service Sector

- (i) Job costing method
- (ii) Process costing method
- (iii) Hybrid costing method

4. Job costing method in service sector

The two significant costs which are incurred in service sectors are :

- (i) Direct labour

Advanced Management Accounting

(ii) Service overheads

5. Process costing method in service sector :

In this method the cost of service is obtained by assigning costs to masses of units and then computing unit costs on an average basis.

6. Customer costing in service sector

The central theme of this approach is customer satisfaction. For customer costing purpose, the costs are divided into following categories. These are:

- (i) Customer Specific costs
- (ii) Customer-line categories
- (iii) Company costs

Question 1

Discuss with examples, the basic costing methods to assign costs to services.

Answer

- (i) **Job costing method:** The cost of a particular service is obtained by assigning costs to a distinct identifiable service.
e.g. Job Costing method is used in service sectors – like Accounting Firm, Advertisement campaign.
- (ii) **Process Costing method:** Cost of a service is obtained by assigning costs to masses of similar unit and then computing cost / unit on an average basis.
e.g. Retail banking, postal delivery, credit card etc.
- (iii) **Hybrid method:** Combination of both (i) & (ii) above.

Question 2

A city health centre provides health and other related services to the citizens who are covered under insurance plan. The health centre receives a payment from the insurance company each time any patient attends the centre for consultation as under:

<i>Consultations involving</i>	<i>Payment from Insurance company</i>
	<i>Rs.</i>
<i>No treatment</i>	<i>60</i>
<i>Minor treatment</i>	<i>250</i>
<i>Major treatment</i>	<i>500</i>

In addition, the adult patients will have to make a co-payment which is equivalent to the amount of payment for the respective category of treatment made by the insurance company. However, children and senior citizens are not required to make any such co-payment.

The health centre will remain open for 6 days in a week for 52 weeks in a year. Each physician treated 20 patients per day although the maximum number of patients that could have been treated by a physician on any working day is 24 patients.

The health centre received a fixed income of Rs. 2,25,280 per annum for promotion of health products from the manufacturers.

The annual expenditure of the health centre is estimated as under:

Materials and consumable (100% variable)	Rs. 22,32,000
Staff salaries per annum per employee (fixed):	
Physician	Rs. 4,50,000
Assistants	Rs. 1,50,000
Administrative staff	Rs. 90,000
Establishment and other operating costs (fixed)	Rs. 16,00,000

The non-financial information is as under:

(i) Staff:

Number of physicians employed	6
Assistants	7
Administrative staff	2

(ii) Patient Mix:

Adults	50%
Children	40%
Senior Citizens	10%

(iii) Mix of patient appointments (%)

Consultation requiring no treatment	70%
Minor treatment	20%
Major treatment	10%

Required:

- (i) Calculate the Net income of the city health centre for the next year;

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- (ii) Determine the percentage of maximum capacity required to be utilized next year in order to break even.

Answer

1. (1) Total number of patients attended

<i>Number of patients attended per day by a physician:</i>	20
<i>Number of physicians employed</i>	6
<i>Number of days in week</i>	6
<i>Number of weeks in a year</i>	52
<i>Total number of patients attended = $20 \times 6 \times 6 \times 52 = 37,440$.</i>	

- (2) Patient Mix:

<i>Adults (50%)</i>	$37,440 \times 50/100$	=	18,720
<i>Children (40%)</i>	$37,440 \times 40/100$	=	14,976
<i>Senior Citizens (10%)</i>	$37,440 \times 10/100$	=	<u>3,744</u>
			<u>37,440</u>

- (3) Patient Appointments:

<i>No treatment required (70%)</i>	$37,440 \times 70/100$	=	26,208
<i>Minor treatment (20%)</i>	$37,440 \times 20/100$	=	7,488
<i>Major treatment (10%)</i>	$37,440 \times 10/100$	=	<u>3,744</u>
			<u>37,440</u>

- (4) Income from Insurance Companies:

	<i>Number of patients</i>	<i>of Rs.</i>	<i>Rs.</i>
	<i>(A)</i>	<i>(B)</i>	<i>(A × B)</i>
<i>No treatment patients</i>	26,208	60	15,72,480
<i>Minor treatment patients</i>	7,488	250	18,72,000
<i>Major treatment patients</i>	3,744	500	<u>18,72,000</u>
<i>Total</i>			<u>53,16,480</u>

Costing of Service Sector

(5) Co-payment from adult patients:

	<i>Number patients</i>	<i>of Payment (Rs.)</i>	<i>Total payment (Rs.)</i>
<i>Total number of adult patients</i>	18,720		
<i>No treatment patients (70%)</i>	13,104	60	7,86,240
<i>Minor treatment (20%)</i>	3,744	250	9,36,000
<i>Major treatment (10%)</i>	1,872	500	<u>9,36,000</u>
<i>Total</i>			<u>26,58,240</u>

(6) Net income:

	<i>Rs.</i>	<i>Rs.</i>
<i>Payment from Insurance companies</i>	53,16,480	
<i>Co-payment from adult patients</i>	<u>26,58,240</u>	
<i>Total</i>	79,74,720	
<i>Other Income (fixed)</i>	<u>2,25,280</u>	
<i>Total Income (A)</i>		82,00,000
<i>Less: Expenditure</i>		
<i>Variable expenses:</i>		
<i>Material and consumables</i>	22,32,000	
<i>Fixed expenses:</i>		
<i>Physician's salary (6 × 4,50,000)</i>	27,00,000	
<i>Assistants salary (7 × 1,50,000)</i>	10,50,000	
<i>Administrative staff's salary (2 × 90,000)</i>	1,80,000	
<i>Establishment and other operating costs</i>	16,00,000	<u>55,30,000</u>
<i>Total Expenditure (B)</i>		<u>77,62,000</u>
<i>Net Income (A – B)</i>		<u>4,38,000</u>

(ii) 1. Contribution Analysis:

	<i>(Rs.)</i>
<i>Total Fees from Insurance Companies and adult patients</i>	79,74,720
<i>Less: Variable costs</i>	22,32,000

Advanced Management Accounting

<i>Contribution</i>	57,42,720
<i>Average contribution per patient</i>	$\frac{57,42,720}{37,440} = 153.38$

2. Break-even patients:

	(Rs.)
<i>Fixed costs</i>	55,30,000
<i>Less: Fixed income</i>	2,25,280
<i>Net Fixed costs</i>	53,04,720
<i>Break-even patients</i> = $\frac{\text{Net fixed costs}}{\text{Contribution per patient}}$	$\frac{53,04,720}{153.38} = 34,585$

3. Percentage of maximum capacity required to be utilized in order to break-even

$$\text{Present utilization} = \frac{20 \text{ patients}}{24 \text{ patients}} = 83.33\% = 37,440$$

$$100\% \text{ patient capacity is } \frac{37,440}{0.8333} = 44,930 \text{ patients}$$

Percentage of maximum capacity required to be utilized in order to break-even

$$= \frac{\text{Break - even patients}}{100\% \text{ patient capacity}} \times 100$$

$$= \frac{34,585}{44,930} \times 100 = 76.98\% \text{ say } 77\%.$$

Assumption: Patient mix and mix of patient appointments will be same in the next year.

Question 3

Give an appropriate cost unit for each of the following service sectors:

- (i) Hotel
- (ii) School
- (iii) Hospital
- (iv) Accounting firm

- (v) *Transport*
 (vi) *Staff Canteen*
 (vii) *Machine maintenance*
 (viii) *Computer Department*

Answer

Service Sector	Cost Unit
Hotel	Bednights available or occupied
School	Student hours or no. of full time students
Hospital	Patient-day / Room-day
Accounting firm	Client hours
Transport	Passenger-Kms, or Quintal km or tonne-km
Staff Canteen	No. of meals provided or no. of staff
Machine maintenance	Maintenance hours to user departments
Computer Department	Computer time to user departments.

Question 4

Explain the main characteristics of Service sector costing.

Answer

Main characteristics of service sector are as below:

- (a) **Activities are labour intensive:** The activities of service sector generally are labour intensive. The direct material cost is either small or non-existent.
- (b) **Cost-unit is usually difficult to define:** The selection of cost units usually, for service sector is difficult to ascertain as compared to the selection of cost unit for manufacturing sector. The following table provides some examples of the cost units for service sector.
- *Hospital* – Patient per day, Room per day
 - *Accounting firm* – Charged out client hours
 - *Transport* – passenger km., quintal km.
 - *Machine maintenance* – Maintenance hours provided to user department
 - *Computer department* – Computer time provided to user department.

Advanced Management Accounting

- (c) **Product costs in service sector:** Costs are classified as product or period costs in manufacturing sector for various reasons.

Question 5

B Ltd. makes industrial power drills, which is made by the use of two components A (electrical and mechanical components and B (plastic housing). The following table shows the cost of plastic housing separately from the cost of the electrical and mechanical components:

	A <i>Electrical and Mechanical Components</i> Rs.	B <i>Plastic Housing</i> Rs.	A & B <i>Industrial Drills</i> Rs.
Sales 1,00,000 units @ Rs.100			1,00,00,000
Variable Costs:			
Direct materials	44,00,000	5,00,000	49,00,000
Direct Labour	4,00,000	3,00,000	7,00,000
Variable factory overhead	1,00,000	2,00,000	3,00,000
Other Variable Costs	1,00,000	-	1,00,000
Sales commission @10% of sales	10,00,000	-	10,00,000
Total variable costs	60,00,000	10,00,000	70,00,000
Contribution	-	-	30,00,000
Total fixed costs	22,20,000	4,80,000	27,00,000
Operating income			3,00,000

Answer the following questions independently:

- (i) During the year, a prospective customer offered Rs.82, 000 for 1,000 drills. The drills would be manufactured in addition to the 1,00,000 units sold. B Ltd. would pay the regular sales commission rate on the 1,000 drills. The Chairman rejected the order because "it was below our costs". Calculate operating income if B Ltd. accepts the offer.
- (ii) A supplier offers to manufacture the yearly supply of 1,00,000 units plastic housing components for Rs.13.50 each. Assume that B Ltd. would avoid Rs.3,50,000 of the costs assigned to plastic housing if it purchases. Calculate operating income if B Ltd. decides to purchase the plastic housing from the supplier.

Costing of Service Sector

- (iii) Assuming that B Ltd. could purchase 1,20,000 units (plastic housing components) for Rs.13.50 each and use the vacated plant capacity for the manufacture of deluxe version of drill of 20,000 units (and sell them for Rs.130 each in addition to the sales of the 1,00,000 regular units) at a variable cost of Rs.90 each, exclusive of housings and exclusive of the 10% sales commission. All the fixed costs pertaining to the plastic housing would continue, because these costs are related to the manufacturing facilities primarily used. Calculate operating income of B Ltd. purchases the plastic housings and manufacture the deluxe version of drills.

Answer

- (i) The costs of filling the special order of 1000 drills:

	Rs.
Direct Materials	49,000
Direct Labour	7,000
Variable Factory Overhead	3,000
Other Variable Cost	1,000
Sales commission @ 10% of Rs.82,000	<u>8,200</u>
Total Variable Costs	68,200
Selling Price	<u>82,000</u>
Contribution	<u>13,800</u>

Operating income would have been Rs.3,00,000 + Rs.13,800 = Rs.3,13,800, if B Ltd had accepted the order.

- (ii) Assuming that B Ltd. could have avoided Rs.3,50,000 of the fixed costs by not making the housings and that the other fixed costs would have continued, we can summarize the alternatives as follows:

	<i>Make</i>	<i>Buy</i>
Purchase Cost		Rs.13,50,000
Variable Costs	Rs.10,00,000	
Avoidable fixed Costs	<u>Rs.3,50,000</u>	—
Total relevant Costs	<u>Rs.13,50,000</u>	<u>Rs.13,50,000</u>

If the facilities used for plastic housings became idle, the B Ltd. would be indifferent whether to make or buy. The present operating income would be unaffected.

Advanced Management Accounting

- (iii) The effect of purchasing the plastic housings and using the vacated facilities for the manufacture of a deluxe version of its drill is as follows:

Increase in sales 20,000 units @ Rs.130		26,00,000
Increase in Variables cost 20,000 units, @Rs.90	18,00,000	
Plus: Sales commission, 10% of Rs.26,00,000	<u>2,60,000</u>	<u>20,60,000</u>
Contribution on 20,000 units		5,40,000
Housings: 1,20,000 rather than 1,00,000 would be needed Buy 1,20,000 @ Rs.13.50	16,20,000	
Less: Make 1,00,000 @ Rs.10 (only the variable costs are relevant)	<u>10,00,000</u>	
Excess cost of outside purchase		<u>6,20,000</u>
Loss on making deluxe units		<u>Rs.80,000</u>

Conclusion: Operating income would decline to Rs.2, 20,000 (3, 00,000 – 80,000).

EXERCISE**Question 1**

A Multinational company runs a Public Medical Health Centre. For this purpose, it has hired a building at a rent of Rs. 10,000 per month with 5% of total taking. Health centre has three types of wards for its patients namely. General ward, Cottage ward and Deluxe ward. State the rent to be charged to each bed-day for different type of ward on the basis of the following informations:

- (i) The number of beds of each type are General ward 100, Cottage ward 50, Deluxe ward 30.
- (ii) The rent of Cottage ward bed is to be fixed at 2.5 times of the General ward bed and that of Deluxe ward bed as twice of the Cottage ward bed.
- (iii) The occupancy of each type of ward is as follows:
General ward 100%, Cottage ward 80% and Deluxe ward 60%. But, in general ward there were occasions when beds are full, extra beds were hired at a charges of Rs. 20 per bed. The total hire charges for the extra beds incurred for the whole year amount to Rs. 12,000.
- (iv) The Health Centre engaged a heart specialist from outside and on an average fees paid to him was Rs. 15,000 per trip. He makes three trips in the whole year.
- (v) The other expenses for the year were as under:

	Rs.
Salary of Supervisors, Nurses, Ward boys	4,25,000
Repairs and maintenance	90,000
Salary of doctors	13,50,000
Food supplied to patients	40,000
Laundry charges for their bed linens	80,500
Medicines supplied	74,000
Cost of oxygen, X-ray etc. other than directly borne for	
Treatment of patients	49,500
General administration charges	63,000

- (vi) Provide profit @ 20% on total taking.
- (vii) The Health Centre imposes 8% service tax on rent received.
- (viii) 360 days may be taken in a year.

Advanced Management Accounting

Answer

Rent to be charged

Particulars	Basic	Service tax	Total
General ward	30.65	2.45	33.10
Cottage ward	76.63	6.13	82.76
Deluxe ward	153.25	12.26	165.51

TRANSFER PRICING

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Transfer Price

Transfer price is the price which one division of an organisation charges for a product or service supplied to another division of the same organisation.

2. Objectives of Transfer Pricing System

The main-objectives of intra-company transfer pricing are as below:

- i) Emphasis on Profits
- ii) Maximum Utilisation of plant capacity
- iii) Optimise allocation of financial resources

3. Pricing at Cost

In this method the goods and services are transferred at the following costs:

- a. Actual manufacturing cost:
- b. Standard cost
- c. Full cost:
- d. Full cost plus mark up

4. Pricing at market price

Under this method, the transfer prices of goods/services transferred to other units/divisions are based on market prices. Since market prices will, by and large be determined by demand and supply in the long run, it is claimed that profits which results under this method, will provide a good indicator of the overall efficiency of the various units.

5. Bargained or Negotiated Prices

Under this method each decentralised unit is considered as an independent unit and such units decide the transfer price by negotiations or bargaining. Divisional managers have full freedom to purchase their requirement from outside if the

Advanced Management Accounting

prices quoted by their sister unit are lower.

6. Multinational Transfer Pricing

Multinational companies use transfer prices to minimize worldwide income taxes, import duties, and tariffs. By setting a low transfer price, the company can recognize most of the profit from the production in the low-income-tax-rate country, thereby minimizing taxes. Likewise, items produced by divisions in a low-income-tax-rate country and transferred to a division in a high-income-tax-rate country should have a high transfer price to minimize taxes. Sometimes import duties offset income tax effects

Question 1

A company is engaged in the manufacture of edible oil. It has three divisions as under:

- (i) Harvesting oil seeds and transportation thereof to the oil mill.*
- (ii) Oil Mill, which processes oil seeds and manufactures edible oil.*
- (iii) Marketing Division, which packs the edible oil in 2 kg. containers for sale at Rs.150 each container.*

The Oil Mill has a yield of 1,000 kgs of oil from 2,000 kg of oil seeds during a period. The Marketing Division has a yield of 5,000 cans of edible oil of 2 kg each from every 1,000 kg of oil. The net weight per can is 2 kgs of oil.

The cost data for each division for the period are as under:

Harvesting division

Variable cost per kg of oil seed	Rs.2.50
----------------------------------	---------

Fixed cost per kg of oil seed	Rs.5.00
-------------------------------	---------

Oil Mill Division:

Variable cost of processed edible oil	Rs.10.00 per kg
---------------------------------------	-----------------

Fixed cost of processed edible oil	Rs.7.50 per kg
------------------------------------	----------------

Marketing Division:

Variable cost per can of 2 kg of oil	Rs.3.75
--------------------------------------	---------

Fixed cost per can of 2 kg of oil	Rs.8.75
-----------------------------------	---------

The fixed costs are calculated on the basis of the estimated quantity of 2,000 kg of oil seeds harvested, 1,000 kg of processed oil and 500 cans of edible oil packed by the aforesaid divisions respectively during the period under review.

The other oil mills buy the oil seeds of same quality at Rs.12.50 per kg in the market. The market price of edible oil processed by the oil mill, if sold without being packed in the marketing division is Rs.62.50 per kg of oil.

Required:

- (i) Compute the overall profit of the company of harvesting 2,000 kg of oil seeds, processing it into edible oil and selling the same in 2 kg cans as estimated for the period under review.
- (ii) Compute the transfer prices that will be used for internal transfers from (1) Harvesting Division to Oil Mill Division and (2) from Oil Mill Division to Marketing Division under the following pricing methods:
 - (1) Shared contribution in relation to variable costs; and
 - (2) Market price.
- (iii) Which transfer pricing method will each divisional manager prefer to use?

Answer

(i) Statement of the overall profit of the company					
(By harvesting 2,000 kgs of oil seeds, processing it into edible oil & selling the same in 2 kg cans)					
Output of each department	Harvesting Division 2,000 kgs of oil seed	Oil Mill Division 1,000 kgs. of oil produced	Marketing Division 500 cans of 2 kg each	Total Rs.	
Total costs					
Variable cost (Rs.): (A)	5,000 (2,000 kgs × Rs.2.50)	10,000 (1,000 kgs × Rs.10)	1,875 (500 × Rs.3.75)	16,875	
Fixed cost (Rs.): (B)	10,000 (2,000 kgs × Rs.5)	7,500 (1,000 kgs × Rs.7.50)	4,375 (500 × Rs.8.75)	21,875	
Total cost (Rs.): (C) = [(A)+(B)]	15,000	17,500	6,250	38,750	
Sales revenue (Rs.): (D) (500 cans × Rs.150)					75,000
Profit (Rs.) [(D) – (C)]					36,250

Advanced Management Accounting

(ii) Working note:

$$\begin{aligned} \text{(a) Total Contribution} &= (\text{Sales revenue} - \text{total variable cost}) \\ &= \text{Rs.75,000} - \text{Rs.16,875} = \text{Rs.58,125} \end{aligned}$$

(b) Amount of shared contribution in relation to variable costs:

$$\text{Harvesting Division} = \text{Rs.58,125} \times \frac{\text{Rs.5,000}}{\text{Rs.16,875}} = \text{Rs.17,222}$$

$$\text{Oil Mill Division} = \text{Rs.58,125} \times \frac{\text{Rs.10,000}}{\text{Rs.16,875}} = \text{Rs.34,445}$$

$$\text{Marketing Division} = \text{Rs.58,125} \times \frac{\text{Rs.1,875}}{\text{Rs.16,875}} = \text{Rs.6,458}$$

Computation of Transfer Price (for internal transfers) under the following pricing methods:

(1) Shared contribution in relation to variable costs:

Transfer price from harvesting Division to Oil Mill Division

$$= \text{Variable cost of Harvesting Division} + \text{Shared contribution of Harvesting Division in relation to variable costs}$$

$$= \text{Rs.5,000} + \text{Rs.17,222 (Refer to working note 2)} = \text{Rs.22,222}$$

Transfer price from Oil Mill Division to Marketing Division

$$= \text{Transfer price from Harvesting Division to Oil Mill Division} + \text{Variable cost of Oil Mill}$$

$$\text{Division} + \text{Shared contribution of Oil Mill Division in relation to variable costs (Refer to working note 2)}$$

$$= \text{Rs.22,222} + \text{Rs.10,000} + 34,445$$

$$= \text{Rs.66,667}$$

(2) Market price:

Transfer price from Harvesting Division to Oil Mill Division

$$= \text{Market price of 2,000 kgs of Oil seeds transferred to Oil Mill Division}$$

$$= 2,000 \text{ kgs.} \times \text{Rs.12.50} = \text{Rs.25,000}$$

Transfer price from Oil Mill Division to Marketing Division

$$= \text{Market price of 1,000 kgs of edible oil}$$

$$= 1,000 \text{ of kgs} \times \text{Rs.62.50} = \text{Rs.62,500}$$

(iii) Statement of profitability (under different transfer prices method)

	<i>From Harvesting Division to Oil Mill Division</i>	<i>From Oil Mill to Marketing Division</i>	<i>From Marketing Division to market (500 cans of 2 Kgs.)</i>
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>
Shared contribution method			
Transfer price:	22,222	66,667	75,000
(Refer to (1) above)			
Less: Transfer price	—	22,222	66,667
(Refer to (ii) above)			
Less: Variable cost	5,000	10,000	1,875
Less: Fixed cost	10,000	7,500	4,375
(Refer to (i) above)			
Profit	7,222	26,945	2,083
Market price method			
Transfer price	25,000	62,500	75,000
(Refer to (2) above)			
Less: Transfer in price	—	25,000	62,500
(Refer to (ii) above)			
Less: Variable cost	5,000	10,000	1,875
(Refer to (ii) above)			
Less: Fixed cost	10,000	7,500	4,375
(Refer to (i) above)			
Profit	10,000	20,000	6,250

Decision: Divisional Manager of Harvesting Division would prefer the use of market price method for transferring 2,000 kgs of oil seeds to Oil Mill Division because its usage increases the profit by Rs.2,778 (Rs.7,222) over the shared contribution method.

Whereas Oil Mill Division manager would prefer the use of shared contribution method over the market price method because its use would increase its profit by

Advanced Management Accounting

Rs.6,945 (Rs.26,945 – Rs.20,000). Similarly Marketing Divisional Manager would be benefited to the extent of Rs.4,167 (Rs.6,250 – Rs.2,083) by using market price method.

Question 2

Indicate the possible disadvantages of treating divisions as profit centres.

Answer

The Possible disadvantages of treating divisions as profit centres are as follows:

1. Divisions may compete with each other and may take decisions to increase profits at the expense of other divisions thereby overemphasizing short term results.
2. It may adversely affect co-operation between the divisions and lead to lack of harmony in achieving organizational goals of the company. Thus it is hard to achieve the objective of goal congruence.
3. It may lead to reduction in the company's overall total profits.
4. The cost of activities, which are common to all divisions, may be greater for decentralized structure than centralized structure. It may thus result in duplication of staff activities.
5. Top management loses control by delegating decision making to divisional managers. There are risks of mistakes committed by the divisional managers, which the top management, may avoid.
6. Series of control reports prepared for several departments may not be effective from the point of view of top management.
7. It may under utilize corporate competence.
8. It leads to complications associated with transfer pricing problems.
9. It becomes difficult to identify and define precisely suitable profit centres.
10. It confuses division's results with manager's performance.

Question 3

The two manufacturing divisions of a company is organized on profit centre basis. Division X is the only source of a component required by Division Y for their product 'P'. Each unit of P requires one unit of the said component. As the demand of the product is not steady, orders for increased quantities can be obtained by manipulating prices.

The manager of Division Y has given the following forecast:

Sales per day (Unit)
5,000

Average price per unit of P (Rs.)
393.75

10,000	298.50
15,000	247.50
20,000	208.50
25,000	180.00
30,000	150.75

The manufacturing cost (excluding the cost of the component from Division X) of P in Division Y is Rs.14,06,250 on first 5,000 units and Rs.56.25 per unit in excess of 5,000 units.

Division X incurs a total cost of Rs.5,62,500 per day for an output upto 5,000 components and the total costs will increase by Rs.3,37,500 per day for every additional 5,000 components manufactured. The Manager of Division X has set the transfer price for the component at Rs.90 per unit to optimize the performance of his Division.

Required:

- (i) Prepare a divisional profitability statement at each level of output, for division X and Y separately;
- (ii) Find out the profitability of the company as a whole at the output level where:
 - (a) Division X's net profit is maximum;
 - (b) Division Y's net profit is maximum.
- (iii) Find out at what level of output, the company will earn maximum profit, if the company is not organized on profit centre basis.

Answer

(i) Statement of profitability of Division X

No. of components	Transfer price for the component to Department Y @ Rs.90 per unit	Total cost of components (Rs.)	Profit / (Loss) (Rs.)
(a)	(b)	(c)	(d) = {(b) – (c)}
5,000	4,50,000	5,62,500	(1,12,500)
10,000	9,00,000	9,00,000	—
15,000	13,50,000	12,37,500	1,12,500
20,000	18,00,000	15,75,000	1,25,000
25,000	22,50,000	19,12,500	3,37,500
30,000	27,00,000	22,50,000	4,50,000

Advanced Management Accounting

Statement of profitability of Division Y

No. of Components	Sale revenue on average price basis	Component cost (Transfer price) to Dept. Y	Manufacturing cost in division Y	Total cost	Profit/(Loss)
	Rs.	Rs.	Rs.	Rs.	Rs.
(a)	(b)	(c)	(d)	(e)={{(c)+(d)}}	(f)={{(b)-(e)}}
5,000	19,68,750	4,50,000	14,06,250	18,56,250	1,12,500
10,000	29,85,000	9,00,000	16,87,500	25,87,500	3,97,500
15,000	37,12,500	13,50,000	19,68,750	33,18,750	3,93,750
20,000	41,70,000	18,00,000	22,50,000	40,50,000	1,20,000
25,000	45,00,000	22,50,000	25,31,250	47,81,250	(2,81,250)
30,000	45,00,000	27,00,000	28,12,500	55,12,500	(9,90,000)

(ii) Profitability of the company as a whole

(a)	At 30,000 units level, at which Division X's net profit is maximum	Rs.
	Profit of Division X	4,50,000
	Profit of division Y	<u>(9,00,000)</u>
	Operating profitability / (Loss) of the company	<u>(5,40,000)</u>
(b)	At 10,000 units level, at which Division Y's net profit is maximum	Rs.
	Profit of division X	NIL
	Profit of division Y	<u>3,97,500</u>
	Operating profitability of the company	<u>3,97,500</u>

(iii) Profitability of the company, if it is not organised on profit centre basis

No. of components	Sales revenue on average basis	Cost of component to division X	Manufacturing cost in division Y	Total cost	Profit/ (Loss)
	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
(a)	(b)	(c)	(d)	(e)={{(c) + (d)}}	(f)={{(b)-(e)}}
5,000	19,68,750	5,62,500	14,06,250	19,68,750	-

Transfer Pricing

10,000	29,85,000	9,00,000	16,87,500	25,87,500	3,97,500
15,000	37,12,500	12,37,500	19,68,750	32,06,250	5,06,250
20,000	41,70,000	15,75,000	22,50,000	38,25,000	3,45,000
25,000	45,00,000	19,12,500	25,31,250	44,43,750	56,250
30,000	45,22,500	22,50,000	28,12,500	50,62,500	(5,40,000)

The level of output, the company will earn maximum profit, if the company is not organized on profit centre basis is 15,000 components.

Question 4

Tycon Ltd. has two manufacturing departments organized into separate profit centres known as Textile unit and Process House. The Textile unit has a production capacity of 5 lacs metres cloth per month, but at present its sales is limited to 50% to outside market and 30% to process house.

The transfer price for the year 2004 was agreed at Rs. 6 per metre. This price has been fixed in line with the external wholesale trade price on 1st January, 2004. However, the price of yarn declined, which was the raw material of textile unit, with effect, that wholesale trade price reduced to Rs. 5.60 per metre with effect from 1st June, 2004. This price was however not made applicable to the sales made to the processing house of the company. The textile unit turned down the processing house request for revision of price.

The Process house refines the cloth and packs the output known as brand Rayon in bundles of 100 metres each. The selling price of the Rayon is Rs. 825 per bundle. The process house has a potential of selling a further quantity of 1,000 bundles of Rayon provided the overall price is reduced to Rs. 725 per bundle. In that event it can buy the additional 1,00,000 metres of cloth from textile unit, whose capacity can be fully utilised. The outside market has no further scope.

The cost data relevant to the operations are:

	Textile unit Rs.	Process house Rs.
Raw material (per metre) on 1 st June, 2004	3.00	Transfer price
Variable cost	1.20 (per metre)	80 (per bundle)
Fixed cost (per month)	4,12,000	1,00,000

You are required to:

- (i) *Prepare statement showing the estimated profitability for June, 2004 for Textile unit and Process house and company as a whole on the following basis:*

Advanced Management Accounting

- (a) At 80% and 100% capacity utilisation of the Textile unit at the market price and the transfer price to the Processing house of Rs. 6 per metre.
- (b) At 80% capacity utilisation of the Textile unit at the market price of Rs. 5.60 per metre and the transfer price to the Processing house of Rs. 6 per metre.
- (c) At 100% capacity utilisation of the Textile unit at the market price of Rs. 5.60 per metre and the transfer price to the Processing house of Rs. 5.60 per metre.
- (ii) Comment on the effect of the company's transfer pricing policy on the profitability of Processing house.

Answer

- (i) (a) At 80% level (in Rs)

-Textile unit		-Process house	
Sales (4,00,000 × 6)	24,00,000	Sales (1,50,000/100) × 825	12,37,500
Less		Less	
Raw material (4,00,000 × 3)	12,00,000	Transfer Price (1,50,000 × 6)	9,00,000
Variable cost (4,00,000 × 1.2)	4,80,000	Variable cost (1,500 × 80)	1,20,000
Fixed cost	4,12,000	Fixed cost	1,00,000
Profit	3,08,000	Profit	1,17,500

Overall profit = 3,08,000 + 1,17,500 = Rs 4,25,500

At 100% level

Sales (5,00,000 × 6)	30,00,000	Sales (2,50,000/100) × 725	18,12,500
Less		Less	
Raw material (5,00,000 × 3)	15,00,000	Transfer Price (2,50,000 × 6)	15,00,000
Variable cost (5,00,000 × 1.2)	6,00,000	Variable cost	2,00,000
Fixed cost	4,12,000	Fixed cost	1,00,000
Profit	4,88,000	Profit	12,500

Overall profit = 4,88,000 + 12,500 = Rs 5,00,500

- (b) At 80% level (market price 5.60 and transfer price 6/-) (in Rs)

Textile unit	Process house
Sale (2,50,000 × 5.6)	1400000

(1,50,000 × 6.0)	900000	
	23,00,000	
Less		
Raw material (4,00,000 × 3)	12,00,000	
Variable cost (4,00,000 × 1.2)	4,80,000	
Fixed cost	4,12,000	
Profit	2,08,000	Profit 1,17,500
Overall profit = 2,08,000 + 1,17,500 = Rs 3,25,500		

(c) Sales 100% level at (5.60) (in Rs)

Sale (5,00,000 × 5.6)	28,00,000	Sales (2,50,000 × 725)	18,12,500
Less		Less	
Raw material (5,00,000 × 3)	15,00,000	Transfer Profit (2,50,000 × 5.6)	14,00,000
Variable cost (5,00,000 × 1.20)	6,00,000	Variable cost (2,500 × 80)	2,00,000
Fixed cost	4,12,000	Fixed cost	1,00,000
Profit	2,88,000	Profit	1,12,500

Overall profit = 2,88,000 + 1,12,500 = 4,00,500

(ii) Comments on the profitability of processing units:-

	Transfer price (Rs)	Profit (Rs)
(a) 80% capacity	6.00	1,17,500
100% capacity	6.00	12,500
(b) 80% capacity	6.00	1,17,500
(c) 100% capacity	5.60	1,12,500

Processing house will not be interested to buy more than 1,50,000 meters from textile units.

Question 5

AB Cycles Ltd. has 2 divisions, A and B which manufacture bicycle. Division A produces bicycle frame and Division B assembles rest of the bicycle on the frame. There is a market for sub-assembly and the final product. Each division has been treated as a profit

Advanced Management Accounting

centre. The transfer price has been set at the long-run average market price. The following data are available to each division:

Estimated selling price of final product	Rs. 3,000 p.u.
Long run average market price of sub-assembly	Rs. 2,000 p.u.
Incremental cost of completing sub-assembly in division B	Rs. 1,500 p.u.
Incremental cost in Division A	Rs. 1,200 p.u.

Required:

- (i) If Division A's maximum capacity is 1,000 p.m. and sales to the intermediate are now 800 units, should 200 units be transferred to B on long-term average price basis.
- (ii) What would be the transfer price, if manager of Division B should be kept motivated?
- (iii) If outside market increases to 1,000 units, should Division A continue to transfer 200 units to Division B or sell entire production to outside market?

Answer

- (i) In this case there are two options available –

- (a) Sell at the sub assembly stage (after completion of Div. A) @
Rs. 2000/-

Incremental cost in Div. A Rs 1,200/-

Contribution Rs 800/-

- (b) Sell at the final product stage Rs. 3,000

Cost at Div. A and Div. B Rs(1200+1500) Rs 2,700

Contribution Rs 300

Therefore it is profitable to sell at the subassembly stage because of higher contribution, provided there is a market.

Hence, if there is market at intermediate stage, first priority is to sell intermediary (sub assembly). Therefore, 800 units should be sold as sale of intermediary.

The balance capacity available of $(1000 - 800) = 200$ units should be transferred to B and B should complete the assembly and sell as final product, since the company can earn Rs. 300 per unit for each unit of such sale.

- (ii) If B Div. receives the subassembly at market price of Rs. 2,000, plus its own incremental cost of Rs. 1,500 will give total cost of Rs. 3,500, thereby yielding a

loss of Rs. 3500 – Rs. 3000 = Rs. 500 per unit, whereas the company makes a profit of Rs. 300 per unit.

In order to keep the manager of Div. B motivated, the profit earned of Rs. 300 per unit should be shared between A and B. Hence transfer price will be variable cost of Div. A + 50% of profit earned in the final product = 1200 + 150 = Rs. 1,350

- (iii) Both Div. A and the Company make higher contribution by selling to intermediate market. If the market demand increases to 1,000 units, the full quantity should be sold outside as intermediary and nothing should be transferred to Div. B.

Question 6

What are some goals of a 'transfer-pricing' system in an organization?

Answer

The goals of transfer pricing are that it should:

1. provide information that motivates divisional managers to take good economic decisions which will improve the divisional profits and ultimately the profits of the company as a whole.
2. provide information which will be useful for evaluating the divisional performance.
3. seek to achieve goal congruence.
4. ensure that divisional autonomy is not undermined.

Question 7

Division Z is a profit center which produces four products A, B, C and D. Each product is sold in the external market also. Data for the period is:

	A	B	C	D
Market price per unit (Rs.)	150	146	140	130
Variable cost of pdn. Per unit (Rs.)	130	100	90	85
Labour hours required per unit	3	4	2	3

Product D can be transferred to division Y, but the maximum quantity that may be required for transfer is 2,500 units of D.

The maximum sales in the external market are:

A	2,800 units
B	2,500 units
C	2,300 units
D	1,600 units

Advanced Management Accounting

Division Y can purchase the same product at a price of Rs. 125 per unit from outside instead of receiving transfer of product D from Division Z.

What should be the transfer price for each unit for 2,500 units of D, if the total labour hours available in division Z are 20,000 hours?

Answer

Ranking of products when availability of time is the key factor

Products	A	B	C	D
Market price	150	146	140	130
Less: Variable cost	130	100	90	85
Contribution p.u. (Rs.)	20	46	50	45
Labour hours p.u.	3	4	2	3
Contribution/labour hour	6.66	11.5	25	15
Ranking	IV	III	I	II
Maximum demand (units)	2,800	2,500	2,300	1,600
Total No of hours	8,400	10,000	4,600	4,800
Allocation of 20,000 hours on the basis of ranking	600*	10,000	4,600	4,800

***Balancing figure**

Note: Time required meeting the demand of 2,500 units of product D for division Y is 7,500 hours. This requirement of time viz, 7,500 hours for providing 2,500 units of product D for division Y can be met by sacrificing 600 hours of Product A (200 units) and 6,900 hours of Product B (1,725 units)

Transfer Price = Variable cost + Opportunity cost

$$\text{Or } \frac{\text{Rs}85 + (\text{Rs}6,900 \times 11.5 + 600 \times 6.66)}{2,500} = \frac{\text{Rs}.85 + (79350 + 4000)}{2500}$$

$$= \text{Rs } (85 + 33.34) = \text{Rs } 118.34$$

Question 8

X Ltd. has two divisions, A and B, which manufacture products A and B respectively. A and B are profit centres with the respective Divisional Managers being given full responsibility and credit for their performance.

The following figures are presented:

	Division A	Division B	
	Rs. Per Unit	Rs. Per Unit	
Direct material cost	50	24*	*(other than A)
Material A, if transferred from Division A	—	144	
Material A, if purchased from outside	—	160	
Direct labour	25	14	
Variable production overhead	20	2	
Variable selling overhead	13	26	
Selling price in outside market	160	300	
Selling price to B	144	—	
Selling price to S Ltd.	—	250	

Other Information:

To make one unit of B, one unit of component A is needed. If transferred from A, B presently takes product A at Rs.144 per unit, with A not incurring variable selling overheads on units transferred to B.

Product A is available in the outside market at Rs. 160 per unit from competitors.

B can sell its product B in the external market at Rs. 300 per unit, whereas, if it supplied to X Ltd.'s subsidiary, S Ltd., it supplies at Rs. 250 per unit, and need not incur variable selling overhead on units transferred to S Ltd. S Ltd. requires 6,000 units and stipulates a condition that either all 6,000 units be taken from B or none at all.

	A(units)	B(units)	
Manufacturing capacity	20,000	28,000	
Demand in external market	18,000	26,000	
S Ltd.'s demand	—	6,000	or zero

Assume that Divisions A and B will have to operate during the year.

What is the best strategy for:

- Department A?
- Department B, given that A will use its best strategy?
- For X Ltd. As a whole?

Advanced Management Accounting

Answer

	<i>Div A</i>	<i>B</i>	<i>B</i>
	<i>Rs. / unit</i>	<i>Rs. / unit</i>	<i>Rs. / unit</i>
Direct Material (Other than A)	50	24	
Direct Labour	25	14	
Variable Overhead (Production)	<u>20</u>	<u>2</u>	
Variable Production Cost (excl. A)	95	40	40
From A		144	
From Outside		_____	<u>160</u>
Variable production Cost / unit		184	200
Selling Price			
From outside	160	300	
Less: Selling Overhead	<u>13</u>	<u>26</u>	
Net Selling Price (outside)	<u>147</u>	<u>274</u>	
Net Selling Price to B	<u>144</u>		
Net Selling Price to S		<u>250</u>	
Net Selling Price (outside)	147	274	274
Variable Production Cost	<u>- 95</u>	<u>- 184</u>	<u>-200</u>
Contribution / unit (outside)	52	90	74
(Sale to B & S respectively)	144	250	250
Variable Production Cost	<u>-95</u>	<u>-184</u>	<u>-200</u>
Contribution / unit	<u>49</u>	<u>66</u>	<u>50</u>

Best strategy

A = Maximise Production; Sell maximum no. of units @ $18,000 \times 52 = 9,36,000$
52 / unit (outside)

(To B) remaining units $2,000 \times 49 = \underline{98,000}$

Total Contribution for A 10,34,000

Best strategy for B:

Maximise contribution / unit by selling outside and procuring from A 90 / unit

Contribution $\times$ 2,000 units

Balance units can yield contribution of either 74/ unit for outside or Rs. 50 / unit to S Ltd.

Production Capacity = 28,000.

	Option I	Option II
Outside Sales	Sales to S	Outside Sales $\times$ contribution / unit
$20,000 \times 74 = 14,80,000$	$6,000 \times 50 = 3,00,000$	$24,000 \times 74 = 17,76,000$
$2,000 \times 90 = 1,80,000$		$2,000 \times 90 = 1,80,000$
16,60,000	3,00,000	
Total Contribution	(16,60,000 + 3,00,000)19,60,000	19,56,000

(B) Choose Option I i.e. get 2,000 units from A, sell 6,000 units to S and 20,000 to outside. Make 28,000 units @ full capacity. Total Contribution Rs19,60,000.

If A and B are allowed to act independent of the group synergy,

Rs.

Total contribution	A – 10,34,000
	B – <u>19,60,000</u>
Total contribution for X Ltd.	<u>29,94,000</u>

Cost from X Ltd.'s Perspective

Variable Cost of production	Div A	Rs. 95
	Div B	
Variable cost of production other than A	40	40
A supplied by Division	95	
A – Variable Cost		
A purchased	<u>135</u>	<u>160</u>
	<u>135</u>	<u>200</u>

Option I	Outside 26,000 units	Option II
Outside $20,000 \times (274 - 135)$	27,80,000	$20,000 (274 - 135)$ 27,80,000
<u>$2,000 \times (274 - 200)$</u>	1,48,000	$6,000 (274 - 200)$ <u>4,44,000</u>
22,000		

Advanced Management Accounting

S Ltd. 6,000 units (250 – 200)	<u>3,00,000</u>	
	<u>32,28,000</u>	<u>32,24,000</u>

Choose Option I

Contribution = Rs. 32,28,000 for X Ltd. as a whole

Transfer (2,000 units)

Make A transfer all output to B. Sell 6,000 units of B to S and 22,000 units to outside market. This will make X Ltd. better off by $32,28,000 - 29,94,000 = \text{Rs } 2,34,000$

(i.e. 18,000 units of A sold to outside increases contribution to A by 3 Rs. / unit and decreases contribution to B by 16 Rs. / unit Net negative effect = $13 \times 18,000 = \text{Rs. } 2,34,000$).

Question 9

A large business consultancy firm is organized in to several divisions. One of the divisions is the Information Technology (IT) division which provides consultancy services to its clients as well as to the other divisions of the firm. The consultants in the IT divisions always work in a team of three professional consultants on each day of consulting assignment. The external clients are charged a fee at the rate of Rs. 4,500 for each consulting day. The fee represents the cost plus 150% profit mark up. The break up of cost involved in the consultancy fee is estimated at 80% as being variable and the balance is fixed.

The textiles division of the consultancy firm which has undertaken a big assignment requires the services of two teams of IT consultants to work five days in a week for a period of 48 weeks. While the director of the textiles division intends to negotiate the transfer price for the consultancy work, the director of IT division proposes to charge the textiles division at Rs. 4,500 per consulting day.

In respect of the consulting work of the textiles division, IT division will be able to reduce the variable costs by Rs. 200 per consulting day. This is possible in all cases of internal consultations because of the use of specialized equipment.

You are required to explain the implications and set transfer prices per consulting day at which the IT division can provide consultancy services to the textiles division such that the profit of the business consultancy firm as a whole is maximized in each of the following scenarios:

- (i) *Every team of the IT division is fully engaged during the 48 week period in providing consultancy services to external clients and that the IT division has no spare capacity of consultancy teams to take up the textiles division assignment.*

- (ii) *IT division will be able to spare only one team of consultants to provide services to the textiles division during the 48 week period and all other teams are fully engaged in providing services to external clients.*
- (iii) *A new external client has come forward to pay IT division a total fee of Rs. 15,84,000 for engaging the services of two teams of consultants during the aforesaid period of 48 weeks.*

Answer

Transfer Price is Rs. 4,500 for each consulting day.

Profit mark-up = 150%

Let cost = x

$$\text{Profit} = x \times \frac{150}{100}$$

$$= 1.5x$$

Cost + profit = Transfer price

$$\Rightarrow x + 1.5x = 4,500$$

$$\Rightarrow 2.5x = 4,500$$

$$\Rightarrow x = \frac{4,500}{2.5} = 1,800$$

$\therefore$ Cost = Rs. 1,800

and profit = $1.5x = 1.5 \times 1,800$

$$= \text{Rs. } 2,700$$

Variable cost (80%) = Rs. $1,800 \times 80\%$

$$= \text{Rs. } 1,440$$

Fixed cost (20%) = Rs. $1,800 \times 20\%$

$$= \text{Rs. } 360.$$

Scenario (i):

Every consultancy team is fully engaged. There is no idle time or spare capacity.

Hence, transfer price = Marginal cost plus opportunity cost

Marginal cost = Rs. 1,440

Saving for internal work = Rs. 200

Advanced Management Accounting

Net Marginal Cost = Rs. 1,240

Opportunity cost is the lost contribution.

Lost contribution = Contribution from external client

= Fee charged from external client – Variable cost

= Rs. (4,500 – 1,440)

= Rs. 3,060.

∴ Transfer price = Rs. 1,240 + 3,060

= Rs. 4,300 per consulting day per team.

Scenario (ii):

One team is idle. Idle time has no opportunity cost. Variable cost for internal work is Rs. 1,240 per consulting day. Second team is busy. Hence opportunity cost is relevant in case of second team. Hence charge of second team is Rs. 4,300 per consulting day per team.

Average of charge of two teams = Rs. (1,240 + 4,300) / 2

= Rs. 2,770 per consulting day per team.

Scenario (iii):

New client offers a fee of Rs. 15,84,000

Duration: 5 days of 48 weeks × 2 teams = 480 days

Fee per day 15,84,000 / 480 = Rs. 3,300

Variable cost = Rs. 1,440

Contribution Rs. (3,300 – 1,440) = Rs. 1,860

Fee for consulting day for internal work:

Variable cost = Rs. 1,240

Contribution lost = Rs. 1,860

Fee to be charged = Rs. 3,100 per consulting day per team.

Question 10

Tripod Ltd. has three divisions – X, Y and Z, which make products X, Y and Z respectively. For division Y, the only direct material is product X and for Z, the only direct material is product Y. Division X purchases all its raw material from outside. Direct selling overhead, representing commission to external sales agents are avoided on all internal transfers.

Division Y additionally incurs Rs. 10 per unit and Rs. 8 per unit on units delivered to external customers and Z respectively. Y also incurs Rs. 6 per unit picked up from X, whereas external suppliers supply at Y's factory at the stated price of Rs. 85 per unit.

Additional information is given below:

	Figures Rs./unit		
	X	Y	Z
Direct materials (external supplier rate)	40	85	135
Direct labour	30	50	45
Sales Agent's commission	15	15	10
Selling price in external market	110	170	240
Production capacity	20,000	30,000	40,000 units
External demand	14,000	26,000	42,000 units

You are required to discuss the range of negotiation for Managers X, Y and Z, for the number of units and the transfer price for internal transfers.

Answer

Analysis of range of negotiation for Manager of Division X

(Figures in Rs.)

(a)

Division X			
	Outside sales	Sales to Y (Range)	
Selling Price	110	70	— 79
(–) Commission	<u>15</u>	<u>—</u>	<u>—</u>
Net Selling Price	95	70	— 79
Variable Cost	<u>70</u>	<u>70</u>	— <u>70</u>
Contribution per unit	25	0	9
Units	14,000	6,000	6,000
Total contribution			
(Units × Contribution per unit)	<u>3,50,000</u>	0	54,000

Analysis of Range of negotiation for Manager of Division Y

Advanced Management Accounting

(Figures in Rs.)

Division Y							
Outside Sales				Sale to Z			
	From A	From outside		From A	From outside		
Price range	— 70	79	85	70	79	85	
Add: Transport	<u>6</u>	<u>6</u>	—	<u>6</u>	<u>6</u>	—	
	76	85	85	76	85	85	
Add: Direct Labour	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	
	126	135	135	126	135	135	
Add: Delivery cost	<u>10</u>	<u>10</u>	<u>10</u>	<u>8</u>	<u>8</u>	<u>8</u>	
	136	145	145	134	143	143	
Add: Sales Commission	<u>15</u>	<u>15</u>	<u>15</u>	—	—	—	
Total Cost	151	160	160	134	143	143	
Selling Price	<u>170</u>	<u>170</u>	<u>170</u>	<u>134</u>	<u>135</u>	<u>135</u>	
Contribution	19	10	10	<u>0</u>	<u>+1</u>	<u>(-) 8</u>	<u>(-) 8</u>

Range of Negotiations:

Manager of division X will sell 14,000 units outside at 110 Rs. per unit and earn contribution of Rs. 3.50 lakhs.

Excess capacity of 6,000 units can be offered to Y at a price between 70 (the variable manufacturing cost at X) and Rs. 95 (the maximum amount to equal outside contribution). But Y can get the material outside @ 85. So, y will not pay to X anything above (Rs.85 – 6) = Rs. 79 to match external available price.

X will be attracted to sell to Y only in the range of 71 – 79 Rs. per unit at a volume of 6,000 units.

At Rs. 70, X will be indifferent, but may offer to sell to Y to use idle capacity.

Z will not buy from Y at anything above 135. If X sells to Y at 70 per unit, Y can sell to Z at 134 and earn no contribution, only for surplus capacity and if units transferred by X to Y at Rs. 70 per unit.

	Y	Z
Provided X sells to Y at Rs. 70 per unit	Sell 4,000 units to Z at 134 (Indifferent)	Buy 4,000 units from y at 134 (attracted)
	Sell 4,000 units to Z at 135 (willingly for a contribution of Re. 1)	Indifferent, since market price is also 135

For buying from X at 71 – 79 price range, Y will be interested in selling to Z only at prices 136 – 143, which will not interest Z.

Thus Y will sell to Z only if X sells to Y at Rs. 70 per unit and Y will supply to Z maximum 4,000 units.

Question 11

Bearings Ltd. makes three products, A, B and C in Divisions A, Band C respectively. The following information is given:

	A	B	C
<i>Direct Materials (excluding material A for Divisions B and C)</i>	4	15	20 Rs./u
<i>Direct Labour</i>	2	3	4 Rs./u
<i>Variable overhead</i>	1	1	1 Rs./u
<i>Selling price to outside customers</i>	15	40	50 Rs./u
<i>Existing Capacity</i>	5,000	2,500	2,500 (No. of units)
<i>Maximum External demand</i>	3,750	5,000	4,000 (No. of units)
<i>Additional fixed costs that would be incurred to install additional capacity</i>	24,000	6,000	18,700 Rs.
<i>Maximum Additional units that can be produced by additional capacity</i>	5,000	1,250	2,250 (No. of units)

B and C need material A as their input. Material A is available outside at Rs.15 per unit. Division A supplies the material free from defects. Each unit of B and C requires one unit of A as the input material.

Advanced Management Accounting

If B purchases from outside, it has to pay Rs.15 per unit. If B purchases from A, it has to incur in addition to the transfer price, Rs.2 per unit as variable cost to modify it.

B has sufficient idle capacity to inspect its inputs without additional costs.

If C gets material from A, it can use it directly, but if it gets material from outside, which is at Rs.15, it has to do one of the following:

(i) Inspect it at its own shop floor at Rs.3 per unit

Or

(ii) Get the supplier to supply inspected products and pay the supplier Rs.2 p. u. as inspection charges.

Or

(iii) A has enough idle labour, which it can lend to C to inspect at Re 1 p.u. even though C purchases from outside.

A has to fix a uniform transfer price for both B and C. The transfer price will not be known to outsiders and is at the discretion of the Divisional Managers.

What is the best strategy for each division and the company as a whole?

Answer

B will not pay A anything more than 13, because at 13, it will incur additional cost of Rs.2/- to modify it, $13 + 2 = 15$, the outside cost.

	A		B	C
	Outside sale	Transfer to B & C		
Divisional variable cost of production	7	7	19	25
Transfer from A			13	13
Modification			2	
Total Variable Cost of production	7	7	34	38
Selling Price	15	13	40	50
Contribution	8	6	6	12

Option for C, Purchase all units from A @ 13: Any other option is costlier.

	A	B	C
Maximum external demand	3,750	5,000	4,000

Transfer Pricing

Existing capacity	5,000	2,500	2,500
Maximum capacity that can be added	5,000	1,250	2,250
Total maximum that can be produced	10,000	3,750	4,750
Additional fixed cost on expansion	24,000	6,000	18,700
Units that must be sold/transfer to get this amount as contribution	$\frac{24,000}{6} = 4,000$	$\frac{6,000}{6} = 1,000$	$\frac{18,700}{6} = 1,558.33$
External demand not covered by existing capacity	-	2,500	1,500
Decision	Expand make 10,000 units 3,750 – outside 3,750 – B 2,500 – C	Expand make 2,500 + 1,250 = 3,750 units	Do not expand make only 2,500 units.

	A		B	C
	Outside sale	Transfer to B & C		
Units	3,750	3,750 + 2,500 = 6,250	3,750	2,500
Contribution / unit	8	6	6	12
Contribution (Rs.)	30,000	37,500	22,500	30,000
	67,500		22,500	30,000
Additional Fixed Cost	24,000		6,000	-
Net revenue addition	43,500		16,500	30,000

Individual strategy is the Company's best strategy.

Question 12

Optically Ltd. makes two kinds of products, P (lenses) and Q (swimming goggles) in divisions P and Q respectively. P is an input for Q and two units of P are needed to make one unit of Q.

Advanced Management Accounting

The following data is given to you for a period :

	<i>P</i> Rs./u of P	<i>Q</i> Rs./u of Q
Direct Materials	20	25 (excluding P)
Direct Labour	30	35
Variable Overhead	10	20
External Demand (units)	3,000	3,000
Capacity (units)	7,000	2,500
Selling Price Rs./u (outside market)	100	410

If Q buys P from outside, it has the following costs:

For order quantity 2,499 or less Rs.90 per unit for the entire quantity ordered.

For order quantity 2,500 – 5,000 Rs.80 per unit for the entire quantity ordered.

For order quantity more than 5,000 Rs.70 per unit for the entire quantity ordered.

You are required to:

- Evaluate the best strategies for Division P and Q.
- Briefly explain the concept of goal congruence.

Answer

Opticals Ltd manufactures P (lenses) and Q (swimming goggles).

Division P has option to supply to Division Q or sell to outside market.

Division Q has option to buy from Division P or purchase from outside market.

However, both divisions have to work within their individual capacity.

Variable Cost for product P in Division P = Rs 60.

Variable cost for product Q in Division Q (excluding 2 Nos P's) = Rs 80.

Division P has better market price of its product P than the market price offered to Q division.

For maximizing profit of the organization : Rs

P division should optimise its profit by selling maximum units to outside market.

Contribution per unit for sale to outside for division P 40

Contribution per unit for Div Q as follows :

Sale price - Variable cost (excluding lenses) 330

Transfer Pricing

Max Contribution per unit (if procured from P div at its variable cost i.e Rs 60)	210
Min Contribution per unit (if procured at Rs 90 per unit from outside)	150
Contribution per unit at transfer price of Rs 70 i.e minimum market price	190

Option 1 : Division Q buys 5001 units from market @ Rs 70 and meets its capacity. Division P sells 3000 units to outside market @ Rs 100

Sale / Transfer	Contrib. /unit	Contribution in thousand rupees		
	Rs	P Div	Q Div	Total
DivP :Sale of 3000 units to outside market @ Rs 100	40	120		120
DivQ: Sale of 2500 units with P from market @ Rs 70	190		475	475
Less : cost of rejection of one unit of product P			-0.07	-0.07
Total		120	474.93	594.93

Option 2 : Division P sells 3000 units to outside market, transfer 4000 units to div Q and Division Q buys 1000 units from outside market to work within the capacity

P Division agrees to a transfer price so that profitability of Q is not affected. To maintain the same profitability of Q, contribution required from 2000 units for Div Q is Rs 400,000 i.e contribution per unit Rs 200 i.e transfer price per unit of P is Rs 65 per unit to make cost of lences Rs 130

Sale / Transfer	Contrib /unit	Contribution in thousand rupees		
	Rs	P Div	Q Div	Total
Div P : Sale of 3000 units to outside market	40	120		120
Div P : Transfer of 4000 units to div Q at Rs 65	5	20		20
Div Q :Sale of 2000 units with P from P div @ Rs 65	200		400	400
Div Q : Sale of 500 units with P from market @ Rs 90	150		75	75
Total		140	475	615

Under Option 1, both divisions worked dis-jointly without caring for capacity utilization resulting lower profitability of the organization.

Under Option 2, both divisions worked with mutual advantages for optimizing their individual profits and overall profit for the organization has gone up by effective utilization of capacity.

Product P from Division P fetches higher price from open market indicating good quality of product. Moreover, supply from P division is well assured in the long run which is the justification of establishment of two parallel divisions.

Advanced Management Accounting

Hence, Option 2 is suggested.

- (ii) Division functioning as profit centers strive to achieve maximum divisional profits, either by internal transfers or from outside purchase. This may not match with the organisation's objective of maximum overall profits. Divisions may be commercial to advice overall objects objectives, where divisional decisions are in line with the overall best for the company, and this is goal congruence. Divisions at a disadvantage may be given due weightage while appraising their performance. Goal incongruence defeats the purpose of divisional profit centre system.

Question 13

A company is organized on decentralized lines, with each manufacturing division operating as a separate profit centre. Each division manager has full authority to decide on sale of division's output to outsiders or to other divisions. Division AB manufactures a single standardized product. Some output is sold externally and remaining is transferred to division XY where it is a subassembly in the manufacture of the division product. The unit cost of division AB product and division XY is as follows:

	Division AB (Rs.)	Division XY (Rs.)
Transfer from division AB to XY	--	42.00
Direct Material	6.00	35.00
Direct Labour	3.00	4.50
Direct expenses	3.00	--
Variable manufacturing overheads	3.00	18.00
Fixed manufacturing overheads	6.00	18.00
Variable selling and packing expenses	3.00	2.50
	24.00	120.00

Division AB sold 40,000 units annually at the standard price of Rs.45 in external market. In additions to the external sales, 10,000 units are transferred annually to division XY at internal price of Rupees 42 per unit. Variable selling and packing expenses are not incurred by supplying division- for the internal transfer of the product. Division XY incorporates the transferred goods into more advance product. The manager of division XY disagrees with the basis used to set the transfer price. He argues that transfer price should be made at variable cost since he claims that his division is taking output that division AB should be unable to sell at price Rs.45.

He also submitted a report of the relationship between selling price and demand to support of his disagreement. The report of customer demand at various selling prices for division AB and for division XY is as follows:

Division AB

Selling price per unit (Rs.)	30	45	60
Demand (Units)	60,000	40,000	20,000

Division XY

Selling price per unit (Rs.)	120	135	150
Demand (Units)	15,000	10,000	5,000

The company has sufficient capacity to meet demand at various selling prices. Internal transfer demanded units will be decided by XY division.

Required:

- To calculate divisional profitability and overall profitability of company if division AB transfers demanded units to XY at price of Rs. 42.
- To calculate divisional profitability and overall profitability of company if division AB transfers demanded units to XY at variable cost.
- In place of internal transfers, AB division can sell 10,000 units of their product in new external market without effecting existing market, at price Rs. 32 per unit and XY division can purchase these units at the rate of Rs. 31 in open market. Calculate company's profit by following above strategies.

Answer

(i) AB sells product at external market

Selling price (Rs.)	30	45	60
Less Variable cost	18	18	18
Contribution (per unit)	12	27	42
Demands (units)	60,000	40,000	20,000
Total contribution	7,20,000	10,80,000	8,40,000

Optimal output is 40,000 units at a selling price of Rs.45

AB transfer at Rs.42 to XY division then contribution of XY

Selling price (Rs.)	120	135	150
Less Variable cost V+TP	102	102	102

Advanced Management Accounting

(42+60)			
Contribution (per unit)	18	33	48
Demands (units)	15,000	10,000	5,000
Total contribution	2,70,000	3,30,000	2,40,000

Manager will choose out put level 10,000 units at a selling price of Rs.135.

Overall profit when transfer made at Rs.42

Division AB contribution on 10,000 units $[42 - (18 - 3)]$	= 2,70,000
Division XY contribution 10,000 $(135 - 102)$	= <u>3,30,000</u>
Total contribution	= 6,00,000
Division AB contribution from external market sale	= <u>10,80,000</u>
Total profit	= <u>16,80,000</u>

(ii) AB transfer at variable cost

Selling price (Rs.)	120	135	150
Less Variable cost (15+60)	75	75	75
Contribution (per unit)	45	60	75
Demands (units)	15,000	10,000	5,000
Total contribution	6,75,000	6,00,000	3,75,000

Optimal is 15,000 units at the rate of 120 per unit.

If AB transfer at Variable cost (Rs.15) then no contribution will be generated by AB division

XY division choose 15,000 units level gives contribution $15,000 \times 45$	= 6,75,000
Division AB contribution from external market sale	= <u>10,80,000</u>
Total contribution	= <u>17,55,000</u>

(iii) Contribution AB division by selling 10,000 units to new external market at Rs.32 and XY division purchasing at Rs.31.

Contribution $(32 - 18) \times 10,000$	= 1,40,000
XY contribution $[135 - (31 + 60)]$	= 4,40,000
Division AB contribution from external market sale	= <u>10,80,000</u>
Total contribution	= <u>16,60,000</u>

Question 14

What should be the basis of transfer pricing, if unit variable cost and unit selling price are not constant?

Answer

If unit variable cost and unit selling price were not constant then the main problem that would arise while fixing the transfer price of a product would be as follows:

There is an optimum level of output for a firm as a whole. This is so because there is a certain level of output beyond which its net revenue will not rise. The ideal transfer price under these circumstances will be that which will motivate these managers to produce at this level of output.

Essentially, it means that some division in a business house might have to produce its output at a level less than its full capacity and in all such cases a transfer price may be imposed centrally.

Question 15

- (a) *What will be the marketable transfer pricing procedure regarding the goods transferred under the following conditions (each condition is independent of the other)?*
- (i) *When division are not captives of internal divisions and the divisions are free to do business both internally and externally and when there are reasonably competitive external markets for the transferred products.*
 - (ii) *If the external market for the transferred good is not reasonably competitive.*
- (b) *Discuss the potential for maximization of income by a multinational through the use of transfer pricing mechanism.*

Answer

(a) Marketable Transfer Pricing Procedure

- (i) When division are not captives of internal divisions and the divisions are free to do business both internally and externally and when there are reasonably competitive external markets for the transferred products, then the most suitable transfer price would be, the market price, as it generally leads to optimal decisions.
- (ii) In case, the external market for the transferred good is not reasonable competitive, following two situations may arise in this case.
 - (a) If there is idle capacity: Under this situation opportunity cost will be zero hence minimum transfer price should be equal to the additional

Advanced Management Accounting

outlay costs incurred upto the point of transfer (sometimes approximated by variable costs).

- (b) If there is no idle capacity: Under this situation opportunity cost should be added to outlay costs for determining minimum transfer price.
- (b) The potential for maximization of income by a multinational through the use of transfer pricing mechanism is based on the successful implementation of the following steps:
 - (i) Transfer pricing may be set relatively higher for affiliates in relatively high-tax countries that purchase inputs from affiliates located in relatively low-tax countries.
 - (ii) Transfer prices to affiliates in countries which are subject to import duties for goods or services purchase may be set low so as to avoid host country taxes.
 - (iii) Transfer prices to an affiliate in a country that is encountering relatively high inflation may be set relatively high to avoid some of the adverse effects of local currency devaluation that are related to the high inflation.
 - (iv) Transfer prices may be set high for goods and services purchased by an affiliate operating in a country that has imposed restriction on the repatriation of income to foreign companies.
 - (v) Transfer prices may be set low for an affiliate that is trying to establish a competitive advantage over a local company either to break into a market or to establish a higher share of the company's business.

EXERCISE**Question 1**

In transfer pricing what is common conflict between a division and the company as a whole.

Answer

Refer Chapter 8: Paragraph: 8.4

Question 2

A Company has two Division, Division 'A' and Division 'B'. Division 'A' has a budget of selling 2,00,000 nos. of a particular component 'x' to fetch a return of 20% on the average assets employed. The following particulars of Division 'A' are also known:

<i>Fixed Overhead</i>	<i>Rs.5 lakhs</i>
<i>Variable Cost</i>	<i>Re.1 per unit</i>
<i>Average Assets</i>	
<i>Sundry Debtors</i>	<i>Rs.2 lakhs</i>
<i>Inventories</i>	<i>Rs.5 lakhs</i>
<i>Plant & Equipments</i>	<i>Rs.5 lakhs</i>

However, there is constraint in Marketing and only 1,50,000 units of the component 'x' be directly sold to the proposed price.

It has been gathered that the balance 50,000 units of component 'x' can be taken up by Division 'B' Division 'A' wants a price of Rs.4 per unit of 'x' but Division 'B' is prepared to pay Rs.2 per unit of 'x'.

Division 'A' has another option in hand, which is to produce only 1,50,000 units of component 'x'. This will reduce the holding of assets by Rs.2 lakhs and fixed overhead by Rs.25,000.

You are required to advise the most profitable course of action for Division 'A'.

Answer

Most Profitable Course of Action: Sale to market and transfer to division B.

Question 3

Enumerate and briefly explain any three methods of determining transfer price.

Answer

Refer Chapter 8: Paragraph: 8.3.1

Advanced Management Accounting

Question 4

A company is organized on decentralized lines, with each manufacturing division operating as a separate profit centre. Each division manager has full authority to decide on sale of the division's output to outsiders and to other divisions.

Division C has always purchased its requirements of a component from Division A. But when informed that Division A was increasing its selling price to Rs.150, the manager of Division C decided to look at outside suppliers.

Division C can buy the component from an outside supplier for Rs.135. But Division A refuses to lower its price in view of its need to maintain its return on the investment.

The top management has the following information:

C's annual purchase of the component	1,000 units
A's variable costs per unit	Rs.120
A's fixed cost per unit	Rs.20

Required:

- (i) Will the company as a whole benefit, if Division C bought the component at Rs.135 from an outside supplier?
- (ii) If A did not produce the material for C, it could use the facilities for other activities resulting in a cash operating savings of Rs.18,000. Should C then purchase from outside sources?
- (iii) Suppose there is no alternative use of A's facilities and the market price per unit for the component drops by Rs.20. Should C now buy from outside?

Answer

(i)	Net cost (benefit) to the company as a whole	Rs. 15,000
(ii)	Net cost (benefit) to the company as a whole	Rs. (3,000)
(iii)	Net cost (benefit) to the company	Rs. (5,000)

Question 5

Division Z is a profit centre, which produces four products A, B, C and D. Each product is sold in the external market also. Data for the period is as follows:

	A	B	C	D
Market Price per unit	Rs.150	Rs.146	Rs.140	Rs.130
Variable cost of Production per Unit	Rs.130	Rs.100	Rs.90	Rs.85
Labour Hours required per Unit	3	4	2	3

Product D can be transferred to division Y but the maximum quantity that might be required for transfer is 2,500 units of D.

The maximum sales in the external market are:

A	2,800 units
B	2,500 units
C	2,300 units
D	1,600 units

Division Y can purchase the same product at a slightly cheaper price of Rs.125 per unit instead of receiving transfers of product D from division Z.

What should be transfer price for each unit for 2,500 units of D, if the total labour hours available in division Z are:

- (i) 20,000 hours?
- (ii) 30,000 hours?

Answer (i)

	2,500 units of product D	Per unit of Product D
Transfer price	2,95,850	118.34

(ii)

	2,500 units of product D	Per unit of Product D
Transfer price	2,47,833.20	99.13

Question 6

City Instrument Company (CIC) consists of the Semi-conductor Division and the Mini-computer Division, each of which operates as an independent profit centre. Semi-conductor Division employs craftsmen, who produce two different electronic components, the new – high performance Super chip and an older product called Okay-chip. These two products have the following cost characteristics:

	Super-chip		Okay-chip	
Material	Parts	Rs.20	Parts	Rs.10
Labour	2 hours × Rs.140	280	½ hours × Rs.140	70

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Annual Overhead in Semi-conductor Division is Rs.40,00,000 all fixed. Owing to high skill level necessary for the craftsmen, the Semi-conductor Divisions capacity is set at 50,000 hours per year.

To date, only one customer has developed a product utilizing super-chip, and this customer orders a maximum of 15,000 super-chips per year at a price of Rs.600 per chip. If CIC cannot meet his entire demand, the customer curtails his own production. The rest of the semi-conductor's capacity is devoted to Okay-chips, for which there is unlimited demand at Rs.120 per chip.

The Mini-computer Division produces only one product, a process control unit, which requires a complex circuit board imported at a price of Rs.600. The control units costs are:

Control Unit		
Material	Circuit board	Rs.600
	Other parts	80
Labour	5 hours @ Rs.100	500

The Mini-computer Division is composed of only a small assembly plant and all overhead is fixed at a total of Rs.8,00,000 per year. The current market price for the control unit is Rs.1,400 per unit.

A joint research project has just revealed that with minor modifications, a single super-ship could be substituted for the circuit board currently used by the Mini-computer Division. The modification would require an extra one-hour of labour by Mini-computer's staff, for a total of 6 hours per control unit. Mini-Computer has therefore asked Semi-conductor division to declare a transfer price at which Semi-conductor division would sell super-chip internally.

Required:

- (i) Mini-computer expects to sell 5,000 control units this year .From the overall view point of CIC, how many super-chips should be transferred to Mini-computer Division to replace circuit boards?*
- (ii) If the demand for the control units is sure to be 5,000 units, but its price is uncertain, what should be the transfer price of super-chip to ensure proper decisions? (All other data unchanged)*
- (iii) If demand for the control unit rises to 12,000 units at a price of Rs.1,400 per unit, how many of 12,000 units should be built using super-chip? (All other data unchanged.)*

Answer

1. Contribution per hour of Super-chips and Okay-chips:

	Super-chips	Okay-chips
Contribution per hour	150	80

2. hours utilized in meeting the demand of 15,000 units of Super-chips and utilizing the remaining hours for Okay-chips out of available hours of 50,000 per annum:

50000 Hours

3. Contribution of a process control unit (using an imported complex circuit board):

Contribution per unit (Rs.) :	220
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4. Contribution of process control unit (using a Super-chips):

Contribution per unit (Rs.) :	420
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Question 7

A Company is organised into two divisions. Division X produces a component, which is used by division Y in making of a final product. The final product is sold for Rs540 each. Division X has capacity to produce 2,500 units and division Y can purchase the entire production. The variable cost of division X in manufacturing each component is Rs256.50.

Division X informed that due to installation of new machines, its depreciation cost had gone up and hence wanted to increase the price of component to be supplied to division Y to Rs297, however division Y can buy the component from outside the market at Rs270 each. The variable cost of division Y in manufacturing the final product by using the component is Rs202.50 (excluding component cost).

Present the statement indicating the position of each Division and the company as whole taking each of the following situations separately:

- If there is no alternative use for the production facility of X, will the company benefit, if division Y buys from outside suppliers at Rs270 per component.*
- If internal facilities of X are not otherwise idle and the alternative use of the facilities will bring an annual cash saving of Rs50,625 to division X, should division Y purchase the component from outside suppliers?*
- If there is no alternative use for the production facilities of division X and the selling price for the component in the outside market drops by Rs20.25, should division Y purchase from outside supplier?*
- What transfer price would be fixed for the component in each of the above circumstances?*

Advanced Management Accounting

Answer

(i) When component is purchased by division Y from outside

Total contribution Rs. 1,68,750

When component is purchased from division X

Total contribution Rs. 2,02,500

(ii) When there is alternative use of Division X with given cash saving

Company's total contribution Rs. 2,19,375

(iii) When there is no alternative use of Division X & selling price of component reduces in the market

Total contribution Rs. 2,19,375

(iv) Transfer price

- (a) Where there is no alternative use of capacity of division X, then variable cost i.e. Rs256.50 per component will be charged.
- (b) If facilities of division X can be put to alternative use then variable cost Rs256.50+ opportunity cost Rs20.25 =Rs276.75 will be transfer price.
- (c) If market price gets reduced to Rs. 249.75 and there is no alternative use of facilities of Division X the variable cost Rs256.50 per component should be charged.

UNIFORM COSTING AND INTER FIRM COMPARISON

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Uniform Costing

When several undertakings start using the same costing principles and/or practices they are said to be following uniform costing. The basic idea behind uniform costing is that the different concerns in an industry should adopt a common method of costing and apply uniformly the same principles and techniques for better cost comparison and common good.

2. Objectives of Uniform Costing

- i. Facilitates Comparison
- ii. Eliminates Unhealthy Competition
- iii. Improves Efficiency
- iv. Provides Relevant Data
- v. Ensures Standardisation
- vi. Reduces Cost

3. Inter-Firm Comparison

It is technique of evaluating the performance, efficiency, costs and profits of firms in an industry. It consists of voluntary exchange of information/data concerning costs, prices, profits, productivity and overall efficiency among firms engaged in similar type of operations for the purpose of bringing improvement in efficiency and indicating the weaknesses.

4. Requisites of inter-firm comparison system

- i. Centre for Inter-Comparison
- ii. Membership
- iii. Nature of information to be collected
- iv. Method of Collection and presentation of information

Advanced Management Accounting

Question 1

What are the requisites for the installation of a uniform costing system ?

Answer

Requisites for the installation of uniform costing: Essential requisites for the installation of uniform costing are as under:

- (i) The firm's in the industry should be willing to share / furnish relevant data or information.
- (ii) A spirit of cooperation and mutual trust should prevail among the participating firms.
- (iii) Mutual exchange of ideas, methods used, special achievement made, research and know how etc. should be frequent.
- (iv) Bigger firms should take the lead towards sharing their experience and know how with the smaller firm to enable the latter to improve their performance.
- (v) In case of accounting methods, principles, procedure and production method uniformity must be established.

Question 2

What is uniform costing? Why is it recommended?

Answer

Uniform Costing: It is not a distinct method of costing when several undertakings start using the same costing principles or practices, they are said to be following uniform costing. Different concerns in an industry should adopt a common method of costing and apply uniformly the same principles and techniques for better cost comparison and common good and helps in mutual cost control and cost reduction. Hence, it is recommended that a uniform method of costing should be adopted by the member units of an industry.

EXERCISE

Question 1

What is inter-firm comparison and requisites of inter-firm comparison system?

Answer

Refer Chapter: 9 Paragraph: 9.2

Question 2

State the limitations of uniform costing.

Answer

Refer Chapter: 9 Paragraph: 9.1.4

Question 3

What are the advantages of inter firm comparison.

Answer

Refer Chapter: 9 Paragraph: 9.2.2

COST SHEET, PROFITABILITY ANALYSIS AND COMPARISON

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Cost Sheet

A Cost Sheet or Cost Statement is “a document which provides for the assembly of the detailed.

2. Cost of a Cost Centre

Cost of a Cost Centre or Cost Unit”. It is a detailed statement depicting the sub-division of cost arranged in a logical order under different heads.

3. Market driven standard costs

The allowable or target cost per unit is a market driven standard cost that has to be met if the desired profit are to be achieved.

4. Direct product profitability (DPP)

This is a new way of spreading overheads in retail organisations, which is used in the grocery trade in particular. DPP has become much more sophisticated and is now very similar to activity-based costing.

5. Categorisation of Indirect Costs for DPP

- i. Overhead cost
- ii. Volume related cost
- iii. Product batch cost
- iv. Inventory financing costs

6. Customer profitability analysis

This is a relatively new technique that ABC makes possible because it creates cost pools for activities. Customers use some activities but not all, and different groups of customers have different ‘activity profiles’. Different customers or

Advanced Management Accounting

categories of customers will each use different amounts of these activities and so customer profitability profiles can be built up, and customers can be charged according to the cost to serve them.

7. The Balanced Scorecard

The Balanced Scorecard can be defined as 'an approach to the provision of information to management to assist strategic policy formulation and achievement'. It emphasizes the need to provide the user with a set of information, which addresses all relevant areas of performance in an objective and unbiased fashion.

Question 1

"Costs may be classified in a variety of ways according to their nature and the information needs of the management" Explain.

Answer

Cost classification is the process of grouping costs according to their characteristics. Costs are classified or grouped according to their common characteristics. Costs may be classified according to elements, according to functions or operations, according to their behaviour, according to controllability or according to normality.

The break up of the aggregate costs into relevant types, is an essential pre-requisite of decision making as well as of controlling costs. Classification of costs on different bases is thus necessary for various purposes. For the purpose of decision-making and control, costs are distinguished on the basis of their relevance to different type of decisions and control functions. The importance of distinguishing cost as direct or indirect lies in the fact that direct costs of a product or an activity can be accurately allocated while indirect costs have to be apportioned on the basis of certain assumptions. This is so because direct costs are controllable at the operational level whereas indirect costs are not amenable to such control.

Question 2

A company produces and sells four types of dolls for children. It also produces and sells a set of dress kit for the dolls.

The company has worked out the following estimates for the next year:

Doll	Estimated Demand	Standard Material Cost (Rs.)	Standard Labour Cost Rs.	Estimated Sales Per Unit (Rs.)
A	50,000	20	15	60
B	40,000	25	15	80

Cost Sheets, Profitability Analysis and Comparison

C	35,000	32	18	100
D	30,000	50	20	120
Dress Kit	2,00,000	15	5	50

To encourage the sale of dress kits, a discount of 20% in its price is offered if it were to be purchased along with the doll. It is expected that all the customer, buying dolls will also buy the dress kit.

The company's factory has effective capacity of 2,00,000 labour hours per annum on a single-shift basis and it produces all the products on that basis. The labour hour rate is Rs.15 Overtime of labour has to be paid at double the normal rate.

Variable cost works out to 50% of direct labour cost. Fixed costs are Rs.30 lakhs per annum.

There will be no inventory at the end of the year.

You are to draw a conservative estimate of the year's profitability.

Answer**Working notes:**

- Total labour hours required to meet estimated demand of four types of dolls and their dress kit:

Doll	Estimated Demand (units)	*Std labour time per doll	Total labour hours
(a)	(b)	(c)	(d) = (b) × (c)
A	50,000	1 hr	50,000.00
B	40,000	1 hr	40,000.00
C	35,000	1.2 hrs	42,000.00
D	30,000	1.33 hrs	40,000.00
Dress Kit	2,00,000	0.33 hrs	66,666.66
Total labour hours to meet estimated demand			2,38,666.66

*Standard labour time per doll has been calculated by dividing standard labour cost (per doll) by Rs.15.

Since the total available hours are only 2,00,000 therefore 38,666.66 hours will be utilised by employing the labour on overtime basis.

Advanced Management Accounting

2. Total discount on the sale of dress kit.

Out of 2,00,000 dress kits, 1,55,000 were sold along with four type of dolls. Each unit of sale of dress kit along with a unit of doll is entitled for a discount of 20% of Rs.50 i.e. Rs.10. The total discount amount on the sale of 1,55,000 dress kit comes to Rs.15,50,000.

Statement of Conservative Estimate of the Year's Profitability

		<i>Doll A</i>	<i>Doll B</i>	<i>Doll C</i>	<i>Doll D</i>	<i>Dress Kit</i>
Estimated demand (units)		50,000	40,000	35,000	30,000	2,00,000
		Rs.	Rs.	Rs.	Rs.	Rs.
Selling price per unit: (A)		60	80	100	120	50
Material cost per unit		20	25	32	50	15
Labour cost		15	15	18	20	5
Variable cost		6	6	7.20	8	2
*40% of labour cost		—	—	—	—	—
Total marginal cost: (B)		41	46	57.20	78	22
Contribution p.u. (C):{(A) – (B)}		19	34	42.80	42	28
Total contribution		<u>9,50,000</u>	<u>13,60,000</u>	<u>4,98,000</u>	<u>12,60,000</u>	<u>56,00,000</u>
On estimated demand		(50,000× Rs.19)	(40000× Rs.34)	(35000× Rs.42.80)	(30000× Rs.42)	(200000× Rs.28)
Less: Discount on dress kits (Refer to working note 2)						(15,50,000)
Net contribution		<u>9,50,000</u>	<u>13,60,000</u>	<u>4,98,000</u>	<u>12,60,000</u>	<u>40,50,000</u>
Total net contribution (Rs.)			91,18,000			
Less: Overtime premium (Rs.) (38,666.66 hrs × Rs.)15 (Refer to working note 1)			5,80,000			
Less: Fixed cost (Rs.)			<u>30,00,000</u>			
Profit (Rs.)			<u>55,38,000</u>			

Question 3

What do you understand by a Balanced Scorecard? Give reasons why Balanced Scorecards sometimes fail to provide for the desired results. Do you think that such a scorecard is useful for external reporting purposes?

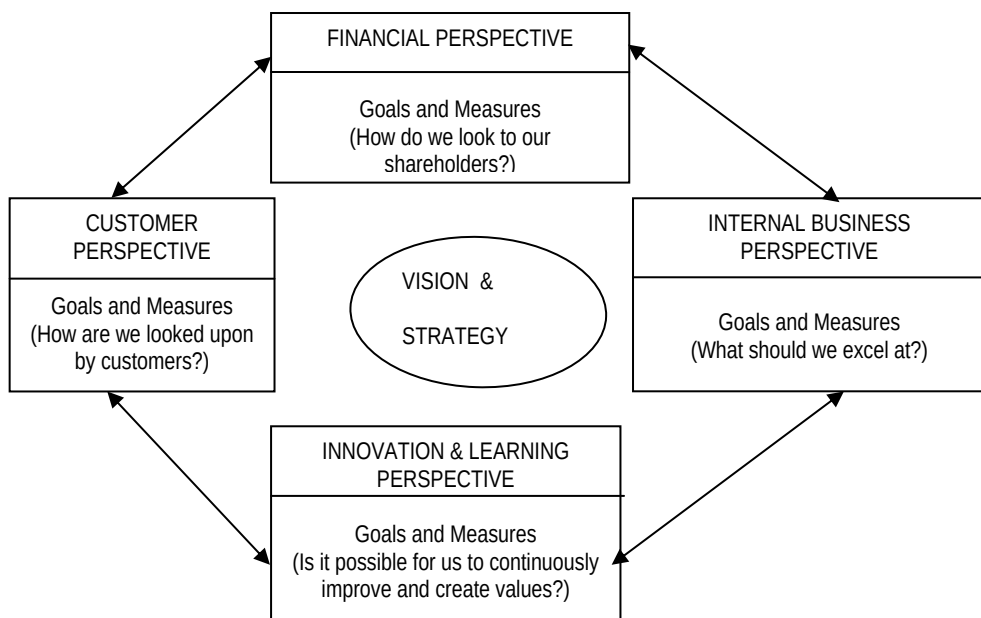
Answer

The Balanced Scorecard can be defined as 'an approach to the provision of information to management to assist strategic policy formulation and achievement. It emphasises the need to provide the user with a set of information, which addresses all relevant areas of performance in an objective and unbiased fashion. The information provided may include both financial and non financial elements, and cover areas such as profitability, customer satisfaction, internal efficiency and innovation'.

It is clear from the above definition that the central idea of the Balanced Scorecard is that managers should develop the measures on which they manage the business from four different perspectives:

1. customer satisfaction
2. internal business process e.g., operating cycle time.
3. kaizen approach (can we continue to improve and create value)
4. financial e.g., operating income by segments.

The following figure summarises the ideas of a Balanced Scorecard:



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According to Kaplan and Norton, the ultimate result of using the Balanced Scorecard approach should be an improved long-term financial performance. Since the scorecard gives equal importance to the relevant non – financial measures, it should discourage the short termism that leads to cuts in spending on new product development, human resource development etc which are ultimately detrimental for the future prospects of the company.

The responsibility to devise and implement a Balanced Scorecard should be that of the managers working with the business. Since every company is different, it shall need to work out for itself the various financial and non – financial measures, which need to be focussed upon for its own development. Since the Balanced Scorecard is recommended as a management tool used both for internal and external reporting purposes, it is again the manager's responsibility to decide as to what information needs to be disclosed and how any problems of confidentiality can best be overcome.

The following are some reasons why Balanced Scorecards sometimes fail to provide for the desired results;

- The use of non financial measures leads managers to think that they have a Balanced Scorecard already working for strategic purposes.
- Senior executives misguidedly delegate the responsibility of the Scorecard implementation to middle level managers.
- Company's try to copy measures and strategies used by the best companies rather than developing their own measures suited for the environment under which they function.
- There are times when Balanced Scorecards are thought to be meant for reporting purposes only. This notion does not allow a Business to use the Scorecard to manage Business in a new and more effective way.

It may be noted that the above-mentioned difficulties refer to the internal use of the Scorecard. It remains a matter of debate whether a Balanced Scorecard is applicable to external reporting. Critics argue that if the Scorecard is indeed a relevant driver of long term performance, shouldn't the information generated be of interest to the investment community? However, it has been noticed that the Scorecard does not translate easily to the investment community for the simple reason that it makes sense for individual business units and different individual projects rather than the company as a whole. Most companies have different divisions with their own mission and strategy and hence these individual scorecards cannot be aggregated into an overall corporate scorecard. However, in case the company somehow manages to overcome such a problem and indeed use its Scorecard for external reporting, it may end up passing sensitive information to its competitors which may end up being detrimental to the company in the long run. However,

Cost Sheets, Profitability Analysis and Comparison

with changes in the thinking process of the investment community, such strategic reporting could well be accepted in the near future.

For a further understanding of the concept, please refer to chapter 14 of the Institute's Cost Management book.

Question 4

Kitchen King company makes a high-end kitchen range hood 'Maharaja'. The company presents the data for the year 2007 and 2008:

	2007	2008
1. Units or maharaja produced and sold	40,000	42,000
2. Selling Price per unit in Rs.	1,000	1,100
3. Total Direct Material (Square feet)	1,20,000	1,23,000
4. Direct material cost per square feet in Rs.	100	110
5. Manufacturing Capacity (in units)	50,000	50,000
6. Total Conversion cost in Rs.	1,00,00,000	1,10,00,000
7. Conversion cost per unit of capacity (6)/(5)	200	220
8. Selling and customer service capacity	300 customer	290 customer
9. Total selling and customer service cost in Rs.	72,00,000	72,50,000
10. Cost per customer of selling and customer service capacity (9)/(8)	24,000	25,000

Kitchen King produces no defective units, but it reduces direct material used per unit in 2008. Conversion cost in each year depends on production capacity defined in terms of Maharaja units that can be produced. Selling and Customer service cost depends on the number of customers that the selling and service functions are designed to support. Kitchen King has 230 customers in 2007 and 250 customers in 2008.

You are required

1. Describe briefly key elements that would include in Kitchen King's Balance Score Card.
2. Calculate the Growth, Price-recovery and productivity component that explain the change in operating income from 2007 to 2008.

Answer

Kitchen King's Score card should describe its product differentiation strategy. The key points that should be included in its balance score card are:

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- Financial Perspective – Increase in operating income by charging higher margins on Maharaja.
- Customer Perspective – Market share in high-end kitchen range market and customer satisfaction.
- Internal business Perspectives: Manufacturing quality, order delivery time, on time delivery and new product feature added.
- Learning and Growth Perspective: Development time for designing new end product and improvement in manufacturing process.

Operative Income:

	<i>(Amount in 000' Rs.)</i>	
	2007	2008
Revenue (40,000 × 1,000: 42,000 × 1,100)	40,000	46,200
Direct Material	12,000	13,530
Conversion cost	10,000	11,000
Selling and Customer service	7,200	7,250
Total cost	29,200	31,780
Operative Income	10,800	14,420

Change in operating Income is Rs. 36,20,000 (F)

A. Growth Component

- (a) Revenue effect = Output Price in 2007 {Actual units sold in 08 – Actual units sold in 07}
- $$= \text{Rs. } 1,000 (42,000 \text{ units} - 40,000 \text{ units})$$
- $$= \text{Rs. } 20,00,000 \text{ (F)}$$
- (b) The cost effect = Input price in 2007 {Actual units of input to produce 2007 output less Actual units of input which would have been used to produce year 2008 output on the basis of 2007}
- (i) Direct Material = Rs. 100 [1, 20,000 sq.ft. – 1, 20,000 sq.ft. $\times \frac{42,000 \text{ units}}{40,000 \text{ units}}$]
- $$= \text{Rs. } 6,00,000 \text{ (A)}$$

Cost Sheets, Profitability Analysis and Comparison

- (ii) Conversion cost and selling and customer service will not change since adequate capacity exists in 2007 to support 2008 output and customers. Hence variance

$$\text{Conversion cost} = 200 (50,000 - 50,000) = 0$$

$$\text{S \& Customer Service} = 25,000 (300 - 300) = 0$$

Increase in operating effect of Growth component is Rs. 14,00,000 (F)

B. Price recovery Component:

- (i) Revenue effect = Actual output in 2008 [Selling price per unit in 2008 less Selling price per unit in 2007]
 = 42,000 units (Rs. 1,100 – Rs. 1,000)
 = Rs. 42,00,000 (F)

- (ii) Cost effect = Unit of input based on 2007 actual that would have been used to produce 2008 output {Input prices per unit in 2007 less Input prices per unit in 2008}

(a) Direct material = 1,26,000 sq. ft. (Rs. 100/sq. ft. – Rs. 110/sq. ft.)
 = Rs. 12,60,000 (A)

(b) Conversion Cost = 50,000 units (Rs. 200/unit – Rs. 220/unit)
 = Rs. 10,00,000 (A)

(c) S & Customer Service = 300 customers (Rs. 24,000 – Rs. 25,000)
 = Rs. 3,00,000 (A)
 = Rs. 25,60,000 (A)

Increase in Operating income due to Price Recovery is Rs. 16,40,000 (F)
 {Rs. 42,00,000 – Rs. 25,60,000}

(C) Productivity Component

Productivity component = Input Prices in 08{Actual units of input which would have been used to produce year 2008 output on the basis of 2007 actual less Actual Input}

(i) Direct Material: Rs. 110/sqft
 (1,26,000 units – 1,23,000 units) = Rs. 3,30,000 (F)

(ii) Conversion Cost: Rs. 200/unit
 (50,000 units – 50,000 units) = 0

Advanced Management Accounting

- (iii) Selling & Customer = Rs. 25,000
 (300 customers – 290 customers) = Rs. 2,50,000 (F)
 = Rs. 5,80,000 (F)

The change in operating income from 2007 to 2008 is analysed as follows:

	(Amount in 000' Rs.)				
	2007	Growth component	Price recovery	Cost effect of productivity component	2008
Revenue	40,000	2,000 (F)	4,200 (F)	—	46,200
Cost	29,200	600 (A)	2,560 (A)	580 (F)	31,780
Operating Income	10,800	1,400(F)	1,640 (F)	580 (F)	14,420

Question 5

EXE Wood Company is a metal and woodcutting manufacturer, selling products to the home construction market. Consider the following data for 2008:

	Rs.
Sandpaper	1,000
Materials-handling costs	35,000
Lubricants and coolants	2,500
Miscellaneous indirect manufacturing labour	20,000
Direct manufacturing labour	1,50,000
Direct materials inventory, Jan. 1, 2008	20,000
Direct materials inventory, Dec. 31, 2008	25,000
Finished goods inventory, Jan. 1, 2008	50,000
Finished goods inventory, Dec. 31, 2008	75,000
Work in process inventory, Jan. 1, 2008	5,000
Work in process inventory, Dec. 31, 2008	7,000
Plant-leasing costs	27,000
Depreciation – plant equipment	18,000
Property taxes on plant equipment	2,000
Fire insurance on plant equipment	1,500

Cost Sheets, Profitability Analysis and Comparison

Direct materials purchased	2,30,000
Revenues	6,80,000
Marketing promotions	30,000
Marketing salaries	50,000
Distribution costs	35,000
Customer-service costs	50,000

Required:

1. Prepare an income statement with a separate supporting schedule of cost of goods manufactured. For all manufacturing items, classify costs as direct costs or indirect costs and indicate by V or F whether each is basically a variable cost or a fixed cost (when the cost object is a product unit). If in doubt, decide on the basis of whether the total cost will change substantially over a wide range of units produced.
2. Suppose that both the direct material costs and the plant-leasing costs are for the production of 4,50,000 units. What is the direct material cost of each unit produced ? What is the plant-leasing cost per unit ? Assume the plant-leasing cost is a fixed cost.
3. Suppose EXE Wood Company manufactures 5,00,000 units next year. Repeat the computation in requirement 2 for direct materials and plant-leasing costs. Assume the implied cost-behaviour patterns persist.

Answer

1. EXE Wood Company			
Income Statement			
For the year ended December 31, 2008			
		<i>Rs.</i>	<i>Rs.</i>
Revenues			6,80,000
Cost of goods sold:			
Beginning finished goods, January 1, 2008	50,000		
Cost of goods manufactured (see schedule below)	<u>4,80,000</u>		
Cost of goods available for sale	5,30,000		
Deduct ending finished goods, December 31, 2008	<u>75,000</u>		<u>4,55,000</u>

Advanced Management Accounting

Gross margin (or gross profit)		2,25,000
Operating costs		
Marketing promotions	30,000	
Marketing salaries	50,000	
Distribution costs	35,000	
Customer-service costs	<u>50,000</u>	<u>1,65,000</u>
Operating income		<u>60,000</u>

EXE Wood Company
Schedule of Cost of Goods Manufactured
For the year ended December 31, 2008

	<i>Rs.</i>	<i>Rs.</i>
Direct materials:		
Beginning inventory, January 1, 2008		20,000
Purchases of direct materials		<u>2,30,000</u>
Cost of direct materials available for use		2,50,000
Ending inventory, December 31, 2008		<u>25,000</u>
Direct materials used		2,25,000 (v)
Direct manufacturing labour		1,50,000 (v)
Manufacturing overhead costs:		
Sandpaper	1,000 (v)	
Materials-handling costs	35,000 (v)	
Lubricants and coolants	2,500 (v)	
Miscellaneous indirect manufacturing labour	20,000 (v)	
Plant-leasing costs	27,000 (F)	
Depreciation – plant equipment	18,000 (F)	
Property taxes on plant equipment	2,000 (F)	
Fire insurance on plant equipment	<u>1,500 (F)</u>	<u>1,07,000</u>
Manufacturing costs incurred during 2007		4,82,000
Beginning work in process, January 1, 2007		<u>5,000</u>

Cost Sheets, Profitability Analysis and Comparison

Total manufacturing costs to account for	4,87,000
Ending work in process, December 31, 2007	<u>7,000</u>
Cost of goods manufactured (to income statement)	4,80,000

2. Direct material unit cost = direct materials used ÷ Units produced
= Rs. 2,25,000 ÷ 4,50,000 units = Re. 0.50 per unit

Plant-leasing unit cost = Plant-leasing costs ÷ Units produced
= Rs. 27,000 ÷ 4,50,000 units = Re. 0.06 per unit
3. The direct material costs are variable, so they would increase in total from Rs. 2,25,000 to Rs. 2,50,000 (5,00,000 units × Re. 0.50 per unit). However, their unit cost would be unaffected: Rs. 2,50,000 ÷ 5,00,000 units = Re. 0.50 per unit.

In contrast, the plant-leasing costs of Rs. 27,000 are fixed, so they would not increase in total. However, the plant leasing cost per unit would decline from Re. 0.060 to Re. 0.054: Rs. 27,000 ÷ 5,00,000 units = Re. 0.054 per unit.

Note: All the Questions are arranged in a sequence as per the syllabus of 'Advanced Management Accounting' (AMA) [Paper 5 of Final (New) Course]. This RTP contains chapter name followed by the topic against each theory/practical question

Advanced Management Accounting

EXERCISE**Question 1**

The trading results of ZED Ltd. for 1995-96 and 1996-97 are as follows:

	1995-96	1996-97
	Rs.	Rs.
Material	1,60,000	2,05,200
Wages	96,000	1,32,000
Variable Overheads	40,000	46,000
Fixed Overheads	50,000	54,800
Total Costs	3,46,000	4,38,000
Profit	54,000	90,000
Sales	4,00,000	5,28,000

Selling price was enhanced by 10% 1996-97. Material prices and wage rates too have increased by 8% respectively.

Prepare a statement showing how much each factor has contributed to the variation in profit.

Answer

2. Rise in the figure of sales volume in 1996-97 = Rs.80,000
3. Percentage rise in the figure of sales volume in 1996-97 = 20%
4. Increase in material prices in 1996-97 due to 8% price increase = Rs.15,200
5. Increase in wages due to 10% increase in wage rates = Rs.12,000

Question 2

“Balanced score card and performance measurement system endeavours to create a blend of strategic measures, outcomes and drive measures and internal and external measures”. Discuss the statement and explain the major components of a balanced score card.

Answer

Refer to Chapter 10: Paragraph 10.4

Question 3

What are the elements of a Balanced Score card? Also explain how it can be used as a Financial Planning model.

Answer

Refer to Chapter 10: Paragraph: 10.4

LINEAR PROGRAMMING

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Linear Programming

Linear programming is a mathematical technique for determining the optimal allocation of re- sources nd achieving the specified objective when there are alternative uses of the resources like money, manpower, materials, machines and other facilities.

2. Categories of the Linear Programming Problems

- i. General Linear Programming Problems.
- ii. Transportation Problems.
- iii. Assignment Problems.

3. Methods of Linear Programming

- i. Graphical Method
- ii. Simplex Method

4. Graphical Method

It involves the following:

- i. Formulating the linear programming problem
- ii. Plotting the capacity constraints on the graph paper.
- iii. Identifying feasible region and coordinates of corner points.
- iv. Testing the corner point which gives maximum profit.
- v. For decision – making purpose, sometimes, it is required to know whether optimal point leaves some resources unutilized.

5. Extreme Point Theorem

It states that an optimal solution to a LPP occurs at one of the vertices of the feasible region.

Advanced Management Accounting

6. Basis theorem

It states that for a system of m equations in n variables (where $n > m$) has a solution in which at least $(n-m)$ of the variables have value of zero as a vertex. This solution is called a basic solution.

7. The Simplex Method

The simplex method is a computational procedure - an algorithm - for solving linear programming problems. It is an iterative optimizing technique.

8. The Simplex Method for Minimization and Maximization Problems

The simplex algorithm applies to both maximization and minimization problems. The only difference in the algorithm involves the selection of the incoming variable. In the maximization problem the incoming variable is the one with highest +ve net evaluation row (NER) element. Conversely, it is the most - ve variable that is selected as the incoming variable in a minimization problem. And if all elements in the NER are either positive or zero, it is the indication for the optimal solution.

9. Practical Application of Linear Programming

1. Industrial Application: To derive the optimal production and procurement plan for specific time period.
2. Administrative Application: in both academic circles and the area of business operations.

Question 1

A farm is engaged in breeding pigs. The pigs are fed on various products grown in the farm. In view of the need to ensure certain nutrient constituents (call them X, Y and Z), it becomes necessary to buy two additional products say, A and B. One unit of product A contains 36 units of X, 3 units of Y and 20 units of Z. One unit of product B contains 6 units of X, 12 units of Y and 10 units of Z. The minimum requirement of X, Y and Z is 108 units, 36 units and 100 units respectively. Product A costs Rs.20 per unit and product B Rs.40 per unit.

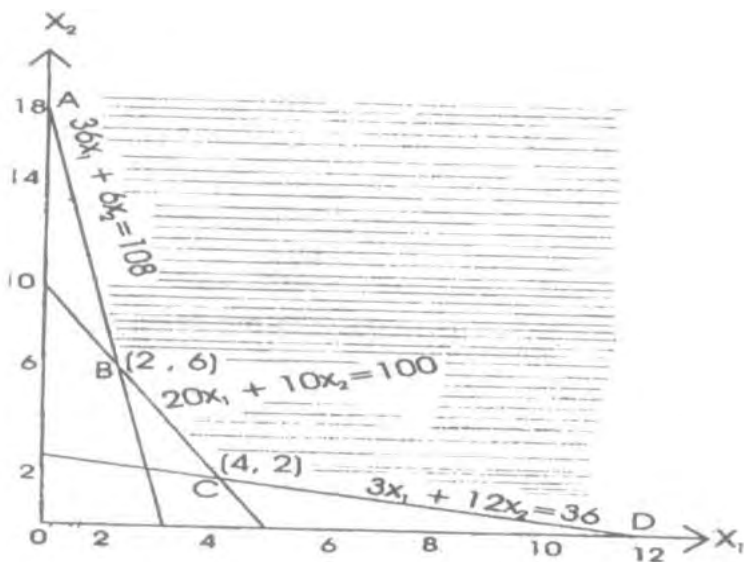
Formulate the above as a linear programming problem to minimize the total cost and solve this problem by using graphic method.

Answer

The data of the given problem can be summarized as under:

Nutrient constituents	Nutrient content in product		Minimum requirement of nutrient
	A	B	
X	36	06	108
Y	03	12	36
Z	20	10	100
Cost of product	Rs.20	Rs.40	

Let x_1 units of product A and x_2 units of product B are purchased. Making use of the above table, the required mathematical formulation of L.P. problem is as given below:



Minimize $Z = 20x_1 + 40x_2$ subject to the constraints

$$36x_1 + 6x_2 \geq 108$$

$$3x_1 + 12x_2 \geq 36$$

$$20x_1 + 10x_2 \geq 100$$

$$\text{and } x_1, x_2 \geq 0$$

For solving the above problem graphically, consider a set of rectangular axis x_1Ox_2 in the plane. As each point has the coordinates of type (x_1, x_2) , any point satisfying the conditions $x_1 \geq 0$ and $x_2 \geq 0$ lies in the first quadrant only.

Advanced Management Accounting

The constraints of the given problem as described earlier are plotted by treating them as equations:

$$36x_1 + 6x_2 = 108$$

$$3x_1 + 12x_2 = 36$$

$$20x_1 + 10x_2 = 100$$

Or

$$\frac{x_1}{2} + \frac{x_2}{18} = 1$$

$$\frac{x_1}{12} + \frac{x_2}{3} = 1$$

$$\frac{x_1}{5} + \frac{x_2}{10} = 1$$

The area beyond these lines represents the feasible region in respect of these constraints, any point on the straight lines or in the region above these lines would satisfy the constraints. The coordinates of the extreme points of the feasible region are given by

A = (0,18), B = (2,6), C = (4,2) and D = (12,0)

The value of the objective function at each of these points can be evaluated as follows:

Extreme Point	(x ₁ , x ₂)	Z = 20x ₁ + 40x ₂	
A	(0,18)	720	
B	(2,6)	280	
C	(4,2)	160	Minimum ←
D	(12,0)	240	

The value of the objective function is minimum at the point C (4,2).

Hence, the optimum solution is to purchase 4 units of product A and 2 units of product B in order to have minimum cost of Rs.160.

Question 2

A Computer Company produces three types of models, which are first required to be machined and then assembled. The time (in hours) for these operations for each model is give below:

Linear Programming

Model	Machine Time	Assembly Time
P III	20	5
P II	15	4
Celeron	12	3

The total available machine time and assembly time are 1,000 hours and 1,500 hours respectively. The selling price and other variable costs for three models are:

	P III	P II	Celeron
Selling Price (Rs.)	3,000	5,000	15,000
Labour, Material and other Variable Costs (Rs.)	2,000	4,000	8,000

The company has taken a loan of Rs.50,000 from a Nationalised Bank, which is required to be repaid on 1.4.2001. In addition, the company has borrowed Rs.1,00,000 from XYZ Cooperative Bank. However, this bank has given its consent to renew the loan.

The balance sheet of the company as on 31.3.2001 is as follows:

Liabilities	Rs.	Assets	Rs.
Equity Share Capital	1,00,000	Land	80,000
Capital reserve	20,000	Buildings	50,000
Profit & Loss Account	30,000	Plant & Machinery	1,00,000
Long-term Loan	2,00,000	Furniture etc.	20,000
Loan from XYZ Cooperative Bank	1,00,000	Cash	2,10,000
Loan from Nationalized Bank	50,000		
Total	5,00,000	Total	5,00,000

The company is required to pay a sum of Rs.15,000 towards the salary. Interest on long-term loan is to be paid every month@ 18% per annum. Interest on loan from XYZ Cooperative and Nationalised Banks may be taken as Rs.1,500 per month. The company has already promised to deliver three P III, Two P II and five Celeron type of computers to M/s. ABC Ltd. next month. The level of operation I the company is subject to the availability of cash next month.

The Company Manager is willing to know that how many units of each model must be manufactured next month, so as to maximize the profit.

Advanced Management Accounting

Formulate a linear programming problem for the above.

Answer

Let X_1 , X_2 and X_3 denote the number of P III, P II and Celeron computers respectively to be manufactured in the company. The following data is given:

	P III	P II	Celeron
Selling price per unit (Rs.)	3,000	5,000	15,000
Labour Material & other Variable cost per unit (Rs.)	2,000	4,000	8,000
Profit per unit (Rs.)	1,000	1,000	7,000

Since the company wants to maximize the profit, hence the objective function is given by:

$$\text{Maximize } Z = 1,000X_1 + 1,000X_2 + 7,000X_3 - (\text{Rs.}15,000 + 3,000 + \text{Rs.}1,500)$$

From the data given for time required for various models and the total number of hours available for machine time and assembly time, we get the following constraints:

$$20X_1 + 15X_2 + 12X_3 \leq 1,000 \text{ (Machine Time Restriction)}$$

$$5X_1 + 4X_2 + 3X_3 \leq 1,500 \text{ (Assembly Time Restriction)}$$

The level of operations in the company is subject to availability of cash next month i.e.; the cash required for manufacturing various models should not exceed the cash available for the next month.

The cash requirements for X_1 units of P III, X_2 units of P II and X_3 units of Celeron computers are:

$$2,000 X_1 + 4,000 X_2 + 8,000 X_3 \quad \dots\dots(1)$$

The cash availability for the next month from the balance sheet is as below:

Cash availability (Rs.)	=	Cash balance (Rs.2,10,000)
		- Loan to repay to Nationalized Bank (Rs.50,000)
		- Interest on loan from XYZ Cooperative bank and Nationalized bank (Rs.1,500)
		- Interest on long term loans $\left(\frac{0.18 \times 2,00,000}{12} \right)$
		- Salary to staff (Rs.15,000)

$$\begin{aligned} \text{or, Cash availability} &= \text{Rs.}2,10,000 - (\text{Rs.}50,000 + \text{Rs.}1,500 + \text{Rs.}3,000 + 15,000) \\ &= \text{Rs.}1,40,500 \qquad \qquad \qquad \dots\dots(2) \end{aligned}$$

Thus, from (1) and (2),

$$2,000 X_1 + 4,000 X_2 + 8,000 X_3 \leq \text{Rs.}1,40,500$$

The company has also promised to deliver 3 P III, 2 P II and 5 Celeron computers to M/s Kingspen Ltd.

$$\text{Hence, } X_1 \geq 3, X_2 \geq 2, X_3 \geq 5$$

The LP formulation of the given problem is as follows:

$$\text{Maximize } Z - 1,000 X_1 + 1,000 X_2 + 7,000 X_3 - (\text{Rs.}15,000 + \text{Rs.}3,000 + \text{Rs.}1,500)$$

Subject to the constraints:

$$20 X_1 + 15 X_2 + 12 X_3 \leq 1,000$$

$$5 X_1 + 4 X_2 + 3 X_3 \leq 1,500$$

$$2,000 X_1 + 4,000 X_2 + 8,000 X_3 \leq \text{Rs.}1,40,500$$

$$X_1 \geq 3, X_2 \geq 2, X_3 \geq 5$$

X_1, X_2 and X_3 can take only positive integral values.

Question 3

Computer Company produces three types of models, which are first required to be machined and then assembled. The time (in hours) for these operations for each model is given below:

Model	Machine Time	Assembly Time
P III	20	5
P II	15	4
Celeron	12	3

The total available machine time and assembly time are 1,000 hours and 1,500 hours respectively. The selling price and other variable costs for three models are:

	P III	P II	Celeron
Selling Price (Rs.)	3,000	5,000	15,000
Labour, Material and other Variable Costs (Rs.)	2,000	4,000	8,000

Advanced Management Accounting

The company has taken a loan of Rs.50,000 from a Nationalised Bank, which is required to be repaid on 1.4.2001. In addition, the company has borrowed Rs.1,00,000 from XYZ Cooperative Bank. However, this bank has given its consent to renew the loan.

The balance sheet of the company as on 31.3.2001 is as follows:

Liabilities	Rs.	Assets	Rs.
Equity share Capital	1,00,000	Land	80,000
Capital reserve	20,000	Buildings	50,000
Profit & Loss Account	30,000	Plant & Machinery	1,00,000
Long-term Loan	2,00,000	Furniture etc.	20,000
Loan from XYZ Cooperative Bank	1,00,000	Vehicles	40,000
Loan from National Bank	50,000		
Total	5,00,000	Total	5,00,000

The company is required to pay a sum of Rs.15,000 towards the salary. Interest on long-term loan is to be paid every month @ 18% per annum. Interest on loan from XYZ Cooperative Bank and Nationalised Bank may be taken as Rs.1,500 per month. The company has already promised to deliver three P III. Two P II and five Celeron Type of Computer of M/s ABC Ltd. next month. The level of operation in the company is subject to the availability of cash next month.

The Company Manager is willing to know that how many units of each model must be manufactured next month, so as to maximize the profit.

Formulate the linear programming problem for the above.

Answer

Let x_1 , x_2 and x_3 denote the number of P III, P II and Celeron Computers respectively to the manufactured in the company. The following data is given:

	P III	P II	Celeron
Selling Price per unit (Rs.)	3,000	5,000	15,000
Labour, Material and other Variable Costs p.u. (Rs.)	2,000	4,000	8,000
Profit per unit (Rs.)	1,000	1,000	7,000

From the data given for time required for various models and the total number of hours available for machine time and assembly time, we get the following constraints:

$$20x_1 + 15x_2 + 12x_3 \leq 1,000 \text{ (Machine Time Restriction)}$$

$$5x_1 + 4x_2 + 3x_3 \leq 1,500 \text{ (Assembly Time Restriction)}$$

The level of operations in the company is subject to availability of cash next month i.e.; the cash required for manufacturing various models should not exceed the cash available for the next month.

The cash requirements for x_1 units of P III, x_2 units of P II and x_3 units of Celeron computers are:

$$2,000x_1 + 4,000x_2 + 8,000x_3 \quad \dots\dots (1)$$

The cash availability for the next month from the balance sheet is as below:

Cash availability (Rs.) Cash balance (Rs. 2,10,000)

Loan to repay to Nationalized bank (Rs. 50,000)

Interest on loan from XYZ cooperative bank and Nationalized bank (Rs. 1500)

$$\text{Interest on long term loans} \left[\frac{0.18 \times 2,00,000}{12} \right]$$

Salary to staff (Rs. 15,000)

$$\begin{aligned} \text{Or, Cash availability} &= \text{Rs. } 2,10,000 - (\text{Rs. } 50,000 + \text{Rs. } 1,500 + \text{Rs. } 3,000 + \text{Rs. } 15,000) \\ &= \text{Rs. } 1,40,500 \quad \dots\dots (2) \end{aligned}$$

Thus, from (1) and (2),

$$2000X_1 + 4000X_2 + X_3 < \text{Rs. } 1,40,500$$

The company has also promised to deliver 3 P III, 2 P II and 5 Celeron computers to M/s. Kingspen Ltd.

$$\text{Hence, } X_1 > 3, X_2 > 2, X_3 > 5$$

Since the company wants to maximize the profit, hence the objective function is given by: Maximize $Z = 1000X_1 + 1000X_2 + 7000X_3$ - (Rs. 15000 + Rs. 3000 + Rs. 1500) The LP formulation of the given problem is as follow:

Maximize $Z = 1000X_1 + 1000X_2 + 7000X_3$ - (Rs. 15000 + Rs. 15000) Subject to the constraints:

$$20X_1 + 15X_2 + 12X_3 < 1000$$

$$5X_1 + 4X_2 + 3X_3 < 1500$$

$$2000X_1 + 4000x_2 + 8000X_3 < \text{Rs. } 1,40,500$$

Advanced Management Accounting

$$X_1 > 3, X_2 > 2, X_3 > 5$$

X_1, X_2 and X_3 can take only positive integral values.

Question 4

A manufacturing company produces two types of product the SUPER and REGULAR. Resource requirements for production are given below in the table. There are 1,600 hours of assembly worker hours available per week. 700 hours of paint time and 300 hours of inspection time. Regular customers bill demand at least 150 units of the REGULAR type and 90 units of the SUPER type. (8 Marks)

Table

Product	Profit/contribution Rs.	Assembly time Hrs.	Paint time Hrs.	Inspection time Hrs.
REGULAR	50	1.2	0.8	0.2
SUPER	75	1.6	0.9	0.2

Formulate and solve the given Linear programming problem to determine product mix on a weekly basis.

Answer

Let x_1 and x_2 denote the number of units produced per week of the product 'REGULAR' and 'SUPER' respectively.

$$\text{Maximise } Z = 50x_1 + 75x_2$$

Subject to

$$1.2x_1 + 1.6x_2 \leq 1,600 \text{ or } 12x_1 + 16x_2 \leq 16,000 \quad \text{-(i)}$$

$$0.8x_1 + 0.9x_2 \leq 700 \text{ or } 8x_1 + 9x_2 \leq 7,000 \quad \text{-(ii)}$$

$$0.2x_1 + 0.2x_2 \leq 300 \text{ or } 2x_1 + 2x_2 \leq 3,000 \quad \text{-(iii)}$$

$$x_1 \geq 150 \quad \text{-(iv)}$$

$$x_2 \geq 90 \quad \text{-(v)}$$

Let

$$x_1 = y_1 + 150$$

$$x_2 = y_2 + 90 \text{ where } y_1, y_2 \geq 0$$

$$\text{Maximize } Z = 50(y_1 + 150) + 75(y_2 + 90) \text{ or } Z = 50y_1 + 75y_2 + 14,250$$

Subject to:

$$12(y_1 + 150) + 16(y_2 + 90) \leq 16,000$$

$$8(y_1 + 150) + 9(y_2 + 90) \leq 7,000$$

$$2(y_1 + 150) + 2(y_2 + 90) \leq 3,000$$

$$\text{and } y_1, y_2 \geq 0$$

Adding slack variables s_1, s_2, s_3 , we get

$$\text{Maximize } Z = 50y_1 + 75y_2 + 14,250 \text{ subject to}$$

$$12y_1 + 16y_2 + s_1 = 12,760$$

$$8y_1 + 9y_2 + s_2 = 4,990$$

$$2y_1 + 2y_2 + s_3 = 2,520$$

Table I

C_j			50	75	0	0	0	
C_b			y_1	y_2	s_1	s_2	s_3	
0	s_1	12,760	12	16	1	0	0	12760/16
0	s_2	4,990	8	9	0	1	0	4990/9
0	s_3	2,520	2	2	0	0	1	2520/2
Δ_j			-50	-75	0	0	0	

Table II

C_j			50	75	0	0	0
C_b			y_1	y_2	s_1	s_2	s_3
0	s_1	3889	-20/9	0	1	-16/9	0
75	y_2	554.44	8/9	1	0	1/9	0
0	s_3	1411	2/9	0	0	-2/9	1
Δ_j			50/3	0	0	75/9	0

Since all the elements in the index row are either positive or equal to zero, table II gives an optimum solution which is $y_1 = 0$ and $y_2 = 554.44$

Substituting these values we get

Advanced Management Accounting

$$x_1 = 0 + 150 = 150$$

$x_2 = 90 + 554.44 = 644.44$ and the value of objective function is

$$Z = 50 \times 150 + 75 \times 644.44$$

$$= \text{Rs. } 55,833$$

Question 5

A company manufactures two products A and B, involving three departments – Machining, Fabrication and Assembly. The process time, profit/unit and total capacity of each department is given in the following table:

	Machining (Hours)	Fabrication (Hours)	Assembly (Hours)	Profit (Rs).
A	1	5	3	80
B	2	4	1	100
Capacity	720	1,800	900	

Set up Linear Programming Problem to maximise profit. What will be the product Mix at Maximum profit level ?

Answer

Maximize	$z = 80x + 100y$ subject to	$x + 2y \leq 720$
		$5x + 4y \leq 1800$
		$3x + y \leq 900$
		$x \geq 0, y \geq 0$
	where	$x = \text{No. of units of A}$
		$y = \text{No. of units of B}$

By the addition of slack variables s_1 , s_2 and s_3 the inequalities can be converted into equations. The problems thus become

$z = 80x + 100y$ subject to	$x + 2y + s_1 = 720$
	$5x + 4y + s_2 = 1800$
	$3x + y + s_3 = 900$
and $x \geq 0$,	$y \geq 0, s_1 \geq 0, s_2 \geq 0, s_3 \geq 0$

Table 1:

			80	100	0	0	0	
	Profit/unit	Qty.	X	Y	S ₁	S ₂	S ₃	
S ₁	0	720	I	2	1	0	0	$\frac{720}{2} = 360$
S ₂	0	1800	5	4	0	1	0	$1800/4 = 450$
S ₃	0	900	3	I	0	0	1	$900/1 = 900$
Net evaluation row			80	100	0	0	0	
$1800 - 720 \times 4/2 = 360$			$900 - 720 \times 1/2 = 540$					
$5 - 1 \times 2 = 3$			$3 - 1 \times 1/2 = 5/2$					
$4 - 2 \times 2 = 0$			$1 - 2 \times 1/2 = 0$					
$0 - 1 \times 2 = -2$			$0 - 1 \times 1/2 = -1/2$					
$1 - 0 \times 2 = 1$			$0 - 0 \times 1/2 = 0$					
$0 - 0 \times 2 = 0$			$1 - 0 \times 1/2 = 1$					

Table 2:

			80	100	0	0	0	
Program	Profit/unit	Qty.	X	Y	S ₁	S ₂	S ₃	
Y	100	360	$\frac{1}{2}$	1	$\frac{1}{2}$	0	0	$360 \div 1/2 = 720$
S ₂	0	360	3	0	-2	1	0	$360 \div 3 = 120$
S ₃	0	540	$5/2$	0	$-1/2$	0	1	$540 \div 5/2 = 216$
Net evaluation row			30	0	-50	0	0	
$360 - 360 \times 1/6 = 300$			$540 - 360 \times 5/6 = 240$					
$\frac{1}{2} - 3 \times 1/6 = 0$			$5/2 - 3 \times 5/6 = 0$					
$1 - 0 \times 1/6 = 1$			$0 - 0 \times 5/6 = 0$					
$\frac{1}{2} - -2 \times 1/6 = 5/6$			$-1/2 - -2 \times 5/6 = 7/6$					
$0 - 1 \times 1/6 = -1/6$			$0 - 1 \times 5/6 = -5/6$					
$0 - 0 \times 1/6 = 0$			$1 - 0 \times 5/6 = 1$					

Advanced Management Accounting

Table 3:

			80	100	0	0	0
Program	Profit/unit	Qty.	X	Y	S ₁	S ₂	S ₃
Y	100	300	0	1	5/6	-1/6	0
X	80	120	1	0	-2/3	1/3	0
S ₃	0	240	0	0	7/6	-5/6	1
Net evaluation row			0	0	-500/6	+100/6	
					+160/3	-80/3	0
					$= \frac{180}{6}$	$= -\frac{60}{6}$	

All the values of the net evaluation row of Table 3 are either zero or negative, the optimal program has been obtained.

Here $X = 120$, $y = 300$ and the maximum profit
 $= 80 \times 120 + 100 \times 300 = 9600 + 30,000$
 $= \text{Rs. } 39,600.$

Question 6

Three grades of coal A, B and C contains phosphorus and ash as impurities. In a particular industrial process, fuel up to 100 ton (maximum) is required which could contain ash not more than 3% and phosphorus not more than .03%. It is desired to maximize the profit while satisfying these conditions. There is an unlimited supply of each grade. The percentage of impurities and the profits of each grade are as follows:

Coal	Phosphorus (%)	Ash (%)	Profit in Rs. (per ton)
A	.02	3.0	12.00
B	.04	2.0	15.00
C	.03	5.0	14.00

You are required to formulate the Linear-programming (LP) model to solve it by using simplex method to determine optimal product mix and profit.

Answer

Let X_1 , X_2 and X_3 respectively be the amounts in tons of grades A, B, and C used. The constraints are:

(i) Phosphorus content must not exceed 0.03%

$$.02 X_1 + .04 X_2 + 0.3 X_3 \leq .03 (X_1 + X_2 + X_3)$$

$$2X_1 + 4 X_2 + 3X_3 \leq 3 (X_1 + X_2 + X_3) \text{ or } -X_1 + X_2 \leq 0$$

(ii) Ash content must not exceed 3%

$$3X_1 + 2 X_2 + 5 X_3 \leq 3 (X_1 + X_2 + X_3) \text{ or } -X_2 + 2X_3 \leq 0$$

(iii) Total quantity of fuel required is not more than 100 tons. $X_1 + X_2 + X_3 \leq 100$

The Mathematical formulation of the problem is

$$\text{Maximize } Z = 12 X_1 + 15X_2 + 14 X_3$$

Subject to the constraints:

$$-X_1 + X_2 \leq 0$$

$$-X_2 + X_3 \leq 0$$

$$X_1 + X_2 + X_3 \leq 100$$

$$X_1, X_2, X_3 > 0$$

Introducing slack variable $X_4 > 0$, $X_5 > 0$, $X_6 > 0$

			12	15	14	0	0	0
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
0	Y_4	0	-1	1*	0	1	0	0
0	Y_5	0	0	-1	2	0	1	0
0	Y_6	100	1	1	1	0	0	1
	Z		-12	-15	-14	0	0	0
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
15	Y_2	0	-1	1	0	1	0	0
0	Y_5	0	-1	0	2	1	1	0
0	Y_6	100	2*	0	1	-1	0	1
	Z		-27		-14	15	0	0
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6

Advanced Management Accounting

15	Y_2	50	0	1	$1/2$	$1/2$	0	$1/2$
0	Y_5	50	0	0	$5/2^*$	$1/2$	1	$1/2$
12	Y_1	50	1	0	$1/2$	$-1/2$	0	$1/2$
	Z		0	0	$-1/2$	$3/2$	0	$27/2$
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
15	Y_2	40	0	1	0	$2/5$	$-1/5$	$2/5$
14	Y_3	20	0	0	1	$1/5$	$2/5$	$1/5$
12	Y_1	40	1	0	0	$-3/5$	$-1/5$	$2/5$
	Z		0	0	0	$8/5$	$1/5$	$68/5$

The optimum solution is $X_1 = 40$, $X_2 = 40$ and $X_3 = 20$ with maximum $Z = 1360$.

Question 7

What are the practical applications of Linear programming?

Answer

Linear programming can be used to find optional solutions under constraints.

In production:

- pdt. mix under capacity constraints to minimise costs/maximise profits along with marginal costing.
- Inventory management to minimise holding cost, warehousing / transporting from factories to warehouses etc.

Sensitivity Analysis: By providing a range of feasible solutions to decide on discounts on selling price, decisions to make or buy.

Blending: Optional blending of raw materials under supply constraints.

Finance: Portfolio management, interest/receivables management.

Advertisement mix: In advertising campaign – analogous to pdn. management and pdt. mix.

Assignment of personnel to jobs and resource allocation problems.

However, the validity will depend on the manager's ability to establish a proper linear relationship among variables considered.

Question 8

Transport Ltd. Provides tourist vehicles of 3 types – 20-seater vans, 8-seater big cars and 5-seater small cars. These seating capacities are excluding the drivers. The company has 4 vehicles of the 20-seater van type, 10 vehicles of the 8-seater big car types and 20 vehicles of the 5-seater small car types. These vehicles have to be used to transport employees of their client company from their residences to their offices and back. All the residences are in the same housing colony. The offices are at two different places, one is the Head Office and the other is the Branch. Each vehicle plies only one round trip per day, if residence to office in the morning and office to residence in the evening. Each day, 180 officials need to be transported in Route I (from residence to Head Office and back) and 40 officials need to be transported in Route II (from Residence to Branch office and back). The cost per round trip for each type of vehicle along each route is given below.

You are required to formulate the information as a linear programming problem, with the objective of minimising the total cost of hiring vehicles for the client company, subject to the constraints mentioned above. (only formulation is required. Solution is not needed).

Figs. – Rs. /round trip

	20-seater vans	8-seater big cars	5-seater small cars
Route I –			
Residence — Head Office and Back	600	400	300
Route II –			
Residence — Branch Office and Back	500	300	200

Answer

Type	I	II	III	Total no. of passengers
	20 – Seater vans	8 – Seater Big cars	5 – Seater Small cars	
Route I Residence H.O. Residence	600	400	300	180
Route II Residence Br. Residence	500	300	200	40
No. of vehicles	4	10	20	220 260
Max. capacity	80	80	100	
No. of passengers				

Advanced Management Accounting

Let i be the i th route,

and j be the type of vehicle, so that

S_{11} = no. of vans (vehicles on Route I, Type I)

S_{12} = no. of 8 seater cars on Route I

S_{13} = no. of 5 seater cars on Route I

S_{21} = no. of vans — on Route II

S_{22} = no. of 8 seater cars on Route II

S_{23} = no. of 5 seater cars on Route II

Objective:

Minimise

$$\text{Cost } Z = 600 S_{11} + 400 S_{12} + 300 S_{13} + 500 S_{21} + 300 S_{22} + 200 S_{23}$$

Subject to

$$20 S_{11} + 8 S_{12} + 5 S_{13} = 180$$

$$20 S_{21} + 8 S_{22} + 5 S_{23} = 40$$

$$S_{11} + S_{21} \leq 4$$

$$S_{21} + S_{22} \leq 10$$

$$S_{31} + S_{32} \leq 20$$

$$\text{All } s_{ij} \geq 0$$

Question 9

Explain the concept and aim of theory of constraints. What are the key measures of theory of constraints?

Answer

The theory of constraints focuses its attention on constraints and bottlenecks within organisation which hinder speedy production. The main concept is to maximize the rate of manufacturing output is the throughput of the organisation. This requires to examine the bottlenecks and constraints. A bottleneck is an activity within the organization where the demand for that resource is more than its capacity to supply.

A constraint is a situational factor which makes the achievement of objectives / throughput more difficult than it would otherwise, for example of constraint may be lack of skilled labour, lack of customer orders, or the need to achieve high quality in product output.

For example let meeting the customers' delivery schedule be a major constraint in an organisation. The bottleneck may be a certain machine in the factory. Thus bottlenecks and constraints are closely examined to increase throughput.

Key measures of theory of constraints:

- (i) **Throughput contribution:** It is the rate at which the system generates profits through sales. It is defined as, sales less completely variable cost, sales – direct are excluded. Labour costs tend to be partially fixed and conferred are excluded normally.
- (ii) **Investments:** This is the sum of material costs of direct materials, inventory, WIP, finished goods inventory, R & D costs and costs of equipment and buildings.
- (iii) **Other operating costs:** This equals all operating costs (other than direct materials) incurred to earn throughput contribution. Other operating costs include salaries and wages, rent, utilities and depreciation.

Question 10

The costs and selling prices per unit of two products manufacturing by a company are as under:

Product	A (Rs.)	B (Rs.)
Selling Price	500	450
Variable costs:		
Direct Materials @ Rs. 25 per kg.	100	100
Direct Labour @ Rs. 20 per hour	80	40
Painting @ Rs. 30 per hour	30	60
Variable overheads	190	175
Fixed costs @ Rs. 17.50/D.L.Hr.	70	35
Total costs	470	410
Profit	30	40

In any month the maximum availability of inputs is limited to the following:

Direct Materials	480 kg.
Direct Labour hours	400 hours
Painting hours	200 hours

Advanced Management Accounting

Required:

- (i) *Formulate a linear programme to determine the production plan which maximizes the profits by using graphical approach.*
- (ii) *State the optimal product mix and the monthly profit derived from your solution in (i) above.*
- (iii) *If the company can sell the painting time at Rs. 40 per hour as a separate service, show what modification will be required in the formulation of the linear programming problem. You are required to re-formulate the problem but not to solve.*

Answer**Contribution analysis:**

<i>Products</i>	<i>A</i>	<i>B</i>
	<i>(Rs.)</i>	<i>(Rs.)</i>
Selling price (A)	<u>500</u>	<u>450</u>
Variable costs:		
Direct Materials	100	100
Direct Labour	80	40
Painting	30	60
Variable Overheads	<u>190</u>	<u>175</u>
Total variable costs (B)	<u>400</u>	<u>375</u>
Contribution (A – B)	<u>100</u>	<u>75</u>
Direct Material per unit	100/25 = 4 kg.	100/25 = 4 kg.
Direct Labour hour per unit	80/20 = 4 hours	40/20 = 2 hours
Painting hour per unit	30/30 = 1 hour	60/30 = 2 hours

Let A be the units to be produced of product A and B be the units to be produced of product B.

LP Problem formulation:

Z Max 100A + 75B

Maximisation of contribution

Subject to:

$$4A + 4B \leq 480$$

Raw material constraint

$$4A + 2B \leq 400$$

Direct Labour hour constraint

$$A + 2B \leq 200$$

Painting hour constraint

$$A, B \geq 0$$

Non negativity constraint

Raw Material Constraint : Put B = 0, A = 120

Put A = 0, B = 120

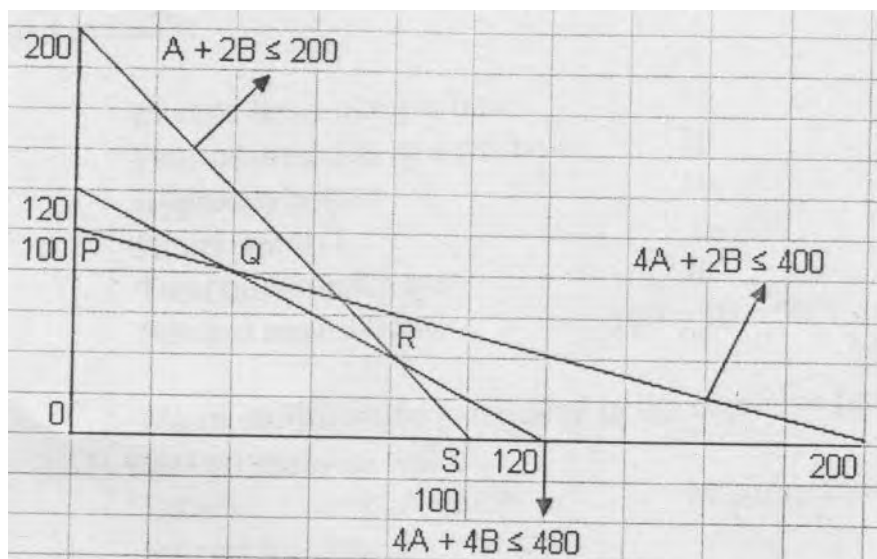
Direct Labour Constraint : Put B = 0, A = 100

Put A = 0, B = 200

Painting Constraint : Put B = 0, A = 200

Put A = 0, B = 100

The graphical representation will be as under:



$$Q \text{ Intersects } 4A + 2B = 400 \quad (1)$$

$$\text{and } 4A + 4B = 480 \quad (2)$$

Subtracting (2) from (1), we get $-2B = -80$

$$\Rightarrow B = 80/2 = 40$$

Putting value of B in (1), we get $4A + 2 \times 40 = 400$

$$\Rightarrow A = \frac{400 - 80}{4} = 80$$

Advanced Management Accounting

$$R \text{ Intersects } 4A + 4B = 480 \quad (3)$$

$$\text{and } A + 2B = 200 \quad (4)$$

Multiplying (4) by (2) and then subtracting from (3), we get

$$2A = 80$$

$$\Rightarrow A = 40$$

Putting the value of A in (4), we get $2B = 200 - 40$

$$\Rightarrow B = 80.$$

Evaluation of corner points:

Point	Products		Contribution		Total Contribution
	A	B	A (Rs.)	B (Rs.)	Rs.
			100 per unit	75 per unit	
P	0	100	0	7,500	7,500
Q	80	40	8,000	3,000	11,000
R	40	80	4,000	6,000	10,000
S	100	0	10,000	0	10,000

Optimal product mix is Q

Product	Units	Contribution
		Rs.
A	80	8,000
B	40	3,000
Total contribution		11,000
Less: Fixed costs 400 D.L. Hrs. $\times$ Rs. 17.50		7,000
Optimal Profit		4,000

(iii) If the painting time can be sold at Rs. 40 per hour the opportunity cost is calculated as under:

	A	B
	(Rs.)	(Rs.)
Income from sale per hour	40	40

Painting variable cost per hour	30	30
Opportunity cost	10	10
Painting hours per unit	1	2
Opportunity cost	10	20
Revised contribution	$100 - 10 = 90$	$75 - 20 = 55$

Hence, modification is required in the objective function.

Re-formulated problem will be:

Z Max.	$90A + 55B$	Maximisation of contribution
Subject to:		
	$4A + 4B \leq 480$	Raw Material constraint
	$4A + 2B \leq 400$	Direct Labour hour constraint
	$A + 2B \leq 200$	Painting hour constraint
	$A, B \geq 0$	Non-negativity constraint

Question 11

The following matrix gives the unit cost of transporting a product from production plants P_1 , P_2 and P_3 to destinations D_1 , D_2 and D_3 . Plants P_1 , P_2 and P_3 have a maximum production of 65, 24 and 111 units respectively and destinations D_1 , D_2 and D_3 must receive at least 60, 65 and 75 units respectively:

To \ From	D_1	D_2	D_3	Supply
P_1	400	600	800	65
P_2	1,000	1,200	1,400	24
P_3	500	900	700	111
Demand	60	65	75	200

You are required to formulate the above as a linear programming problem. (Only formulation is needed. Please do not solve).

Answer

Let p_{ij} be the variable to denote the number of units of product from the i th plant to the j th destination, so that

P_1D_1 = transport from plant P_1 to D_1

Advanced Management Accounting

P_2d_2 = transport from plant P_2 to D_2 etc.

Objective function

Minimize $z = 400 p_1d_1 + 600 p_1d_2 + 800 p_1d_3 + 1000 p_2d_1 + 1200 p_2d_2 + 1400 p_2d_3 + 500 p_3d_1 + 900 p_3d_2 + 700 p_3d_3$.

Subject to:

$$\left. \begin{array}{l} p_1d_1 + p_1d_2 + p_1d_3 \leq 65 \\ p_2d_1 + p_2d_2 + p_2d_3 \leq 24 \\ p_3d_1 + p_3d_2 + p_3d_3 \leq 111 \end{array} \right\} \text{(Plant constraints)}$$

and

$$\left. \begin{array}{l} p_1d_1 + p_2d_1 + p_3d_1 \geq 60 \\ p_1d_2 + p_2d_2 + p_3d_2 \geq 65 \\ p_1d_3 + p_2d_3 + p_3d_3 \geq 75 \end{array} \right\} \text{(destination constraints)}$$

all $p_i d_j \geq 0$

Question 12

Formulate the dual for the following linear program: (6 Marks)

Maximise: $100x_1 + 90x_2 + 40x_3 + 60x_4$

Subject to

$$6x_1 + 4x_2 + 8x_3 + 4x_4 \leq 140$$

$$10x_1 + 10x_2 + 2x_3 + 6x_4 \leq 120$$

$$10x_1 + 12x_2 + 6x_3 + 2x_4 \leq 50$$

$$x_1, x_2, x_3, x_4 \geq 0$$

(Only formulation is required. Please do not solve.)

Answer

Dual:

$$\text{Minimise} \quad 140u_1 + 120u_2 + 50u_3$$

$$\text{S.T.} \quad 6u_1 + 10u_2 + 10u_3 \geq 100$$

$$4u_1 + 10u_2 + 12u_3 \geq 90$$

$$8u_1 + 2u_2 + 6u_3 \geq 40$$

$$4u_1 + 6u_2 + 2u_3 \geq 60$$

$$u_1, u_2, u_3, u_4 \geq 0$$

Question 13

The following is a linear programming problem. You are required to set up the initial simplex tableau. (Please do not attempt further iterations or solution):

Maximise

$$100x_1 + 80x_2$$

Subject to

$$3x_1 + 5x_2 \leq 150$$

$$x_2 \leq 20$$

$$8x_1 + 5x_2 \leq 300$$

$$x_1 + x_2 \geq 25$$

$$x_1, x_2 \geq 0$$

Answer

Under the usual notations where

S1, S2, S3 are stock Variables,

A4 = the artificial variable

S4 = Surplus Variable

We have,

$$\text{Max. } Z = 100x_1 + 80x_2 + 0S_1 + 0S_2 + 0S_3 + 0S_4 - M A_4.$$

S.t.

$$3x_1 + 5x_2 + S_1 = 150$$

$$x_2 + S_2 = 20$$

$$8x_1 + 5x_2 + S_3 = 300$$

$$x_1 + x_2 - S_4 + A_4 = 25$$

		x_1	x_2	S_1	S_2	S_3	S_4	A_4		
Basis	C_j C_B	100	80	0	0	0	0	- M		

Advanced Management Accounting

S ₁	0	3	5	1	0	0	0	0	150	√
S ₂	0	0	1	0	1	0	0	0	20	√
S ₃	0	8	5	0	0	1	0	0	300	√
A ₄	- M	1	1	0	0	0	-1	1	25	√
Z _j		- M	- M	0	0	0	M	-M	-25M	√
C _j -Z _j		100+M	80+M	0	0	0	-M	0		√

Question 14

An oil refinery can blend three grades of crude oil to produce quality A and quality B petrol. Two possible blending processes are available. For each production run, the older process uses 5 units of crude Q, 7 units of crude P and 2 units of crude R and produces 9 units of A and 7 units of B. The newer process uses 3 units of crude Q, 9 unit of crude P and 4 units of crude R to produce 5 units of A and 9 units of B.

Because of prior contract commitments, the refinery must produce at least 500 units of A and at lease 300 units of B for the next month. It has ,1,500 units of crude Q, 1,900 units of crude P and 1,000 of crude R. For each unit of A, refinery receives Rs.60 while for each unit of B, it receives Rs.90

Formulate the problem as linear programming model so as to maximize the revenue.

Answer

$$\begin{aligned}\text{Maximize } Z &= 60 (9x_1 + 5x_2) + 90 (7x_1 + 9x_2) \\ &= 1170x_1 + 1110x_2\end{aligned}$$

Subject to $9x_1 + 5x_2 \geq 500$ commitment for A

$7x_1 + 9x_2 \geq 300$ commitment for B

$5x_1 + 3x_2 \leq 1500$ availability of Q

$7x_1 + 9x_2 \leq 1900$ availability of P

$2x_1 + 4x_2 \leq 1000$ availability of R

and $x_1 \geq 0, x_2 \geq 0$.

Question 15

Write short notes on the characteristics of the dual problem.

Answer

Characteristics of the dual problem:

1. For any linear programming model called primal model, there exists a companion model called the dual model.
2. The number of constraints in the primal model equals the number of variables in the dual model.
3. The number of variables in the primal problem equals the number of constraints in the dual model.
4. If the primal model is a maximization problem then the dual model will be of the form less than or equal to, " $\leq$ " while the restrictions in the dual problem will be of the form-greater than or equal to, " $\geq$ ".
5. The solution of the primal model yields the solution of the dual model. Also, an optimal simplex table for the dual model yields the optimal solution to the primal model. Further, the objective functions of the two optimal tables will have identical values.
6. Dual of the primal's dual problem is the primal problem itself.
7. Feasible solutions to a primal and dual problem are both optimal if the complementary slackness conditions hold, that is, (value of a primal variable) $\times$ (value of the corresponding dual surplus variable) = 0 or (value of a primal slack variable) $\times$ (value of the corresponding dual variable) = 0.
If this relationship does not hold, then either the primal solution or the dual solution or both are not optimal.
8. If the primal problem has no optimal solution because of infeasibility, then the dual problem will have no optimal solution because of unboundedness.
9. If the primal has no optimal solution because of unboundedness, then the dual will have no optimal solution because of infeasibility.

Advanced Management Accounting**EXERCISE****Question 1**

A Sports Club is engaged in the development of their players by feeding them certain minimum amount of Vitamins (say A, B and C), in addition to their normal diet. In view of this, two types of products X and Y are purchased from the market. The contents of Vitamin constituents per unit, are shown in the following table:

Vitamin Constituents	Vitamin contents in products		Minimum requirement for each player
	X	Y	
A	36	06	108
B	03	12	36
C	20	10	100

The cost of product X is Rs.20 and that of Y is Rs.40.

Formulate the linear programming problem for the above and minimize the total cost, and solve problem by using graphic method.

Answer

The optimal solution is to purchase 4 units of product X and 2 units of product Y in order to maintain a minimum cost of Rs.160/-.

Question 2

A manufacturer produces three products Y_1 , Y_2 , Y_3 from three raw materials X_1 , X_2 , X_3 . The cost of raw materials X_1 , X_2 and X_3 is Rs.30, Rs.50 and Rs.120 per kg respectively and they are available in a limited quantity viz 20 kg of X_1 , 15 kg of X_2 and 10 kg of X_3 . The selling price of Y_1 , Y_2 and Y_3 is Rs.90, Rs.100 and Rs.120 per kg respectively. In order to produce 1 kg of Y_1 , $\frac{1}{2}$ kg of X_1 , $\frac{1}{4}$ kg of X_2 and $\frac{1}{4}$ kg of X_3 are required. Similarly to produce 1 kg of Y_2 , $\frac{3}{7}$ kg of X_1 , $\frac{2}{7}$ kg of X_2 and $\frac{2}{7}$ kg of X_3 and to produce 1 kg Y_3 , $\frac{2}{3}$ kg of X_2 and $\frac{1}{3}$ kg of X_3 will be required.

Formulate the linear programming problem to maximize the profit.

Answer

$$\text{Maximise } Z = 32.50 y_1 + 38.57 y_2 + 46.67 y_3$$

$$\frac{1}{2} y_1 + \frac{3}{7} y_2 \leq 20 \text{ or } 7 y_1 + 6 y_2 \leq 280$$

$$\frac{1}{4} y_1 + \frac{2}{7} y_2 + \frac{2}{3} y_3 \leq 15 \text{ or } 21 y_1 + 24 y_2 + 56 y_3 \leq 1,260$$

$$\frac{1}{4} y_1 + \frac{2}{7} y_2 + \frac{1}{3} y_3 \leq 10 \text{ or } 21 y_1 + 24 y_2 + 28 y_3 \leq 840$$

where Y_1 , Y_2 and $Y_3 \geq 0$

Question 3

Write short notes on applications and limitation of Linear Programming Techniques.

Answer

Refer to Chapter 11: Paragraph: 11.9

Question 4

In a chemical industry two products A and B are made involving two operations. The production of B also results in a by-product C. The product A can be sold at a profit of Rs.3 per unit and B at a profit of Rs.8 per unit. The by-product C has a profit of Rs.2 per unit. Forecast show that upto 5 units of C can be sold. The company gets 3 units of C for each unit of B produced. The manufacturing times are 3 h per unit and on each of the operation one and two and 4 h and 5 h per unit for B on operation one and two respectively. Because the product C results from producing B, no time is used in producing C. The available times are 18 h and 21 h of operation one and two respectively. The company desires to know that how much A and B should be produced keeping c in mind to make the highest profit. Formulate LP model for this problem.

Answer

Maximise $Z = 3x_1 + 8x_2 + 2x_3$

Subject to the constraints

$$3x_1 + 4x_2 \leq 18$$

$$3x_1 + 5x_2 \leq 21$$

$$x_3 \leq 5, x_3 = 3x_2$$

$$x_1, x_2, x_3 = 0$$

Question 5

An advertising firm desires to reach two types of audiences – customers with annual income of more than Rs.40,000 (target audience A) and customers with annual income of less than Rs.40,000 (target audience B). The total advertising budget is Rs.2,00,000. One programme of T.V. advertising costs Rs.50,000 and one programme of Radio advertising costs Rs.20,000. Contract conditions ordinarily require that there should be at least 3 programmes on T.V. and the number of programmes on Radio must not exceed 5. Survey indicates that a single T.V. programme reaches 7,50,000 customers in target audience A and 1,50,000 in target audience B. One Radio programme reaches 40,000 customers in target audience A and 2,60,000 in target audience B.

Advanced Management Accounting

Formulate this as a linear programming problem and determine the media mix to maximize the total reach using graphic method.

Answer

the advertising firm should give 4 programmes on TV and no programme on Radio in order to achieve a maximum reach of 36,00,000 customers.

Question 6

Let us assume that you have inherited Rs.1,00,000 from your father-in-law that can be invested in a combination of only two stock portfolios, with the maximum investment allowed in either portfolio set at Rs.75,000. The first portfolio has an average rate of return of 10%, whereas the second has 20%. In terms of risk factors associated with these portfolios, the first has a risk rating of 4 (on a scale from 0 to 10), and the second has 9. Since you wish to maximize your return, you will not accept an average rate of return below 12% or a risk factor above 6. Hence, you then face the important question. How much should you invest in each portfolio?

Formulate this as a Linear Programming Problem and solve it by Graphic Method.

Answer

the company should invest Rs.60,000 in first portfolio and Rs.40,000 in second portfolio to achieve the maximum average rate of return of Rs.14,000.

Question 7

A firm buys casting of P and Q type of parts and sells them as finished product after machining, boring and polishing. The purchasing cost for casting are Rs.3 and Rs.4 each for parts P and Q and selling costs are Rs.8 and Rs.10 respectively. The per hour capacity of machines used for machining, boring and polishing for two products is given below:

Capacity (per hour)	Parts	
	P	C
Machining	30	50
Boring	30	45
Polishing	45	30

The running costs for machining, boring and polishing are Rs.30, Rs.22.5 and Rs.22.5 per hour respectively.

Formulate the linear programming problem to find out the product mix to maximize the profit.

Answer

$$\text{Maximise } Z = 2.75x + 4.15y$$

Subject to the constraints

$$50x + 30y \leq 1,500$$

$$45x + 30y \leq 1,350$$

$$30x + 45y \leq 1,350$$

$$\text{where } x, y \geq 0$$

Question 8

A Mutual Fund Company has Rs.20 lakhs available for investment in Government Bonds, blue chip stocks, speculative stocks and short-term bank deposits. The annual expected return and risk factor are given below:

Type of investment	Annual Expected return (%)	Risk Factor (0 to 100)
Government Bonds	14	12
Blue Chip Stocks	19	24
Speculative Stocks	23	48
Short term deposits	12	6

Mutual fund is required to keep at least Rs.2 lakhs in short-term deposits and not to exceed an average risk factor of 42. Speculative stocks must be at most 20 percent of the total amount invested. How should mutual fund invest the funds so as to maximize its total expected annual return? Formulate this as a Linear Programming Problem. Do not solve it.

Answer

Objective function:

$$\text{Maximise } Z = 0.14x_1 + 0.19x_2 + 0.23x_3 + 0.12x_4$$

Subject to the constraints:

$$x_1 + x_2 + x_3 + x_4 \leq 20,00,000$$

$$x_4 \geq 2,00,000$$

$$-30x_1 - 18x_2 + 6x_3 - 36x_4 \leq 0$$

$$-0.2x_1 - 0.2x_2 + 0.8x_3 + 0.2x_4 \leq 0$$

Advanced Management Accounting

Where $x_1 \geq 0$, $x_2 \geq 0$, $x_3 \geq 0$ and $x_4 \geq 0$

Question 9

The owner of Fancy Goods Shop is interested to determine, how many advertisements to release in the selected three magazines A, B and C. His main purpose is to advertise in such a way that total exposure to principal buyers of his goods is maximized. Percentages of readers for each magazine are known. Exposure in any particular magazine is the number of advertisements released multiplied by the number of principal buyers. The following data are available:

Particulars	Magazines		
	A	B	C
Readers	1.0 Lakhs	0.6 Lakhs	0.4 Lakhs
Principal buyers	20%	15%	8%
Cost per advertisement	8,000	6,000	5,000

The budgeted amount is at the most Rs.1.0 lakh for the advertisements. The owner has already decided that magazine A should have no more than 15 advertisements and that B and C each gets at least 8 advertisements. Formulate a Linear Programming model for this problem.

Answer

$$\text{Maximise } Z = 20,000 x_1 + 9,000 x_2 + 3,200 x_3$$

$$\text{subject to } 8,000 x_1 + 6,000 x_2 + 5,000 x_3 \leq 1,00,000$$

$$x_1 \leq 15, x_2 \geq 8,$$

$$\text{where } x_1, x_2 \text{ and } x_3 \geq 0$$

Question 10

An agriculturist has a farm with 125 acres. He produces Radish, Mutter and Potato. Whatever he raises is fully sold in the market. He gets Rs.5 for Radish per kg Rs.4 for Mutter per kg and Rs. for Potato per kg. The average yield is 1,500 kg of Radish per acre, 1,800 kg of Mutter per acre and 1,200 kg of Potato per acre. To produce each 100 kg of Radish and Mutter and to produce each 80 kg of Potato, a sum of Rs.12.50 has to be used for manure. Labour required for each acre to raise the crop is 6 man days for Radish and Potato each and 5 man days for Mutter. A total of 500 man days of labour at a rate of Rs.40 per man day are available.

Formulate this as a Linear Programming model to maximize the Agriculturist's total profit.

Answer

$$\text{Maximise } Z = 7,072.5x_1 + 6,775x_2 + 5572.5x_3$$

Subject to following constraints:

$$x_1 + x_2 + x_3 \leq 125$$

$$6x_1 + 5x_2 + 6x_3 \leq 500$$

$$\text{Where } x_1, x_2 \text{ and } x_3 \geq 0$$

Question 11

A firm produces three products A, B and C. It uses two types of raw materials I and II of which 5,000 and 7,500 units respectively are available. The raw material requirements per unit of the products are given below:

Raw Material	Requirement per unit of Product		
	A	B	C
I	3	4	5
II	5	3	5

The labour time for each unit of product A is twice that of product B and three times that of product C. The entire labour force of the firm can produce the equivalent of 3,000 units. The minimum demand of the three products is 600, 650 and 500 units respectively. Also the ratios of the number of units produced must be equal to 2: 3: 4. Assuming the profits per unit of A, B and C as Rs.50, 50 and 80 respectively.

Formulate the problem as a linear programming model in order to determine the number of units of each product, which will maximize the profit.

Answer

$$\text{Maximise } Z = 50x_1 + 50x_2 + 80x_3$$

Subject to the constraints

$$3x_1 + 4x_2 + 5x_3 \leq 5,000$$

$$5x_1 + 3x_2 + 5x_3 \leq 7,500$$

$$6x_1 + 3x_3 + 2x_3 \leq 18,000$$

$$3x_1 = 2x_2 \text{ and } 4x_2 = 3x_3$$

$$x_1 \geq 600, x_2 \geq 650 \text{ and } x_3 \geq 500$$

THE TRANSPORTATION PROBLEM

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Transportation Problem:

This type of problem deals with optimization of transportation cost in a distribution scenario involving m factories (sources) to n warehouses (destination) where cost of shipping from i th factory to j th warehouse is given and goods produced at different factories and requirement at different warehouses are given.

2. Northwest corner Rule:

The idea is to find an initial basic feasible solution i.e., a set of allocations that satisfied the row and column totals. This method simply consists of making allocations to each row in turn, apportioning as much as possible to its first cell and proceeding in this manner to its following cells until the row total is exhausted.

3. Algorithm Involved Under North-West Corner Rule

Steps:

1. Before allocation ensure that the total on demand & supply of availability and requirement are equal. If not then make same equal.
2. The first allocation is made in the cell occupying the upper left hand corner of the matrix.

The assignment is made in such a way that either the resource availability is exhausted or the demand at the first destination is satisfied.

3. (a) If the resource availability of the row one is exhausted first, we move down the second row and first column to make another allocation which either exhausts the resource availability of row two or satisfies the remaining destination demand of column one.
(b) If the first allocation completely satisfies the destination demand of column one, we move to column two in row one, and make a second allocation which either exhausts the remaining resource availability

Advanced Management Accounting

of row one or satisfies the destination requirement under column two.

4. The Least Cost Method:

- i) Before starting the process of allocation ensure that the total of availability and demand is equal. The least cost method starts by making the first allocation in the cell whose shipping cost (or transportation cost) per unit is lowest.
- ii) This lowest cost cell is loaded or filled as much as possible in view of the origin capacity of its row and the destination requirements of its column.
- iii) We move to the next lowest cost cell and make an allocation in view of the remaining capacity and requirement of its row and column. In case there is a tie for the lowest cost cell during any allocation, we can exercise our judgment and we arbitrarily choose cell for allocation.
- iv) The above procedure is repeated till all row requirements are satisfied.

5. Vogel's Approximation Method (VAM)

VAM entails the following steps:

Step 1: For each row of the transportation table identify the smallest and next smallest costs. Find the difference between the two costs and display it to the right of that row as "Difference" (Diff.). Likewise, find such a difference for each column and display it below that column. In case two cells contain the same least cost then the difference will be taken as zero.

Step 2: From amongst these row and column differences, select the one with the largest difference. Allocate the maximum possible to the least cost cell in the selected column or row. If there occurs a tie amongst the largest differences, the choice may be made for a row or column which has least cost. In case there is a tie in cost cell also, choice may be made for a row or column by which maximum requirement is exhausted. Match that column or row containing this cell whose totals have been exhausted so that this column or row is ignored in further consideration.

Step 3: Recompute the column and row differences for the reduced transportation table and go to step 2. Repeat the procedure until all the column and row totals are exhausted.

6. Optimality Test

Once the initial allocation is done, we have to do the optimality test if it satisfy the condition that number of allocation is equal to $(m+n-1)$ where m = number of rows, n = number of columns. If allocation is less than $(m+n-1)$, then the problem shows

degenerate situation. In that case we have to allocate an infinitely small quantity (ϵ) in least cost and independent cell.

7. Cell Evaluations

The allocations are $m+n-1$ in number and independent.

For each allocated cell, cell value = $c_{ij} = u_{ij} + v_{ij}$ where u_{ij} = row value + column value.

One row where maximum allocation is made, U value is made zero and u_i and v_j for all rows and columns are calculated.

For each unallocated cell, cell value = [cost of cell $-(u + v)$]

Question 1

A product is manufactured by four factories A, B, C and D. The Unit production costs are Rs.2, Rs.3, Re.1 and Rs.5 respectively. Their daily production capacities are 50, 70, 30 and 50 units respectively. These factories supply the product to four P, Q, R and S. The demand made by these stores are 25, 35, 105 and 20 Units transportation cost in rupees from each factory to each store is given in the following table;

		Stores			
		P	Q	R	S
Factory	A	2	4	6	11
	B	10	8	7	5
	C	13	3	9	12
	D	4	6	8	3

Determine the extent of deliveries from each of the factories to each of the stores so that the total cost (production and transportation together) is minimum.

Answer

The new transportation costs table, which consists of both production and transportation costs, is given in following table.

		Store			
		P	Q	R	S
Factories	A	2+2=4	4+2=6	6+2=8	11+2=13
	B	10+3=13	8+3=11	7+3=10	5+3=8
	C	13+1=14	3+1=4	9+1=10	12+1=13
					Supply
					50
					70
					30

Advanced Management Accounting

D	4+5=9	6+5=11	8+5=13	3+5=8	50
Demand	25	35	105	20	200
					185

Since the total supply of 200 units exceeds the total demand of 185 units by $200-185=15$ units of product, there fore a dummy destination (store) is added to absorb the excess supply. The associated cost coefficients in dummy store are taken as zero as the surplus quantity remains lying in the respective factories and is, in fact, not shipped at all. The modified table is given below. The problem now becomes a balanced transportation one and it is a minimization problem. We shall now apply Vogel's Approximation method to fine an initial solution.

	P	Q	R	S	Dummy	Supply	Difference
A	25	5	20	13	0	50/25/20/0	4 2 2 2 5
	4	6	8				
B	13	11	70	8	0	70/0	8 2 2 2 2 2
			10				
C	14	30	10	13	0	30/0	4 6 _ _ _ _
		4					
D	9	11	15	20	15	50/35/15/0	8 1 1 3 3 5
			13	8	0		
Demand	25/0	35/5/0	105/85/15/0	20/0	15/0	200	
Difference	5	2	2	0	0		
	5	2	2	0	-		
	5	5	2	0	-		
	-	5	2	0	-		
	-	-	2	0	-		

The initial solution is shown in above table. It can be seen that 15 units are allocated to dummy store from factory D. This means that the company may cut down the production by 15 units at the factory where it is uneconomical. We will now test the optimality of the solution. The total number of allocations is 8 which is equal to the required $m+n-1 (=8)$ allocation. Introduce u_i 's, v_j 's, $i=(1,2,- - - -4)$ and $j=(1,2,- - - -5)$ $\Delta_{ij}=C_{ij}-(u_i+v_j)$ for allocated cells. We assume that $u_4=0$ and remaining u_j 's, v_j 's and Δ_{ij} 's are calculated below."

The Transportation Problem

	P	Q	R	S	Dummy	Supply	U_i
A	25 4	5 6	20 8	13 +10	0 +5	50	$U_1 = -5$
B	13 +7	11 +3	70 10	8 +3	0 +3	70	$U_2 =$
C	14 +1	30 4	10 +4	13 +12	0 +7	30	$U_3 = -7$
D	9 0	11 0	15 13	20 8	15 0	50	$U_4 = 0$
Demand	25	35	105	20	15		
V_j	$V_1=9$	2	2	0	0		

Please note that figures in top left hand corners of the cell represent the cost and the one in the bottom right hand corner of the non basic cell are the values of $\Delta_{ij}=c_{ij}-[(u_i+v_j)]$.

Since opportunity cost in all the unoccupied cells is positive, therefore initial solution is an optimal solution also. The total cost (transportation and production together) associated with this solution is

Total cost = $4 \times 25 + 6 \times 5 + 8 \times 20 + 10 \times 70 + 4 \times 30 + 13 \times 15 + 8 \times 20 + 0 \times 15$
= $100 + 30 + 160 + 700 + 120 + 195 + 160$
= Rs.1,465/-

Question 2

A compressed Natural Gas (CNG) company has three plants producing gas and four outlets. The cost of transporting gas from different production plants to the outlets, production capacity of each plant and requirement at different outlets is shown in the following cost-matrix table:

Plants	Outlets				Capacity of Production
	A	B	C	D	
X	4	6	8	6	700
Y	3	5	2	5	400
Z	3	9	6	5	600
Requirement	400	450	350	500	1,700

Advanced Management Accounting

Determine a transportation schedule so that the cost is minimized.

The cost in the cost-matrix is given in thousand of rupees.

Answer

The given problem is a balanced minimization transportation problem. The objective of the company is to minimize the cost. Let us find the initial feasible solution using Vogel's Approximation method (VAM)

Plants	Outlets				Capacity	Difference
	A	B	C	D		
X	400 4	6	8	300 6	700/300/0	2 2 0 0
Y	3	50 5	350 2	5	400/50/0	1 2 0 0
Z	400 3	9	6	200	600/200/0	2 2 4 0
Requirement	400/0	450/400/0	350/0	500/300/0		
Difference	0	1	4	0		
	0	1	-	0		
	-	1	-	0		

The initial feasible solution obtained by VAM is given below:

Plants	Outlets				Capacity
	A	B	C	D	
X	400 4	6	8	300 6	700
Y	3	50 5	350 2	5	400
Z	400 3	9	6	200 5	600
Requirement	400	450	350	500	

The Transportation Problem

Since the number of allocations = 6 = (m+n-1), let us test the above solution for optimality. Introduce u_i ($i=1,2,3$) and v_j ($1,2,3,4$) such that $\Delta_{ij} = C_{ij} - (u_i + v_j)$ for allocated cells. We assume $u_1=0$, and rest of the u_i 's, v_j 's and Δ_{ij} 's are calculated as below:

Outlets					
Plants	A	B	C	D	U_i
X	0 4	400 6	5 8	300 6	0
Y	0 3	50 5	350 2	0 5	-1
Z	400 3	4 9	4 6	200 5	-1
V_j	4	6	3	6	

On calculating Δ_{ij} 's for non-allocated cells, we found that all the $\Delta_{ij} \geq 0$, hence the initial solution obtained above is optimal.

The optimal allocations are given below.

Plants	Outlet	Units		Cost		Total Cost
X	→B	400	×	6	=	2,400
X	→D	300	×	6	=	1,800
Y	→B	50	×	5	=	250
Y	→C	350	×	2	=	700
Z	→A	400	×	3	=	1,200
Z	→D	200	×	5	=	<u>1,000</u>
						<u>7,350</u>

The minimum cost = 7,350 thousand rupees.

Since some of the Δ_{ij} 's = 0, the above solution is not unique. Alternative solutions exist.

Advanced Management Accounting

Question 3

Consider the following data for the transportation problem:

Factory	Destination			Supply to be exhausted
	(1)	(2)	(3)	
A	5	1	7	10
B	6	4	6	80
C	3	2	5	15
Demand	75	20	50	

Since there is not enough supply, some of the demands at the three destinations may not be satisfied. For the unsatisfied demands, let the penalty costs be rupees 1, 2 and 3 for destinations (1), (2) and (3) respectively.

Answer

The initial solution is obtained below by vogel's method.

Since demand (=75+20+50=145) is greater than supply (=10+80+15=105) by 40 units, the given problem is an unbalanced one. We introduce a dummy factory with a supply of 40 units. It is given that for the unsatisfied demands, the penalty cost is rupees 1, 2, and 3 for destinations (1), (2) and (3) respectively. Hence, the transportation problem becomes

Factory	Destination			Supply to be exhausted
	(1)	(2)	(3)	
A	5	1	7	10
B	6	4	6	80
C	3	2	5	15
Dummy	1	2	3	40
Demand	75	20	50	145

		Destination			Supply	Difference
		(1)	(2)	(3)		
Factory	A		10		100	4 _ _
		5	1	7		
	B	20	10	50	80/70/50/0	2 2 2
		6	4	6		

The Transportation Problem

C	15				15/0	1 1 1	
		3	2	5			
Dummy	40				40/0	1 1 _	
		1	2	3			
Demand	75/35/20/0		20/10/0		50/0		
Difference	2		1		2		
	2		0		2		
	3		2		1		

The initial solution is given in the table below.

		Destination			Supply
		(1)	(2)	(3)	
Factory	A		10		10
		5	1	7	
B		20	10	50	80
		6	4	6	
C		15			15
		3	2	5	
Dummy		40			40
		1	2	3	
Demand		75	20	50	

We now apply the optimality test to find whether the initial solution found above is optimal or not.

The number of allocations is 6 which is equal to the required $m+n -1$ (=6) allocations. Also, these allocations are in dependent. Hence, both the conditions are satisfied.

Let us now introduce u_i , and v_j $i = (1,2,3,4)$ and $j = (1,2,3)$ such that $\Delta_{ij} = C_{ij} - (u_i+v_j)$ for allocated cells. We assume that $u_2 = 0$ and remaining u_i 's, v_j 's and Δ_{ij} 's are calculated as below:-

		(1)	(2)	(3)	u_i 's
A		2	10	4	-3
		5	1	7	

Advanced Management Accounting

Factory	B	20		10		50		0
		6		4		6		
	C	15		1		2		-3
		3		2		5		
Dummy		40		3		2		-5
		1		2		3		
v _j 's		6		4		6		

Since all Δ_{ij} 's for non basic cells are positive, therefore, the solution obtained above is an optimal one. The allocation of factories to destinations and their cost is given below:-

Factory	Destination	Units	Cost	Total Cost	
A	(2)	10	Re 1	Rs.10	Transportation Cost
B	(1)	20	Rs.6	Rs.120	
B	(2)	10	Rs.4	Rs.40	
B	(3)	50	Rs.6	Rs.300	
C	(1)	15	Rs.3	Rs.45	Penalty Cost
Dummy	(1)	40	Re 1	Rs.40	
				Rs.555	

Question 4

A manufacturing company produces two types of product the SUPER and REGULAR. Resource requirements for production are given below in the table. There are 1,600 hours of assembly worker hours available per week. 700 hours of paint time and 300 hours of inspection time. Regular customers bill demand at least 150 units of the REGULAR type and 90 units of the SUPER type. (8 Marks)

Table

Product	Profit/contribution Rs.	Assembly time Hrs.	Paint time Hrs.	Inspection time Hrs.
REGULAR	50	1.2	0.8	0.2
SUPER	75	1.6	0.9	0.2

Formulate and solve the given Linear programming problem to determine product mix on a weekly basis.

Answer

Let x_1 and x_2 denote the number of units produced per week of the product 'REGULAR' and 'SUPER' respectively.

$$\text{Maximise } Z = 50x_1 + 75x_2$$

Subject to

$$1.2x_1 + 1.6x_2 \leq 1,600 \text{ or } 12x_1 + 16x_2 \leq 16,000 \quad \text{-(i)}$$

$$0.8x_1 + 0.9x_2 \leq 700 \text{ or } 8x_1 + 9x_2 \leq 7,000 \quad \text{-(ii)}$$

$$0.2x_1 + 0.2x_2 \leq 300 \quad \text{or } 2x_1 + 2x_2 \leq 3,000 \quad \text{-(iii)}$$

$$x_1 \geq 150 \quad \text{-(iv)}$$

$$x_2 \geq 90 \quad \text{-(v)}$$

Let

$$x_1 = y_1 + 150$$

$$x_2 = y_2 + 90 \text{ where } y_1, y_2 \geq 0$$

$$\text{Maximize } Z = 50(y_1 + 150) + 75(y_2 + 90) \text{ or } Z = 50y_1 + 75y_2 + 14,250$$

Subject to:

$$12(y_1 + 150) + 16(y_2 + 90) \leq 16,000$$

$$8(y_1 + 150) + 9(y_2 + 90) \leq 7,000$$

$$2(y_1 + 150) + 2(y_2 + 90) \leq 3,000$$

$$\text{and } y_1, y_2 \geq 0$$

Adding slack variables s_1, s_2, s_3 , we get

$$\text{Maximize } Z = 50y_1 + 75y_2 + 14,250 \text{ subject to}$$

$$12y_1 + 16y_2 + s_1 = 12,760$$

$$8y_1 + 9y_2 + s_2 = 4,990$$

$$2y_1 + 2y_2 + s_3 = 2,520$$

Table -1

C_j			50	75	0	0	0	
C_b			y_1	y_2	s_1	s_2	s_3	
0	s_1	12,760	12	16	1	0	0	12760/16

Advanced Management Accounting

0	s_2	4,990	8	9	0	1	0	4990/9
0	s_3	2,520	2	2	0	0	1	2520/2
Δ_j			-50	-75	0	0	0	

Table II

C_j			50	75	0	0	0
C_b			y_1	y_2	s_1	s_2	s_3
0	s_1	3889	-20/9	0	1	-16/9	0
75	y_2	554.44	8/9	1	0	1/9	0
0	s_3	1411	2/9	0	0	-2/9	1
Δ_j			50/3	0	0	75/9	0

Since all the elements in the index row are either positive or equal to zero, table II gives an optimum solution which is $y_1 = 0$ and $y_2 = 554.44$

Substituting these values we get

$$x_1 = 0 + 150 = 150$$

$x_2 = 90 + 554.44 = 644.44$ and the value of objective function is

$$Z = 50 \times 150 + 75 \times 644.44$$

$$= \text{Rs. } 55,833$$

Question 5

A company manufactures two products A and B, involving three departments – Machining, Fabrication and Assembly. The process time, profit/unit and total capacity of each department is given in the following table:

	Machining (Hours)	Fabrication (Hours)	Assembly (Hours)	Profit (Rs).
A	1	5	3	80
B	2	4	1	100
Capacity	720	1,800	900	

Set up Linear Programming Problem to maximise profit. What will be the product Mix at Maximum profit level ?

Answer

Maximize $z = 80x + 100y$ subject to

$$x + 2y \leq 720$$

$$5x + 4y \leq 1800$$

$$3x + y \leq 900$$

$$x \geq 0, y \geq 0$$

where

$$x = \text{No. of units of A}$$

$$y = \text{No. of units of B}$$

By the addition of slack variables s_1 , s_2 and s_3 the inequalities can be converted into equations. The problems thus become

$z = 80x + 100y$ subject to

$$x + 2y + s_1 = 720$$

$$5x + 4y + s_2 = 1800$$

$$3x + y + s_3 = 900$$

and $x \geq 0, y \geq 0,$ $s_1 \geq 0, s_2 \geq 0, s_3 \geq 0$

Table I:

	Profit/unit	Qty.	80	100	0	0	0	
		X	Y	S_1	S_2	S_3		
S_1	0	720	I	2	1	0	0	$\frac{720}{2} = 360$
S_2	0	1800	5	4	0	1	0	$1800/4 = 450$
S_3	0	900	3	I	0	0	1	$900/1 = 900$
Net evaluation row			80	100	0	0	0	
$1800 - 720 \times 4/2 = 360$			$900 - 720 \times 1/2 = 540$					
$5 - 1 \times 2 = 3$			$3 - 1 \times 1/2 = 5/2$					
$4 - 2 \times 2 = 0$			$1 - 2 \times 1/2 = 0$					
$0 - 1 \times 2 = -2$			$0 - 1 \times 1/2 = -1/2$					
$1 - 0 \times 2 = 1$			$0 - 0 \times 1/2 = 0$					
$0 - 0 \times 2 = 0$			$1 - 0 \times 1/2 = 1$					

Advanced Management Accounting

Table 2:

Program	Profit/unit	Qty.	80 X	100 Y	0 S ₁	0 S ₂	0 S ₃	
Y	100	360	$\frac{1}{2}$	I	$\frac{1}{2}$	0	0	$360 \div \frac{1}{2} = 720$
S2	0	360	3	0	-2	1	0	$360 \div 3 = 120$
S3	0	540	$\frac{5}{2}$	0	$-\frac{1}{2}$	0	I	$540 \div \frac{5}{2} = 216$
Net evaluation row			30	0	-50	0	0	

$$360 - 360 \times \frac{1}{6} = 300$$

$$\frac{1}{2} - 3 \times \frac{1}{6} = 0$$

$$1 - 0 \times \frac{1}{6} = 1$$

$$\frac{1}{2} - 2 \times \frac{1}{6} = \frac{5}{6}$$

$$0 - 1 \times \frac{1}{6} = -\frac{1}{6}$$

$$0 - 0 \times \frac{1}{6} = 0$$

$$540 - 360 \times \frac{5}{6} = 240$$

$$\frac{5}{2} - 3 \times \frac{5}{6} = 0$$

$$0 - 0 \times \frac{5}{6} = 0$$

$$-\frac{1}{2} - 2 \times \frac{5}{6} = \frac{7}{6}$$

$$0 - 1 \times \frac{5}{6} = -\frac{5}{6}$$

$$1 - 0 \times \frac{5}{6} = 1$$

Table 3:

Program	Profit/unit	Qty.	80 X	100 Y	0 S ₁	0 S ₂	0 S ₃
Y	100	300	0	I	$\frac{5}{6}$	$-\frac{1}{6}$	0
X	80	120	I	0	$-\frac{2}{3}$	$\frac{1}{3}$	0
S3	0	240	0	0	$\frac{7}{6}$	$-\frac{5}{6}$	I
Net evaluation row			0	0	$-\frac{500}{6}$	$+\frac{100}{6}$	
					$+\frac{160}{3}$	$-\frac{80}{3}$	0
					$= \frac{180}{6}$	$= -\frac{60}{6}$	

All the values of the net evaluation row of Table 3 are either zero or negative, the optimal program has been obtained.

Here $X = 120$, $y = 300$ and the maximum profit
 $= 80 \times 120 + 100 \times 300 = 9600 + 30,000$
 $= \text{Rs. } 39,600.$

Question 6

Three grades of coal A, B and C contains phosphorus and ash as impurities. In a particular industrial process, fuel up to 100 ton (maximum) is required which could contain ash not more than 3% and phosphorus not more than .03%. It is desired to maximize the profit while satisfying these conditions. There is an unlimited supply of each grade. The percentage of impurities and the profits of each grade are as follows:

Coal	Phosphorus (%)	Ash (%)	Profit in Rs. (per ton)
A	.02	3.0	12.00
B	.04	2.0	15.00
C	.03	5.0	14.00

You are required to formulate the Linear-programming (LP) model to solve it by using simplex method to determine optimal product mix and profit.

Answer

Let X_1 , X_2 and X_3 respectively be the amounts in tons of grades A, B, and C used. The constraints are

(i) Phosphorus content must not exceed 0.03%

$$.02 X_1 + .04 X_2 + 0.3 X_3 \leq .03 (X_1 + X_2 + X_3)$$

$$2X_1 + 4 X_2 + 3X_3 \leq 3 (X_1 + X_2 + X_3) \text{ or } -X_1 + X_2 \leq 0$$

(ii) Ash content must not exceed 3%

$$3X_1 + 2 X_2 + 5 X_3 \leq 3 (X_1 + X_2 + X_3) \text{ or } -X_2 + 2X_3 \leq 0$$

(iii) Total quantity of fuel required is not more than 100 tons. $X_1 + X_2 + X_3 \leq 100$

The Mathematical formulation of the problem is

$$\text{Maximize } Z = 12 X_1 + 15X_2 + 14 X_3$$

Subject to the constraints:

$$-X_1 + X_2 \leq 0$$

$$-X_2 + X_3 \leq 0$$

$$X_1 + X_2 + X_3 \leq 100$$

$$X_1, X_2, X_3 > 0$$

Introducing slack variable $X_4 > 0$, $X_5 > 0$, $X_6 > 0$

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			12	15	14	0	0	0
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
0	Y_4	0	-1	1*	0	1	0	0
0	Y_5	0	0	-1	2	0	1	0
0	Y_6	100	1	1	1	0	0	1
	Z		-12	-15	-14	0	0	0
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
15	Y_2	0	-1	1	0	1	0	0
0	Y_5	0	-1	0	2	1	1	0
0	Y_6	100	2*	0	1	-1	0	1
	Z		-27		-14	15	0	0
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
15	Y_2	50	0	1	1/2	1/2	0	1/2
0	Y_5	50	0	0	5/2*	1/2	1	1/2
12	Y_1	50	1	0	1/2	-1/2	0	1/2
	Z		0	0	-1/2	3/2	0	27/2
C_b	Y_b	X_b	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
15	Y_2	40	0	1	0	2/5	-1/5	2/5
14	Y_3	20	0	0	1	1/5	2/5	1/5
12	Y_1	40	1	0	0	-3/5	-1/5	2/5
	Z		0	0	0	8/5	1/5	68/5

The optimum solution is $X_1 = 40$, $X_2 = 40$ and $X_3 = 20$ with maximum $Z = 1360$.

Question 7

The initial allocation of a transportation problem, alongwith the unit cost of transportation from each origin to destination is given below. You are required to arrive at the minimum transportation cost by the Vogel's Approximation method and check for optimality.

(Hint: Candidates may consider $u_1 = 0$ at Row 1 for initial cell evaluation)

The Transportation Problem

Requirement

		8		6	4	
11	2		8	6	2	18
	10					
9		9	12	9	6	10
			8			
7	6		3	7	7	8
	2			2		
9		3	5	6	11	4
<u>Availability</u>						
12	8	8	8	4		40

Answer

The concept tested in this problem is Degeneracy with respect to the transportation problem. Total of rows and columns = $(4 + 5) = 9$. Hence, the number of allocations = $9 - 1 = 8$. As the actual number of allocation is 7, a 'zero' allocation is called for. To resolve this, an independent cell with least cost should be chosen. R4C2 has the least cost (cost = 3), but this is not independent. The next least cost cell R4C3 (cost = 5) is independent.

	9	2	5	6	2	
	C1	C2	C3	C4	C5	Total
		8		6	4	
0R1	11	2	8	6	2	18
	10					
0R2	9	9	12	9	6	10
			8			
-2R3	7	6	3	7	7	8
	2		0	2		
0R4	9	3	5	6	11	4
Total	12	8	8	8	4	40

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Forming Equations through allocated cells

Basic equation	Setting R1 = 0 other values
$R1 + C2 = 2$	Setting R1 = 0, C2 = 2
$R1 + C4 = 6$	$C4 = 6$
$R1 + C5 = 2$	$C5 = 2$
$R2 + C1 = 9$	$R2 = 0$
$R3 + C3 = 3$	$R3 = -2$
$R4 + C1 = 9$	$C1 = 9$
$R4 + C3 = 5$	$C3 = 5$
$R4 + C4 = 6$	$R4 = 0$

Evaluate unallocated cells

$R1C1 = 11 - 0 - 9 = 2$	$R3C1 = 7 + 2 - 9 = 0$
$R1C3 = 8 - 0 - 5 = 3$	$R3C2 = 6 + 2 - 2 = 6$
$R2C2 = 9 - 0 - 2 = 7$	$R3C4 = 7 + 2 - 6 = 7$
$R2C3 = 12 - 0 - 5 = 7$	$R3C5 = 7 + 2 - 2 = 7$
$R2C4 = 9 - 0 - 6 = 3$	$R4C2 = 3 - 0 - 2 = 1$
$R2C5 = 6 - 0 - 2 = 4$	$R4C5 = 11 - 0 - 2 = 9$

Since all the evaluation is 0 or +ve, the optimal solution is obtained.

Optimal cost = $(8 \times 2) + (6 \times 6) + (4 \times 2) + (10 \times 9) + (8 \times 3) + (2 \times 9) + (0 \times 5) + (2 \times 6)$
 $= 16 + 36 + 8 + 90 + 24 + 18 + 10 + 12 = \text{Rs. } 204.$

Note: As regards allocation of the zero values, the solution to the above problem is also obtained by allocating the zero value in other independent cells such as R1C3, R2C2, R2C3, R3C1, R3C2, R3C4, R3C5. In such situation there will be one more iteration.

Question 8

Goods manufactured at 3 plants, A, B and C are required to be transported to sales outlets X, Y and Z. The unit costs of transporting the goods from the plants to the outlets are given below:

The Transportation Problem

<i>Sales outlets \ Plants</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>Total Demand</i>
<i>X</i>	3	9	6	20
<i>Y</i>	4	4	6	40
<i>Z</i>	8	3	5	60
<i>Total supply</i>	40	50	30	120

You are required to:

- Compute the initial allocation by North-West Corner Rule.
- Compute the initial allocation by Vogel's approximation method and check whether it is optional.
- State your analysis on the optionality of allocation under North-West corner Rule and Vogel's Approximation method.

Answer

20	—	—	20
3	9	6	
20	20	—	40
4	4	6	
—	30	30	60
8	3	5	
40	50	30	120

- (i) Initial allocation under NW corner rule is as above.

$$\begin{aligned}
 \text{Initial cost: } & 20 \times 3 = 60 \\
 & 20 \times 4 = 80 \\
 & 20 \times 4 = 80 \\
 & 30 \times 3 = 90 \\
 & 30 \times 5 = \underline{150} \\
 & \underline{460}
 \end{aligned}$$

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(ii) Initial solution by VAM:

	20	—	—	20	3		
3		9	6				
	20	—		40	0	0	2
4		4	6				
		50	10	60	2	2	2
8		3	5				
	40	50	30				
	1	1	1				
	4	1	1				
		1	1				

$$\begin{aligned}
 \text{Initial solution:} \quad & 20 \times 3 = 60 \\
 & 20 \times 4 = 80 \\
 & 50 \times 3 = 150 \\
 & 20 \times 6 = 120 \\
 & 10 \times 5 = \underline{100} \\
 & \underline{460}
 \end{aligned}$$

Checking for optimality

3			$u_1 = 0$
4		6	$u_2 = 1$

	3	5	$u_3 = 0$
$v_1 = 3$	$v_2 = 3$	$v_3 = 5$	

$u_i + v_j$

	3	5	0
	4		1
3			0
3	3	5	

$$\Delta_{ij} = C_{ij} - (U_i + V_j)$$

	6	1
	0	
5		

$\Delta_{ij} \geq 0 \therefore$ Solution is optimal

Conclusion:

The solution under VAM is optimal with a zero in R_2C_2 which means that the cell C_2R_2 which means that the cell C_2R_2 can come into solution, which will be another optimal solution. Under NWC rule the initial allocation had C_2R_2 and the total cost was the same Rs. 460 as the total cost under optimal VAM solution. Thus, in this problem, both methods have yielded the optimal solution under the 1st allocation. If we do an optimality test for the solution, we will get a zero for Δ_{ij} in C_3R_2 indicating the other optimal solution which was obtained under VAM.

Question 9

State the methods in which initial feasible solution can be arrived at in a transportation problem

Answer

The methods by which initial feasible solution can be arrived at in a transportation model are as under:

- (i) North West Corner Method.
- (ii) Least Cost Method
- (iii) Vogel's Approximation Method (VAM)

Question 10

The cost per unit of transporting goods from the factories X, Y, Z to destinations. A, B and C, and the quantities demanded and supplied are tabulated below. As the company is working out the optimum logistics, the Govt.; has announced a fall in oil prices. The revised unit costs are exactly half the costs given in the table. You are required to evaluate the minimum transportation cost.

Destinations Factories	A	B	C	Supply
X	15	9	6	10
Y	21	12	6	10

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Z	6	18	9	10
Demand	10	10	10	30

Answer

The problem may be treated as an assignment problem. The solution will be the same even if prices are halved. Only at the last stage, calculate the minimum cost and divide it by 2 to account for fall in oil prices.

	A	B	C
X	15	9	6
Y	21	12	6
Z	6	18	9

Subtracting Row minimum, we get

	A	B	C
X	9	3	0
Y	15	6	0
Z	0	12	3

Subtracting Column minimum,

	A	B	C
X	9	3	0
Y	15	6	0
Z	0	12	3

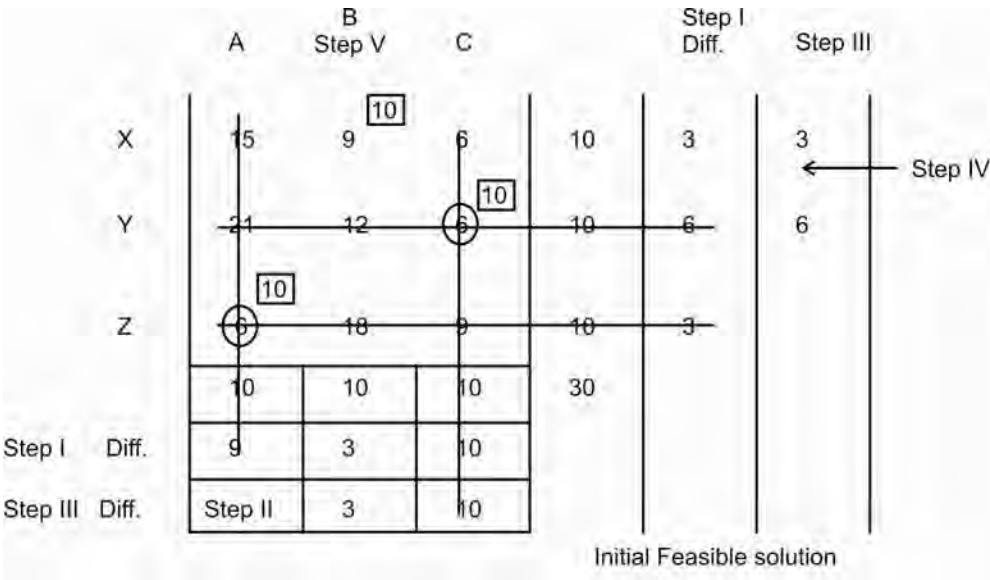
No of lines required to cut Zeros = 3

		Cost / u	Units	Cost	Revised Cost
Allocation:	X B →	9	10	90	45
	Y C →	6	10	60	30
	Z A →	6	10	<u>60</u>	<u>30</u>
				<u>210</u>	<u>105</u>

Minimum cost = 105 Rs.

Alternative Solution I

Least Cost Method



X – B

Y – C

Z – A

Test for optimality

No. of allocation = 3

No. of rows $m = 3$, no. of column = 3

$$m + n - 1 = 3 + 3 - 1 = 5$$

2 very small allocation are done to 2 cells of minimum costs, so that , the following table is got:

	A	B	C
X	15	1 9	e 6
Y	21	12	1 6

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Z	16	18	e9
---	---------------	----	---------------

$m + n - 1 = 5$

Now testing for optimality

				u_i
		9	e	0
			6	0
	6		e	0
v_j	6	9	6	

$u_i + v_j$ for unoccupied cells

	A	B	C
X	6	-	-
Y	6	9	-
Z	-	9	-

$Diff = C_{ij} - (u_i + v_j)$

	A	B	C
X	9	-	-
Y	15	3	-
Z	-	9	-

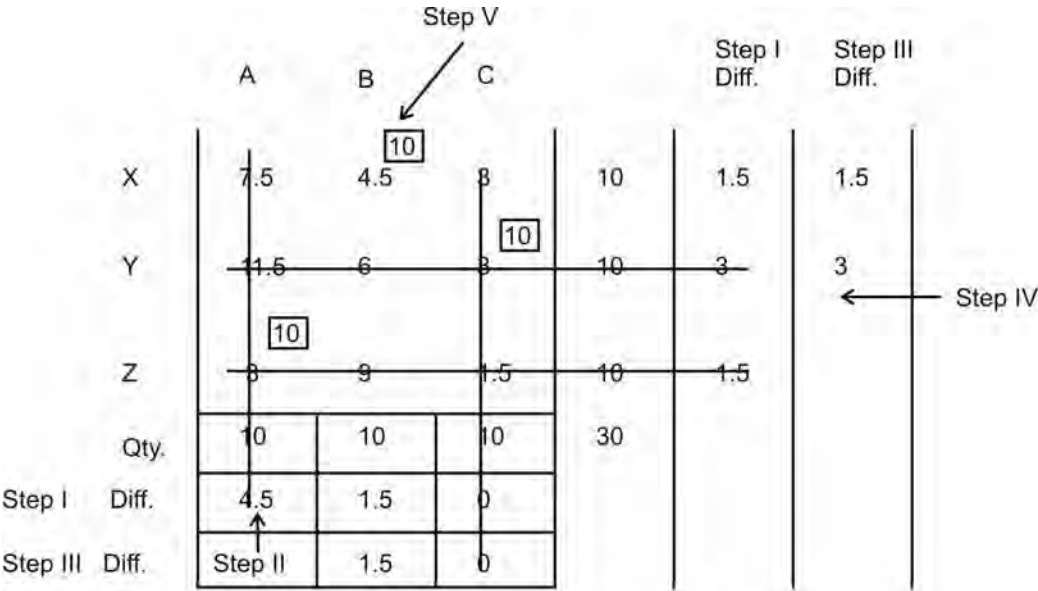
The Transportation Problem

All $\Delta_{ij} > 0$, Hence this is the optimal solution.

	Original Costs	Reduced Costs due to Oil Price	Qty.	Cost
X – B	9	4.5	10	45
Y – C	6	3	10	30
Z – A	6	3	10	<u>30</u>
				<u>105</u>

Total cost of transportation is minimum at Rs.105

Alternative Solution II



Initial Solution :

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	A	B	C
X	7.5	4.5	3
Y	11.5	6	3
Z	3	9	4.5

No. of rows + no. of column – 1

$m + n - 1 = 5$

No. of allocation = 3

Hence add 'e' to 2 least cost cells so that

	A	B	C
X	7.5	4.5	3
Y	11.5	6	3
Z	3	9	4.5

Now $m + n - 1 = 5$

Testing for optimality,

u_i, v_j table

	A	B	C	u_i
X		4.5	e	0
Y			3	0
Z	3		e	0
v_j	3	4.5	3	

$u_i + v_j$ for unoccupied cells

	3	-	-
	3	4.5	-
	-	4.5	-

C_{ij}	$u_i + v_j$				
7.5	-	-		3	-
11.5	6	-		3	4.5
-	9	-		-	4.5

$\Delta_{ij} = C_{ij} - (u_i + v_j)$

4.5	-	-	
11.5	1.5	-	
8.5	4.5	-	

All $\Delta_{ij} > 0$. Hence the solution is optimal.

	Qty.	Cost/u	Total Cost
X – B	10	4.5	45
Y – C	10	3	30
Z – A	10	3	30
Total minimum cost at revised oil prices			105

Question 11

How do you know whether an alternative solution exists for a transportation problem?

Answer

The Δ_{ij} matrix = $\Delta_{ij} = C_{ij} - (u_i + v_j)$

Where c_i is the cost matrix and $(u_i + v_j)$ is the cell evaluation matrix for allocated cell.

The Δ_{ij} matrix has one or more 'Zero' elements, indicating that, if that cell is brought into the solution, the optional cost will not change though the allocation changes.

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Thus, a 'Zero' element in the Δ_{ij} matrix reveals the possibility of an alternative solution.

Question 12

Explain the term degeneracy in a transportation problem.

Answer

If a basic feasible solution of transportation problem with m origins and n destinations has fewer than $m + n - 1$ positive x_{ij} (occupied cells) the problem is said to be a degenerate transportation problem. Such a situation may be handled by introducing an infinitesimally small allocation ϵ in the least cost and independent cell.

While in the simple computation degeneracy does not cause any serious difficulty, it can cause computational problem in transportation problem. If we apply modified distribution method, then the dual variable u_i and v_j are obtained from the C_{ij} value to locate one or more C_{ij} value which should be equated to corresponding $C_{ij} + V_{ij}$.

EXERCISE**Question 1**

A particular product is manufactured in factories A, B, and D: and is sold at centers 1, 2 and 3. The cost in Rs. of product per unit and capacity in kgms per unit time of each plant is given below:

Factory	Coast (Rs.) per unit	Capacity (kgms) per unit
A	12	100
B	15	20
C	11	60
D	13	80

The sale price in Rs. Per unit and the demand is kgms per unit time are as follows:

Sale Centre	Sale price (Rs.) per unit	Demand (Kgms) per unit
1	15	120
2	14	140
3	16	60

Find the optimal sales distribution.

Answer

Total Profit = Rs. 660

Question 2

A Company has four factories F_1 , F_2 , F_3 and F_4 , manufacturing the same product. Production and raw material costs differ from factory to factory and are given in the first two rows of the following table. The Transportation costs from the factories to sales depots S_1 , S_2 and S_3 are given in the next three rows of the table. The production capacity of each factory is given in the last row.

The last two columns in the table given the sales price and the total requirement at each depot:

Item Per unit	Factory				Sales price Per unit	Requirement
	F_1	F_2	F_3	F_4		
Production cost	15	18	14	13	-	-
Raw material cost	10	9	12	9	-	-

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Transportation cost	3	9	5	4	34	80
	1	7	4	5	32	120
	5	8	3	6	31	150
Production capacity	10	150	50	100	-	-

Determine the most profitable production and distribution schedule and the corresponding profit. The surplus should be taken to yield zero profit.

Answer

Profit associated with the optimum Program is Rs. 480.

Question 3

A company has 3 plants and 3 warehouses. The cost of sending a unit from different plants to the warehouses, production at different plants and demand at different warehouses are shown in the following cost matrix table:

Plants	Warehouses A B C	Production
X	8 16 16	152
Y	32 48 32	164
Z	16 32 48	154
Demand	144 204 82	

Determine a transportation schedule, so that the cost is minimized. Assume that the cost in the cost matrix is given in thousand of rupees.

Answer

On calculating Δi_j 's=0, the solution is not unique.

Question 4

Following is the profit matrix based on four factories and three sales depots of the company:

		S_1	S_2	S_3	Availability
Towns	F_1	6	6	1	10
	F_2	-2	-2	-4	150
	F_3	3	2	2	50

The Transportation Problem

F_4	8	5	3	100
Requirement	80	120	150	

Determine the most profitable distribution schedule and the corresponding profit, assuming no profit in case of surplus production.

Answer

Total Profit = Rs. 480

Question 5

A company produces a small component for all industrial products and distributes it to five wholesalers at a fixed prices of Rs.2.50 per unit. Sales forecasts indicate that monthly deliveries will be 3,000, 3,000, 10,000, 5,000 and 4,000 units to wholesalers 1,2,3,4 and 5 respectively. The monthly production capabilities are 5,000, 10,000, 12,500 at plants 1, 2 and 3 respectively. The direct costs of production of each unit are Rs.1.00 and Rs.0.80 at plants 1, 2 and 3 respectively. The transportation costs of shipping a unit from a plant to a wholesaler are given below:

		1	2	3	4	5
Plant	1	0.05	0.07	0.10	0.15	0.15
	2	0.08	0.06	0.09	0.12	0.14
	3	0.10	0.09	0.08	0.10	0.15

Find how many components each plant supplies to each wholesaler in order to maximize profit.

Answer

Profit = Rs.32,520

Question 6

The following table shows all the necessary information on the available supply to each warehouse, the requirement of each market and the unit transportation cost from each warehouse to each market:

		Market				Supply
		I	II	III	IV	
Warehouse	A	5	2	4	3	22
	B	4	8	1	6	15

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	C	4	6	7	5	8
Requirement		7	12	17	9	

The shipping clerk has worked out the following schedule from his experience:

12 Units from A to II

1 Unit from A to III

9 Units from A to IV

15 Units from B to III

7 Units from C to I and

1 Unit from C to III

You are required to answer the following:

- Check and see if the clerk has the optimal schedule;
- Find the optimal schedule and minimum total shipping cost; and
- If the clerk is approached by a carrier of route C to II, who offers to reduce his rate in the hope of getting some business, by how much should the rate be reduced before the clerk should consider giving him an order?

Answer

Total Shipping Cost = Rs.103.

Question 7

A company has three warehouses W_1 , W_2 and W_3 . It is required to deliver a product from these warehouses to three customers A, B and C. These warehouses have the following units in stock.

Warehouse:	W_1	W_2	W_3
No. of units:	65	42	43

and customer requirements are:

Customer:	A	B	C
No. of units:	70	30	50

The Transportation Problem

The table below shows the costs of transporting one unit from warehouse to the customer:

		Warehouse		
		W_1	W_2	W_3
Customer	A	5	7	8
	B	4	4	6
	C	6	7	7

Find the optimal transportation route.

Answer Total Cost = Rs. 830

Question 8

A company has four factories situated in four different locations in the country and four sales agencies located in four other locations in the country. The cost of production (Rs. Per unit), the sales price (Rs. per unit), and shipping cost (Rs. Per unit) in the case of matrix, monthly capacities and monthly requirements are given below:

Factory	Sales Agency				Monthly Capacity (Units)	Cost of production
	1	2	3	4		
A	7	5	6	4	10	10
B	3	5	4	2	15	15
C	4	6	4	5	20	16
D	8	7	6	5	15	15
Monthly Requirement (Units)	8	12	18	22		
Sales Price	20	22	25	18		

Find the monthly production and distribution schedule which will maximize profit.

Answer

Since one of the Δ_{ij} 's is Zero, the optimal solution obtained above is not unique. Alternate solution also exists.

Question 9

XYZ and Co. has provided the following data seeking your advice on optimum investment strategy.

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Investment made at the Beginning of year	Net Return Data (in Paise) of Selected Investment				Amount available (Lacs)
	P	Q	R	S	
1	95	80	70	60	70
2	75	65	60	50	40
3	70	45	50	40	90
4	60	40	40	30	30
Maximum Investment (Lacs)	40	30	60	60	

The following additional information are also provided

- P, Q, R and S represent the selected investments,
- The company has decided to have four years investment plan.
- The policy of the company is that amount invested in any year will remain so until the end of the fourth year.
- The values (Paise) in the table represent net return on investment of one Rupee till the end of the planning horizon (for example, a Rupee investment in Investment P at the beginning of year 1 will grow to Rs.1.95 by the end of the fourth year, yielding a return of 95 paise)

Using the above determine the optimum investment strategy.

Answer

The optimal allocations are given below:

Year	Invest in	Net Return
1	Invest Rs 40 lacs in investment P	$0.95 \times \text{Rs.}40 \text{ lacs} = \text{Rs. } 38,00,000$
	Rs 30 lacs in investment Q	$0.80 \times \text{Rs.}30 \text{ lacs} = \text{Rs. } 24,00,000$
2	Invest Rs 20 lacs in investment Q	$0.65 \times \text{Rs.}20 \text{ lacs} = \text{Rs. } 13,00,000$
	Rs 20 lacs in investment R	$0.60 \times \text{Rs.}20 \text{ lacs} = \text{Rs. } 12,00,000$
3	Invest Rs 40 lacs in investment R	$0.50 \times \text{Rs.}40 \text{ lacs} = \text{Rs. } 20,00,000$
	Rs 50 lacs in investment S	$0.40 \times \text{Rs.}50 \text{ lacs} = \text{Rs. } 20,00,000$
4	Invest Rs.10 lacs in investment S	$0.30 \times \text{Rs.}10 \text{ lacs} = \text{Rs. } 3,00,000$
	Total	Rs.130,00,000

Question 10

A company has four terminals U, V, W and X. At the start of a particular day 10, 4, 6 and 5 trailers respectively are available at these terminals. During the previous night 13, 10, 6 and 6 trailers respectively were loaded at plants A, B, C and D. The company dispatcher has come up with the costs between the terminals and plants as follows:

Plants

		A	B	C	D
<i>Terminals</i>	U	20	36	10	28
	V	40	20	45	20
	W	75	35	45	50
	X	30	35	40	25

Find the allocation of loaded trailers from plants to terminals in order to minimize transportation cost.

Answer Terminal Plant Cost = Rs. 555

THE ASSIGNMENT PROBLEM

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. The Assignment Algorithm

The Assignment Problem is another special case of LPP. It occurs when n jobs are to be assigned to n facilities on a one-to-one basis with a view to optimising the resource required.

2. Steps for Solving the Assignment Problem

Assignment problem can be solved by applying the following steps:

Step 1: Subtract the minimum element of each row from all the elements in that row. From each column of the matrix so obtained, subtract its minimum element. The resulting matrix is the starting matrix for the following procedure.

Step 2: Draw the minimum number of horizontal and vertical lines that cover all the zeros. If this number of lines is n , order of the matrix, optimal assignment can be made by skipping steps 3 and 4 and proceeding with step 5. If, however, this number is less than n , go to the next step.

Step 3: Here, we try to increase the number of zeros in the matrix. We select the smallest element out of these which do not lie on any line. Subtract this element from all such (uncovered) elements and add it to the elements which are placed at the intersections of the horizontal and vertical lines. Do not alter the elements through which only one line passes.

Step 4: Repeat steps 1, 2 and 3 until we get the minimum number of lines equal to n .

Step 5: (A) Starting with first row, examine all rows of matrix in step 2 or 4 in turn until a row containing exactly one zero is found. Surround this zero by, indication of an assignment there. Draw a vertical line through the column containing this zero. This eliminates any confusion of making any further assignments in that column. Process all the rows in this way.

(B) Apply the same treatment to columns also. Starting with the first column, examine all columns until a column containing exactly one zero is found. Mark and

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draw a horizontal line through the row containing this marked zero. Repeat steps 5A and B, until one of the following situations arises:

- (i) No unmarked () or uncovered (by a line) zero is left,
- (ii) There may be more than one unmarked zero in one column or row. In this case, put around one of the unmarked zero arbitrarily and pass 2 lines in the cells of the remaining zeros in its row and column. Repeat the process until no unmarked zero is left in the matrix.

3. Unbalanced Assignment Problems

Like the unbalanced transportation problems there could arise unbalanced assignment problems too. They are to be handled exactly in the same manner i.e., by introducing dummy jobs or dummy men, etc.

Question 1

An Electronic Data Processing (ED) centre has three expert Software professionals. The Centre wants three application software programs to be developed. The head of EDP Centre estimates the computer time in minutes required by the experts for development of Application Software Programs as follows:

Software programs	Computer time (in minutes) required by software Professionals
1	100 85 70
2	50 70 110
3	110 120 130

Assign the software professionals to the application software programs to ensure minimum usage of computer time.

Answer

The given problem is a balanced minimization assignment problem.

Step 1 & II: The minimum time elements in row 1, 2 and 3 are 70, 50 and 110 respectively. We subtract these elements from all elements in their respective row. The reduced matrix is shown in Table 1.

Table 1

Software Programs	A	B	C
1	30	15	0
2	0	20	60
3	0	10	20

The Assignment Problem

The minimum time elements in columns A, B and C are 0, 10, and 0 respectively. Subtract these elements from all the elements in their respective columns to get the reduced time matrix as shown in table 2.

Table 2

Software Programs	A	B	C
1	30	5	0
2	0	10	60
3	10	0	20

Step 3(a): The minimum number of horizontal and vertical lines to cover all zeros is 3, which is equal to the order of the matrix. Examine all rows one by one starting from row 1 until a row containing only single zero element is located. Assign this zero. All zero in the assigned column are crossed off as shown in table 3.

Table 3

Software Programs	A	B	C
1	30	5	0
2	0	10	60
3	10	0	20

Step 3(b): Now examine each column starting from A. There is only one zero in column. B Assign this cell as shown in table 4

Table 4

Software Programs	A	B	C
1	30	15	0
2	0	20	60
3	10	0	20

Step 3(c): Since the number of assignments (=3) equals the number of rows, the optimal solution is obtained. This Pattern of assignments among software professionals and programs with their respective time (in minutes) is given below:

Program	Software Professionals	Time (in Minutes)
1	C	70
2	A	50
3	B	120
	Total	240

Advanced Management Accounting**Question 2**

A Production supervisor is considering, how he should assign five jobs that are to be performed, to five mechanists working under him. He wants to assign the jobs to the mechanists in such a manner that the aggregate cost to perform the jobs is the least. He has following information about the wages paid to the mechanists for performing these jobs:

Jobs

Mechanist	1	2	3	4	5
A	10	3	3	2	8
B	9	7	8	2	7
C	7	5	6	2	4
D	3	5	8	2	4
E	9	10	9	6	10

Assign the jobs to the mechanists so that the aggregate cost is the least.

Answer

The given problem is a standard minimization problem.

Subtracting minimum element of each row from all the elements of that row, the given problem reduces to

Jobs

Mechanist	1	2	3	4	5
A	8	1	1	0	6
B	7	5	6	0	5
C	5	3	4	0	2
D	1	3	6	0	2
E	3	4	3	0	4

Subtract the minimum element of each column from all the elements of that column. Draw the minimum number of lines horizontal or vertical so as to cover all zeros.

Jobs

Mechanist	1	2	3	4	5
A	7	0	0	0	4
B	6	4	5	0	3
C	4	2	3	0	0
D	0	2	5	0	0
E	2	3	2	0	2

The Assignment Problem

Since the minimum number of lines covering all zeros is equal to 4 which is less than the number of columns/rows (=5), the above table will not provide optimal solution. Subtract the minimum uncovered element (=2) from all uncovered elements and add to the elements lying on the intersection of two lines, we get the following matrix.

Jobs					
Mechanist	1	2	3	4	5
A	7	0	0	2	6
B	4	2	3	0	3
C	2	0	1	0	0
D	0	2	5	2	2
E	0	1	0	0	2

Since the minimum number of horizontal and vertical lines to cover all zeros is equal to five which is equal to the order of the matrix, the above table will give the optimal solution. The optimal assignment is made below:

Jobs					
Mechanist	1	2	3	4	5
A	7	2 0	0	2 0	6
B	4	2	3	0	3
C	2	0	1	0	0
D	0	2	5	2	2
E	0	1	0	0	2

The optimal assignment is given below:

Mechanist	Job	Wages
A	2	3
B	4	2
C	5	4
D	1	3
E	3	<u>9</u>
		<u>21</u>

The total least cost associated with the optimal mechanist-job assignment = 21

Advanced Management Accounting

Question 3

A project consists of four (4) major jobs, for which four (4) contractors have submitted tenders. The tender amounts, in thousands of rupees, are given below.

Jobs				
Contractors	A	B	C	D
1	120	100	80	90
2	80	90	110	70
3	110	140	120	100
4	90	90	80	90

Find the assignment, which minimizes the total cost of the project. Each contractor has to be assigned one job.

Answer

The given problem is a standard minimization problem. Subtracting the minimum element of each row from all its elements in turn, the given problem reduces to

Jobs				
Contractors	A	B	C	D
1	40	20	0	10
2	10	20	40	0
3	10	40	20	0
4	10	10	0	10

Now subtract the minimum element of each column from all its elements in turn. Draw the minimum number of lines horizontal or vertical so as to cover all zeros.

Jobs				
Contractors	A	B	C	D
1	30	10	0	10
2	0	10	40	0
3	0	30	20	0
4	0	0	0	10

Since the minimum number of lines to cover all zeros is equal to 4 (=order of the matrix), this matrix will give optimal solution. The optimal assignment is made in the matrix below:

The Assignment Problem

Contractors	Jobs			
	A	B	C	D
1	30 0	10	0	10
2	0	10	40	0
3	0	30	20	0
4	0	0	0	10

The optimal assignment is

Contractor	Job	Cost (in thousands of rupees)
1	C	80
2	A	80
3	D	100
4	B	90

Hence, total minimum cost of the project will be Rs.3,50,000.

Question 4

A project consists of four (4) major jobs, for which four (4) contractors have submitted tenders. The tender amounts, in thousands of rupees, are given below:

Contractors	Jobs			
	A	B	C	D
1	120	100	80	90
2	80	90	110	70
3	110	140	120	100
4	90	90	80	90

Final the assignment, which minimizes the total cost of the project. Each contractor has to be assigned one job.

Answer

The given problem is a standard minimization problem. Subtracting the minimum element of each row from all its elements in turn, the given problem reduces to

Advanced Management Accounting

Jobs

<i>Contractors</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
1	40	20	0	10
2	10	40	20	0
3	10	40	20	0
4	10	10	0	0

Now subtract the minimum element of each column from all its elements in turn. Draw the minimum number of lines horizontal or vertical so as to cover all zeros.

Jobs

<i>Contractors</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
1	30	40	0	10
2	0	10	40	0
3	0	30	20	0
4	0	0	0	10

Since the minimum number of lines to cover all zeros is equal to 4 (= order of the matrix), this matrix will give optimal solution. The optimal assignment is made in the matrix below.

<i>Contractors</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
1	30	40	0	10
2	0	10	40	0
3	0	30	20	0
4	0	0	0	10

The optimal assignment is:

Contractor	Job	Cost (in thousands of rupees)
1	C	80
2	A	80
3	D	100
4	B	90

Hence, total minimum cost of the project will be Rs. 3,50,000.

Question 5

A Marketing Manager has 4 subordinates and 4 tasks. The subordinates differ in efficiency. The tasks also differ in their intrinsic difficulty. His estimates of the time each subordinate would take to perform each task is given in the matrix below. How should the task be allocated one to one man so that the total man-hours are minimised ?

	I	II	III	IV
1	16	52	34	22
2	26	56	8	52
3	76	38	36	30
4	38	52	48	20

Answer

	I	II	III	IV
1	16	52	34	22
2	26	56	8	52
3	76	38	36	30
4	38	52	48	20

Step 1:

Subtract the smallest element of each row from every element of the corresponding row

	I	II	III	IV
1	0	36	18	6
2	18	48	0	44
3	46	8	6	0
4	18	32	28	0

Step 2: Subtract the smallest element of each column from every element in that column

	I	II	III	IV
1	0	28	18	6
2	18	40	0	44
3	46	0	6	0
4	18	24	28	0

Advanced Management Accounting**Step 3:** Drew minimum number of horizontal and vertical lines to cover all the zeros

	I	II	III	IV
1	0	28	18	6
2	18	40	0	44
3	46	0	6	10
4	18	24	28	0

The optimal assignment is

$$1 \quad - \quad I \quad = \quad 16$$

$$2 \quad - \quad III \quad = \quad 8$$

$$3 \quad - \quad II \quad = \quad 38$$

$$4 \quad - \quad IV \quad = \quad \underline{20}$$

82 hours

Minimum time taken = 82 hours

Question 6

A BPO company is taking bids for 4 routes in the city to ply pick-up and drop cabs. Four companies have made bids as detailed below:

Bids for Routes (Rs.)

Company/Routes	R_1	R_2	R_3	R_4
C_1	4,000	5,000	—	—
C_2	—	4,000	—	4,000
C_3	3,000	—	2,000	—
C_4	—	—	4,000	5,000

Each bidder can be assigned only one route. Determine the minimum cost that the BPO should incur.

Answer

Reducing minimum from each column element (figure in '000s)

Step 1					Step 2				
	R ₁	R ₂	R ₃	R ₄		R ₁	R ₂	R ₃	R ₄
C ₁	1	1	—	—	C ₁	0	0	—	—
C ₂	—	0	—	0	C ₂	—	0	—	0
C ₃	0	—	0	—	C ₃	0	—	0	—
C ₄	—	—	2	1	C ₄	—	—	1	0

Number of lines to connect all zeros nos. is 4 which is optional.

Alternatively you may also reduce the minimum from each row.

Step 1					Step 2				
	R ₁	R ₂	R ₃	R ₄		R ₁	R ₂	R ₃	R ₄
C ₁	0	1	—	—	C ₁	0	1	—	—
C ₂	—	0	—	0	C ₂	—	0	—	0
C ₃	1	—	0	—	C ₃	0	—	0	—
C ₄	—	—	0	1	C ₄	—	—	0	0

Number of lines to connect all zeros nos. is 4 which is optional.

All diagonal elements are zeros and are chosen. The minimum cost is Rs.15,000 C₁ – R₁ 4,000; C₂ – R₂ 4,000; C₃ – R₃ 2,000; C₄ – R₄ 5,000; (Total) = 15,000.

Question 7

A gear manufacturing company makes two types of gears – A and B. Both gears are processed on 3 machines, Hobbing M/c, Shaping M/c and Grinding M/c. The time required by each gear and total time available per week on each M/c is as follows:

	Gear (A)	Gear (B)	Available
Machine	(Hours)	(Hours)	Hours
Hobbing M/c	3	3	36
Shaping M/c	5	2	60
Grinding M/c	2	6	60
Other data:			
Selling price (Rs.)	820	960	
Variable cost (Rs.)	780	900	

Advanced Management Accounting

Determine the optimum production plan and the maximum contribution for the next week by simplex method. The initial table is given below:

		C_j	40	60	0	0	0
		Qty.					
C_j	Variable		X_1	X_2	X_3	X_4	X_5
0	X_3	36	3	3	1	0	0
0	X_4	60	5	2	0	1	0
0	X_5	60	2	6	0	0	1

Answer

Table 1

		C_j	40	60	0	0	0	Ratio	
		Qty							
C_j	Variable		X_1	X_2	X_3	X_4	X_5		
0	X_3	36	3	3	1	0	0	12	
0	X_4	60	5	2	0	1	0	30	
0	X_5	60	2	6	0	0	1	10	←
	Z_j	0	0	0	0	0	0		
	$Z_j - C_j$		-40	-60	0	0	0		

Table 2

		C_j	40	60	0	0	0	Ratio	
		Qty							
C_j	Variable		X_1	X_2	X_3	X_4	X_5		
0	X_3	6	2	0	1	0	$-\frac{1}{2}$	3	←
0	X_4	40	$\frac{13}{3}$	0	0	1	$-\frac{1}{3}$	$\frac{120}{13}$	
60	X_2	10	$\frac{1}{3}$	1	0	0	$\frac{1}{6}$	30	
	Z_j	600	20	60	0	0	10		
	$Z_j - C_j$		-20	0	0	0	10		

Table 3

		C_j Qty	40	60	0	0	0
c _j	Variable		X ₁	X ₂	X ₃	X ₄	X ₅
40	X ₁	3	1	0	$\frac{1}{2}$	0	$-\frac{1}{4}$
0	X ₄	27	0	0	$-\frac{13}{6}$	1	$\frac{3}{4}$
60	X ₂	9	0	1	$-\frac{1}{6}$	0	$\frac{1}{4}$
	Z _j	660	40	60	10	0	5
	Z _j – C _j		0	0	10	0	5

Since all $Z_j - C_j$ are positive or zero, this is the optimum solution with. $X_1 = 40$ and $X_2 = 60$ and optimum $Z = 660$.

Note: Alternatively, $C_j - Z_j$ may be used whereby maximum positive value may be considered.

Question 8

A company has four zones open and four marketing managers available for assignment. The zones are not equal in sales potentials. It is estimated that a typical marketing manager operating in each zone would bring in the following Annual sales:

Zones	Rs.
East	2,40,000
West	1,92,000
North	1,44,000
South	1,20,000

The four marketing manages are also different in ability. It is estimated that working under the same conditions, their yearly sales would be proportionately as under:

Manager M	:	8
Manager N	:	7
Manager O	:	5
Manager P	:	4

Required:

If the criterion is maximum expected total sales, find the optimum assignment and the maximum sales.

Advanced Management Accounting**Answer**

Sum of the proportion = $(8 + 7 + 5 + 4) = 24$

Assuming Rs. 1,000 as one unit, the effective matrix is as follows:

Effective Matrix

Managers	Zones			
	East	West	North	South
M	$(8/24) \times 240 = 80$	$(8/24) \times 192 = 64$	$(8/24) \times 144 = 48$	$(8/24) \times 120 = 40$
N	$(7/24) \times 240 = 70$	$(7/24) \times 192 = 56$	$(7/24) \times 144 = 42$	$(7/24) \times 120 = 35$
O	$(5/24) \times 240 = 50$	$(5/24) \times 192 = 40$	$(5/24) \times 144 = 30$	$(5/24) \times 120 = 25$
P	$(4/24) \times 240 = 40$	$(4/24) \times 192 = 32$	$(4/24) \times 144 = 24$	$(4/24) \times 120 = 20$

Convert the maximization problem to minimization problem

The resultant loss matrix is as follows:

Loss Matrix

Managers	East	West	North	South
M	0	16	32	40
N	10	24	38	45
O	30	40	50	55
P	40	48	56	60

Row operation

Managers	East	West	North	South
M	0	16	32	40
N	0	14	28	35
O	0	10	20	25
P	0	8	16	20

Column operation

Managers	East	West	North	South
M	0	8	16	20
N	0	6	12	15
O	0	2	4	5
P	0	0	0	0

The Assignment Problem

Managers	East	West	North	South
M	0	6	14	18
N	0	4	10	13
O	0	0	2	3
P	2	0	0	0

Managers	East	West	North	South
M	0	2	10	14
N	0	0	6	9
O	4	0	2	3
P	6	0	0	0

Managers	East	West	North	South
M	0	2	8	12
N	0	0	4	7
O	4	0	0	1
P	8	2	0	0

Assignment

Sales

Rs.

M – East 80,000

N – West 56,000

O – North 30,000

P – South 20,000

1,86,000

Question 9

The cost matrix giving selling costs per unit of a product by salesman A, B, C and D in regions R_1 , R_2 , R_3 and R_4 is given below:

Advanced Management Accounting

	A	B	C	D
R_1	4	12	16	8
R_2	20	28	32	24
R_3	36	44	48	40
R_4	52	60	64	56

- (i) Assign one salesman to one region to minimise the selling cost.
- (ii) If the selling price of the product is Rs. 200 per unit and variable cost excluding the selling cost given in the table is Rs. 100 per unit, find the assignment that would maximise the contribution.
- (iii) What other conclusion can you make from the above?

Answer

(i)

4	12	16	8
20	28	32	24
36	44	48	40
52	60	64	56

Subtracting minimum element – each row.

0	8	12	4
0	8	12	4
0	8	12	4
0	8	12	4

Subtracting minimum element – each column,

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

Minimum no. of lines to cover all zeros = 4 = order of matrix. Hence optimal assignment is possible.

Minimum cost $= 4 + 28 + 48 + 56 = 136.$
 $= AR_1 + BR_2 + CR_3 + DR_4$

Since all are zeros, there are 24 solutions to this assignment problem.

Viz.

A	B	C	D
R ₁	R ₂	R ₃	R ₄
R ₂	R ₃	R ₄	R ₁
R ₃	R ₄	R ₁	R ₂
R ₄	R ₁	R ₂	R ₃
R ₁	R ₃	R ₄	R ₂

etc.

A can be assigned in 4 ways, B in 3 ways for each of A's 4 ways.

(ii) SP – VC = 100 Rs.

	A	B	C	D
R ₁	96	88	84	92
R ₂	80	72	68	76
R ₃	64	56	52	60
R ₄	48	40	36	44

Subtracting the highest term

0	8	12	4
16	24	28	20
32	40	44	36
48	56	60	52

Subtracting minimum term of each row.

0	8	12	4
0	8	12	4
0	8	12	4
0	8	12	4

Which is the same as the earlier matrix

Maximum contribution = Rs. $(96 + 72 + 52 + 44) = \text{Rs. } 264.$

Advanced Management Accounting

Alternative Solution:

Maximisation of contribution is same as minimizing cost. Hence, same assignments as in (i) will be the optional solution.

Maximum Contribution Rs. $(400 - 136) = \text{Rs. } 264$

- (iii) (a) The relative cost of assigning person i to region r does not change by addition or subtraction of a constant from either a row, or column or all elements of the matrix.
- (b) Minimising cost is the same as maximizing contribution. Hence, the assignment solution will be the same, applying point (i) above.
- (c) Many zero's represent many feasible least cost assignment. Here, all zeros mean maximum permutation of a 4×4 matrix, viz. $4 \times 3 \times 2 \times 1 = 24$ solutions are possible.

Question 10

In an assignment problem to assign jobs to men to minimize the time taken, suppose that one man does not know how to do a particular job, how will you eliminate this allocation from the solution?

Answer

In an assignment minimization problem, if one task cannot be assigned to one person, introduce a prohibitively large cost for that allocation, say M , where M has a high the value. Then, while doing the row minimum and column minimum operations, automatically this allocation will get eliminated.

Question 11

A factory is going to modify of a plant layout to install four new machines $M1$, $M2$, $M3$ and $M4$. There are 5 vacant places J , K , L , M and N available. Because of limited space machine $M2$ cannot be placed at L and $M3$ cannot be placed at J . The cost of locating machine to place in Rupees is shown below:

	(Rs.)				
	J	K	L	M	N
$M1$	18	22	30	20	22
$M2$	24	18	--	20	18
$M3$	--	22	28	22	14
$M4$	28	16	24	14	16

The Assignment Problem

Required:

Determine the optimal assignment schedule in such a manner that the total costs are kept at a minimum.

Answer

Dummy machine (M5) is inserted to make it a balanced cost matrix and assume its installation cost to be zero. Cost of install at cell M3 (J) and M2 (L) is very high marked as é.

	J	K	L	M	N
M1	18	22	30	20	22
M2	24	18	é	20	18
M3	é	22	28	22	14
M4	28	16	24	14	16
M5 (Dummy)	0	0	0	0	0

Step 1

Subtract the minimum element of each row from each element of that row

	J	K	L	M	N
M1	0	4	12	2	4
M2	6	0	é	2	0
M3	é	8	14	8	0
M4	14	2	10	0	2
M5 (Dummy)	0	0	0	0	0

Step 2

Subtract the minimum element of each column from each element of that column

	J	K	L	M	N
M1	0	4	12	2	4
M2	6	0	é	2	0
M3	é	8	14	8	0
M4	14	2	10	0	2
M5 (Dummy)	0	0	0	0	0

Advanced Management Accounting

Step 3

Draw lines to connect the zeros as under:

	J	K	L	M	N
M1	0	4	12	2	4
M2	6	0	e	2	0
M3	e	8	14	8	0
M4	14	2	10	0	2
M5 (Dummy)	0	0	0	0	0

There are five lines which are equal to the order of the matrix. Hence the solution is optimal. We may proceed to make the assignment as under:

	J	K	L	M	N
M1	0	4	12	2	4
M2	6	0	e	2	0
M3	e	8	14	8	0
M4	14	2	10	0	2
M5 (Dummy)	0	0	0	0	0

The following is the assignment which keeps the total cost at minimum:

Machines	Location	Costs Rs.
M1	J	18
M2	K	18
M3	N	14
M4	M	14
M5 (Dummy)	L	0
Total		64

EXERCISE**Question 1**

A Car hiring company has one car at each of the five depots A,B,C,D and E. A customer in each of the five towns V,W,X,Y and requires a car. The distance in kms, between depots (origin) and the towns (destination) are given in the following table:

		Depots				
		A	B	C	D	E
Towns	V	3	5	10	15	8
	W	4	7	15	18	8
	X	8	12	20	20	12
	Y	5	5	8	10	6
	Z	10	10	15	25	10

Find out as to which car should be assigned to which customer so that the total distance traveled is a minimum. How much is the total traveled distance?

Answer

The optimal assignment is

Town	Depot	Distance (in kms)
V	C	10
W	B	7
X	A	8
Y	D	10
Z	E	<u>10</u>
	Total	<u>45</u>

Hence the minimum total traveled distance = 45 kms.

Question 2

ABC airline operating 7 days a week has given the following time-table. Crews must have minimum layover of 5 hours between flights. Obtain the pairing flights that minimize the layover time away from home. For any given pairing the crew will be based at the city that results in the smaller layover.

Advanced Management Accounting

<i>Hyderabad-Delhi</i>			<i>Delhi-Hyderabad</i>		
<i>Flight No.</i>	<i>Depart.</i>	<i>Arrive</i>	<i>Flight No.</i>	<i>Depart.</i>	<i>Arrive</i>
A1	6 AM	8 AM	B1	8 AM	10 AM
A2	8 AM	10 AM	B2	9 AM	11 AM
A3	2 PM	4 PM	B3	2 PM	4 PM
A4	8 PM	10 PM	B4	7 PM	9 PM

Answer

The optimal assignment is

<i>From Flight No.</i>	<i>To Flight No.</i>	<i>Layover time</i>
A ₁	B ₃	6
A ₂	B ₄	9
A ₃	B ₁	16
A ₄	B ₂ *	9
		40 hours

Question 3

Solve the assignment problem represented by the following effective matrix:

	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>
A	9	22	58	11	19	27
B	43	78	72	50	63	48
C	41	28	91	37	45	33
D	74	42	27	49	39	32
E	26	11	57	22	25	18
F	3	56	53	31	17	28

Answer

The assignment is

(i) A→d, B→f, C→b, D→c, E→e, F→a

And total effect = 11+48+28+27+25+3=142

Alternate solutions exist. One of the alternate solutions is given by

(ii) $A \rightarrow d$, $B \rightarrow a$, $C \rightarrow f$, $D \rightarrow c$, $E \rightarrow b$ and $F \rightarrow e$ with total effect = 142

Question 4

To stimulate interest and provide an atmosphere for intellectual discussion, a finance faculty in a management school decides to hold special seminars on four contemporary topics: leasing, portfolio management, private mutual funds, swaps and options. Such seminars should be held once in a week in the afternoons. However, scheduling these seminars (one for each topic, and not more than one seminar per afternoon) has to be done carefully so that the number of students unable to attend is kept to a minimum. A careful study indicates that the number of students who cannot attend a particular seminar on a specific day is as follows:

	Leasing	Portfolio Management	Private Mutual Fund	Swaps & Options
Monday	50	40	60	20
Tuesday	40	30	40	30
Wednesday	60	20	30	20
Thursday	30	30	20	30
Friday	10	20	10	30

Find an optimal schedule of the seminars. Also find out the total number of students who will be missing at least one seminar.

Answer

And the optimal schedule is

	No. of Students Missing
Monday : Swaps and options	20
Tuesday : No Seminar	0
Wednesday : Portfolio Management	20
Thursday : Pvt. Mutual funds	20
Friday : Leasing	<u>10</u>
	<u>70</u>

Thus, the total number of students who will be missing at least one seminar = 70

Advanced Management Accounting**Question 5**

A manufacturing company has four zones A, B, C, D and four sales engineers P, Q, R, S respectively for assignment. Since the zones are not equally rich in sales potential, therefore it is estimated that a particular engineer operating in a particular zone will bring the following sales;

Zone A	:	4,20,000
Zone B	:	3,36,000
Zone C	:	2,94,000
Zone D	:	4,62,000

The engineers are having different sales ability. Working under the same conditions, their yearly sales are proportional to 14, 9, 11 and 8 respectively. The criteria of maximum expected total sales is to be met by assigning the best engineer to the richest zone, the next best to the second richest zone and so on.

Find the optimum assignment and the maximum sales.

Answer

The optimum assignments are as follows:

Zones (Loss in thousands of rupees)

Sales Engineer	A	B	C	D
P	3	13	19	0
Q	0	0	1	2
R	0	4	7	0
S	2	0	0	5

Engineers	Zones	Sales (in Rs.)
P	D	1,54,000
Q	B	72,000
R	A	1,10,000
S	C	<u>56,000</u>
		<u>3,92,000</u>

It can be seen from the above assignments that the best engineer P is assigned to the richest Zone D, the next best engineer R is assigned to second richest zone A, the next

best engineer Q is assigned to zone B and so on. Hence, the optimum assignment matches the company's criteria of achieving the maximum expected total sales.

Question 6

An organization is producing 4 different products viz. A, B, C, and D having 4 operators viz. P, Q, R and S, who are capable of producing any of the four products, works effectively 7 hours a day. The time (in minutes) required for each operator for producing each of the product are given in the cells of the following matrix along profit (Rs. per unit):

Operator	Product			
	A	B	C	D
P	6	10	14	12
Q	7	5	3	4
R	6	7	10	10
S	20	10	15	15
Profit (Rs./Units)	3	2	4	1

Find out the assignment of operators to products which will maximize the profit.

Answer

Specific assignments in this case are as below:

Operator	Product	Profit (Rs.)
P	A	210
Q	C	560
R	B	120
S	D	28
Total	Profit (Rs.)	918

Question 7

A private firm employs typists on hourly piece rate basis for their daily work. Five typists are working in that firm and their charges and speeds are different. On the basis of some earlier understanding, only one job is given to one typist is paid for full hours even when he or she works for a fraction of an hour. Find the least cost allocation for the following when he or she works for a fraction of an hour. Find the least cost allocation for the following data:

Advanced Management Accounting

<i>Typist</i>	<i>Rate per hour (Rs.)</i>	<i>Number of pages typed hour</i>	<i>Job</i>	<i>No. of pages</i>
<i>A</i>	<i>5</i>	<i>12</i>	<i>P</i>	<i>199</i>
<i>B</i>	<i>6</i>	<i>14</i>	<i>Q</i>	<i>175</i>
<i>C</i>	<i>3</i>	<i>8</i>	<i>R</i>	<i>143</i>
<i>D</i>	<i>4</i>	<i>10</i>	<i>S</i>	<i>298</i>
<i>E</i>	<i>4</i>	<i>11</i>	<i>T</i>	<i>178</i>

(Nov 1996)

Answer

Cost (Rs.)

Thus typist A is given job	<i>T</i>	<i>75</i>
Thus typist B is given job	<i>R</i>	<i>66</i>
Thus typist C is given job	<i>Q</i>	<i>66</i>
Thus typist D is given job	<i>P</i>	<i>80</i>
Thus typist E is given job	<i>S</i>	<i>112</i>
	Total	Rs.399

Note: In case the above solution is not unique. Alternate solution also exists.

Question 8

XYZ airline operating 7 days a week has given the following time-table. Crews must have a minimum layover of 5 hours between flights. Obtain the pairing flights and minimize layover time away from home. For any given pairing the crew will be based at the city that results in the smaller layover:

<i>Chennai Mumbai</i>			<i>Mumbai - Chennai</i>		
<i>Flight Number</i>	<i>Depart.</i>	<i>Arrive</i>	<i>Flight Number</i>	<i>Depart.</i>	<i>Arrive</i>
<i>A1</i>	<i>6 AM</i>	<i>8 AM</i>	<i>B1</i>	<i>8 AM</i>	<i>10 AM</i>
<i>A2</i>	<i>8 AM</i>	<i>10 AM</i>	<i>B2</i>	<i>9 AM</i>	<i>11 AM</i>
<i>A3</i>	<i>2 PM</i>	<i>4 PM</i>	<i>B3</i>	<i>2 PM</i>	<i>4 PM</i>
<i>A4</i>	<i>8 PM</i>	<i>10 PM</i>	<i>B4</i>	<i>7 PM</i>	<i>9 PM</i>

The Assignment Problem

Answer

The optimal assignment is

<i>From Flight No.</i>	<i>To Flight No.</i>	<i>Layover</i>
A1	B3	6
A2	B4	9
A3	B1	16
A4	B2*	9
		40 hours

Question 9

A firm produces four products.. There are four operators who are capable of producing any of these four products. The processing time varies from operator to operator. The firm records 8 hours a day and allows 30 minutes for lunch. The processing time in minutes and the profit for each of the products are given below:

<i>Operators</i>	<i>Products</i>			
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
1	15	9	10	6
2	10	6	9	6
3	25	15	15	9
4	15	9	10	10
<i>Profit (Rs.) p. u.</i>	8	6	5	4

Find the optimal assignment of products to operators.

Answer

The optimal assignment is as shown below:

<i>Operator</i>	<i>Product</i>	<i>Profit (Rs.)</i>
1	D	300
2	B	450
3	C	150
4	A	240
	Rs.	1140

CRITICAL PATH ANALYSIS

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Framework of Pert/Cpm

The PERT and CPM models are extremely useful for the purpose of planning, scheduling and controlling the progress and completion of large and complex projects or for carrying out the analysis of these three managerial functions. A *network* is a graphical representation of a project, depicting the flow as well as the sequence of well-defined activities and events. Both CPM (Critical Path Method) and PERT (Programme Evaluation and Review Technique) are network techniques/ models.

2. Network

A network is, then, a graphical representation of a project plan, showing the inter- relation- ship of the various activities. Networks are also called *arrow diagrams* (see figure-6). When the results of time estimates and computations have been added to a network, it may be used as a project schedule.

3. Steps in PERT/CPM Model

PERT/CPM model building consists of following five steps:

1. Analyse and break down the project in terms of specific activities and/ or events.
2. Determine the interdependence and sequence of specific activities and prepare a net- work.
3. Assign estimates of time, cost or both to all the activities of the network.
4. Identify the longest or critical path through the network.
5. Monitor, evaluate and control the progress of the project by replanning, rescheduling and reassignment of resources.

4. Critical Path

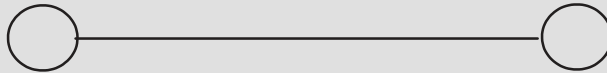
The longest path is the critical path because it equals the minimum time required to complete the project. All other paths other than the critical path (i.e. non-critical

Advanced Management Accounting

or slack paths) offer flexibility in scheduling and transferring resources, because they take less time to complete than the critical path.

5. Activity

An activity is a distinct operation or an element of a project which consumes time or resources and has a definable beginning and ending. Commonly used terms synonymous with "activity" are "task" and "job".



6. Conventions Adopted In Drawing Networks

There are two conventions normally adopted while drawing networks:

- (a) Time flows from left to right.
- (b) Head events always have a number higher than that of the tail events.

7. Graphical Representation of Events and Activities

Events are represented by numbers within circles. Activities are represented by arrows; the arrow-heads represent the completion of the activities. The length and orientation of the arrow are of no significance.

8. Fundamental Properties Governing the Representation of Events and Activities

The representation of events and activities is governed by one simple *dependency rule* which requires that an activity which depends upon another activity is shown to emerge from the head event of the activity upon which it depends and that only dependent activities are drawn in this way. An event cannot occur until all activities leading to it are complete. No activity can start until its tail event is reached.

9. Logical Sequencing and Connection of Activities

A project entails several activities. The arrows are arranged to show the plan of logical sequence in which the activities of the project are to be accomplished. The sequence is ascertained for each activity by three queries viz:

- (i) Which activity or activities must be completed before the start of a particular activity?
- (ii) Which activity or activities should follow this?
- (iii) Which activities can be accomplished simultaneously?

10. Errors in logical sequencing

Two types of errors in logic may arise while drawing a network, particularly when it is a complicated one. These are known as *looping* and *dangling*.

11. Dummy activity

It is a hypothetical activity which consumes no resource and time. It is represented by dotted lines and is inserted in the network to clarify activity pattern under the following situations:

- (i) It is created to make activities with common starting and finishing events distinguishable.
- (ii) to identify and maintain the proper precedence relationship between activities that are not connected by events.
- (iii) to bring all "loose ends" to a single initial and a single terminal event in each network using dummies, if necessary.

Question 1

Explain the following in the context of a network:

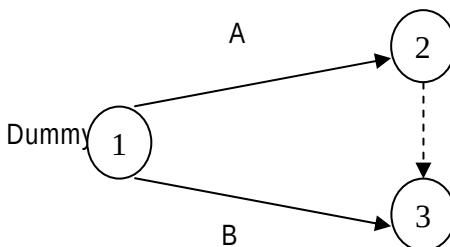
- (i) Critical path
- (ii) Dummy activity.

Answer**(i) Critical Path:**

Critical Path is a chain of activities that begin with the starting event and ends with ending event of a particular project. It is that path that runs through a network with the maximum length of time or it indicates the maximum possible time required for completion of a project. Critical path indicates the minimum time that will be required to complete a project. It is determined after identifying critical events. Critical path goes through critical events.

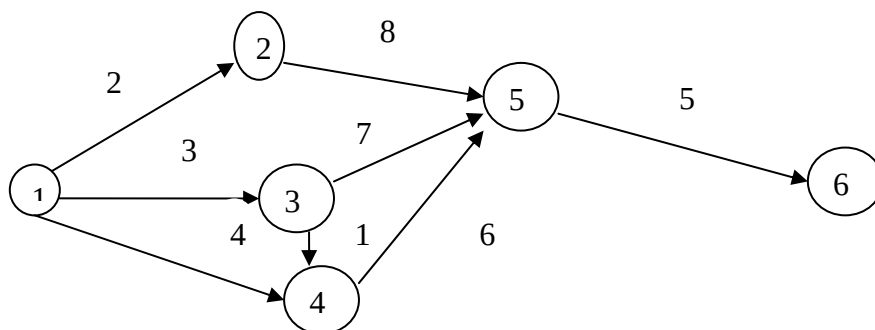
(ii) Dummy Activities:

Dummy Activity is that activity which does not consume time or resources. It is used when two or more activities have same initial and terminal events. As a result of using dummy activities, other activities can be identified by unique end events. These are usually shown by arrows with dashed lines.



Advanced Management Accounting**Question 2**

The following network gives the duration in days for each activity:



- (i) You are required to list the critical paths.
- (ii) Given that each activity can be crashed by a maximum of one day, choose to crash any four activities so that the project duration is reduced by 2 days.

Answer

Critical Paths:

All are critical paths:

- | | | |
|-------|-------------------|----------------------|
| (i) | 1 – 2 – 5 – 6 | $2 + 8 + 5 = 15$ |
| (ii) | 1 – 3 – 5 – 6 | $3 + 7 + 5 = 15$ |
| (iii) | 1 – 4 – 5 – 6 | $4 + 6 + 5 = 15$ |
| (iv) | 1 – 3 – 4 – 5 – 6 | $3 + 1 + 6 + 5 = 15$ |

- (i) Choose 5 – 6, common path;

Crash by 1 day

- (ii) Choose: 1 – 2, 1 – 3, 1 – 4

Or

- (iii) Choose: 1 – 2, 3 – 5, 4 – 5

Or

- (iv) Choose: 2 – 5, 3 – 5, 4 – 5

Or

- (v) Choose: 1 – 3, 1 – 4, 2 – 5

Question 3

A company is launching a new product and has made estimates of the time for the various activities associated with the launch as follows:

Activity	Predecessor	Times (Days)		
		Optimistic	Most likely	Pessimistic
A	None	1	3	5
B	None	3	4	5
C	A, B	1	3	11
D	B	3	3	9
E	A	1	2	3
F	C	2	5	14
G	E, F	2	3	4
H	D, F	2	2	2
I	G, H	10	10	10

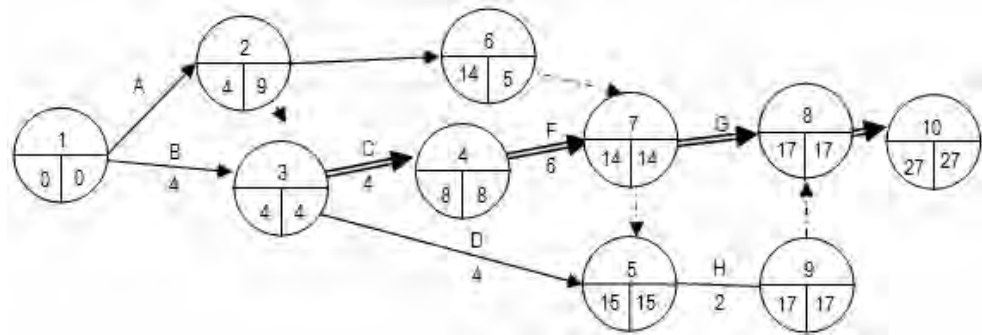
Required:

- (i) Draw the network diagram.
- (ii) Calculate the expected time and variance of each activity.
- (iii) Find out the expected length of critical path and its standard deviation.
- (iv) Find the probability that the launching will be completed in 27 days.
- (v) Find the duration, which has 95% probability of completion.

Answer

(i) Network Diagram

Critical Path B → C → F → G → Z



Advanced Management Accounting

(ii) Calculation of Expected Time, Standard Deviation and Variance of Activities

Activity	Expected Time $t_e = \frac{t_o + 4t_m + t_p}{6}$	Standard Deviation $S = \frac{t_p - t_o}{6}$	Variance σ^2
A (1-2)	$\frac{1+12+5}{6} = 3$	$\frac{5-1}{6} = 0.67$	0.44
B (1-3)	$\frac{3+16+5}{6} = 4$	$\frac{5-3}{6} = 0.33$	0.11
C (3-4)	$\frac{1+12+11}{6} = 4$	$\frac{11-1}{6} = 1.67$	2.78
D (3-5)	$\frac{3+12+9}{6} = 4$	$\frac{9-3}{6} = 1.00$	1.00
E (2-6)	$\frac{1+8+3}{6} = 2$	$\frac{3-1}{6} = 0.33$	0.11
F (4-7)	$\frac{2+20+14}{6} = 6$	$\frac{14-2}{6} = 2.00$	4.00
G (6-8)	$\frac{2+12+4}{6} = 3$	$\frac{4-2}{6} = 0.33$	0.11
H(5-9)	$\frac{2+8+2}{6} = 2$	$\frac{2-2}{6} = 0$	0
I (8-10)	$\frac{10+40+10}{6} = 10$	$\frac{10-10}{6} = 0$	0

(iii) S.D. of Critical Path

$$= \sqrt{\text{Total of variance of Critical Activities}}$$

$$= \sqrt{0.11 + 2.78 + 4 + 0.11 + 0}$$

$$= \sqrt{7}$$

$$= 2.645$$

(iv) Probabilities of completion of job in 27 days.

$$X = 27 \text{ Days}$$

$$Z = \frac{27 - 27}{2.645} = 0$$

For $Z = 0$ the probability is 0.5 from the table of area under normal curve or 50%.

(v) For 95% of area the corresponding Z value is 1.64 (from the table).

Therefore,

$$1.64 = \frac{X - 27}{2.645}$$

$$X = 27 + 4.33 = 31.33 \text{ Days}$$

Question 4

Consider the schedule of activities and related information as given below, for the construction of a Plant:

Activity	Expected Time (Months)	Variance	Expected Cost (Millions of Rs.)
1-2	4	1	5
2-3	2	1	3
3-6	3	1	4
2-4	6	2	9
1-5	2	1	2
5-6	5	1	12
4-6	9	5	20
5-7	7	8	7
7-8	10	16	14
6-8	1	1	4

Assuming that the cost and time required for one activity is independent of the time and cost of any other activity and variations are expected to follow normal distribution.

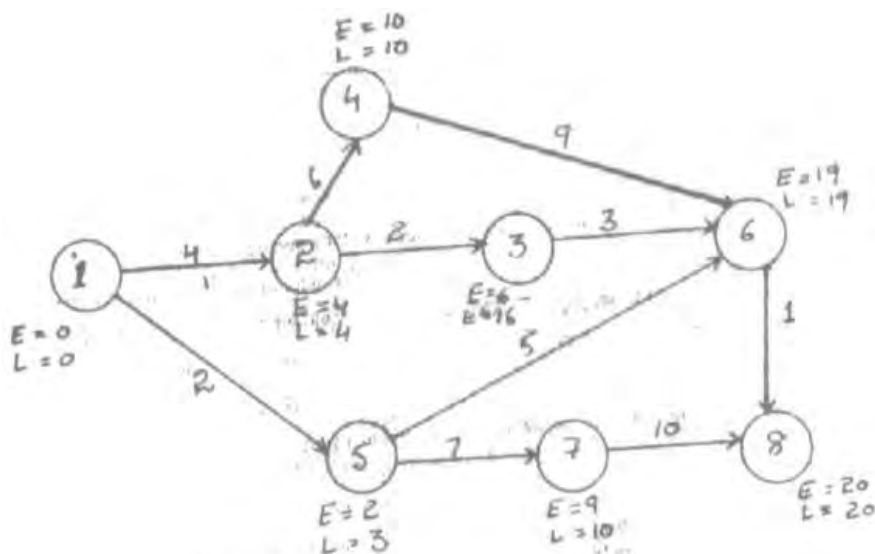
Draw a network based on the above data and calculate:

- (i) Critical path
- (ii) Expected cost of construction of the plant
- (iii) Expected time required to build the plant
- (iv) The standard deviation of the expected time.

Advanced Management Accounting

Answer

The required network is drawn below:



- (i) From the above network, it can be noted that the critical path is 1 – 2 – 4 – 6 – 8.
- (ii) Expected cost of construction of the plant = (5 + 3 + 4 + 9 + 2 + 12 + 20 + 7 + 14 + 4) millions of Rs. = Rs.80 million
- (iii) Expected time required to build the plant = 4 + 6 + 9 + 1 = 20 months.
- (iv) It is given that the time required for one activity is independent of the time and cost of any other activity and variations are expected to follow normal distribution, the S.D.

Hence, the variance of the expected time is determined by summing the variance of critical activities and is = 1 + 2 + 5 + 1 = 9.

Standard Deviation of the expected time = $\sqrt{9} = 3$ months.

Question 5

A product comprised of 10 activities whose normal time and cost are given as follows:

Activity	Normal Time (days)	Normal cost
1-2	3	50
2-3	3	5
2-4	7	70
2-5	9	120

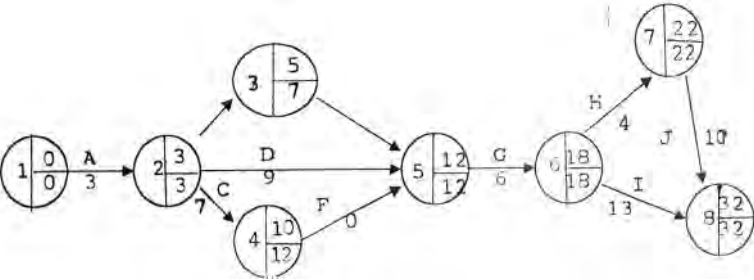
Critical Path Analysis

3-5	5	42
4-5	0	0
5-6	6	54
6-7	4	67
6-8	13	130
7-8	10	166

Indirect cost Rs. 9 per day.

- (i) Draw the network and identify the critical path.
- (ii) What are the project duration and associated cost ?
- (iii) Find out the total float associated with each activity.

Answer



Critical path A D G H J
1-----2-----5-----6-----7-----8

- (ii) A D G H J is the critical path having normal project duration
 $3 + 9 + 6 + 4 + 10 = 32$ days

Normal project cost:- Direct cost = Rs. 704
Indirect cost (32×9) = 288
992

- (iii) Calculation of total float

Activity	Nt(days)	E_F	L_F	Float ($L_F - E_F$)
1-2	3	3	3	0
2-3	3	6	7	1
2-4	7	10	12	2

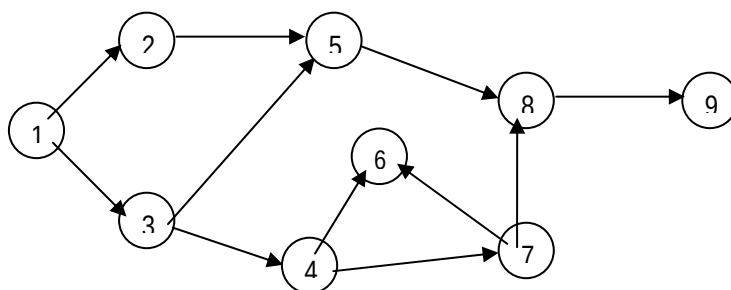
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2-5	9	12	12	0
3-5	5	11	12	1
4-5	0	10	12	2
5-6	6	18	18	0
6-7	4	22	22	0
6-8	13	31	32	1
7-8	10	32	32	0

Question 6

A network is given below:

- (i) Name the paths and give their total duration.
- (ii) Give three different ways of reducing the project above duration by four days.

**Answer**

- (i) Assuming that the duration of activity 3 – 5 is 4 weeks.

The various critical paths are:

1-2-5-8-9	15 weeks
1-3-4-7-8-9	15 weeks
1-3-4-6-7-8-9	15 weeks
1-3-5-8-9	15 weeks

- (ii) **Note:** Since the duration for activity 3-5 is not specified it is open for you to assume the duration. Depending upon the duration assume **three** possibilities emerge.
- If the duration assumed is more than 4 weeks then that path (1, 3, 5, 8, 9) alone will be critical. In that case you can choose any of the activity in the critical path.
 - If the duration assumed is exactly 4 weeks then it will be one of the 4 critical paths and the various possibilities are given below.

3. If the duration assumed is less than 4 weeks then the solution should be based on 3 of the critical paths namely 12,589, 1346789 and 134789. This has 16 combinations.

Reduce in the following ways, the project duration is. Since all the paths are critical, reduction is possible by combining activities. The activities can be independent, common to few paths and common to all the paths. The various categories are as follows:

- | | | | |
|----|---|-------------|-------------------------|
| 1. | Common to all the paths. 8-9 | | |
| 2. | Independent: | Combination | 1. 1-2,3-5,4-6 and 4-7. |
| | Combination | | 2. 2-5,3-5,4-6 and 4-7. |
| | Combination | | 3. 1-2,3-5,4-7, 6-7. |
| | Combination | | 4. 2-5,3-5,4-7, 6-7. |
| 3. | Activities common to two of the paths. | | |
| | Combination | 1. | 1-2,1-3. |
| | Combination | 2. | 1-3,2-5. |
| | Combination | 3. | 3-4,5-8. |
| | Combination | 4. | 5-8,7-8. |
| 4. | Activities common to two of the paths and two independent activities. | | |
| | Combination | 1. | 1-2,3-4,3-5. |
| | Combination | 2. | 1-2,3-5,7-8. |
| | Combination | 3. | 2-5,3-4,3-5. |
| | Combination | 4. | 2-5,3-5,7-8. |
| | Combination | 5. | 4-6,4-7,5-8. |
| | Combination | 6. | 4-7,5-8,6-7. |

(Any three of the above combination.)

Question 7

A company had planned its operations as follows:

<i>Activity</i>	<i>Duration (days)</i>
1–2	7
2–4	8
1–3	8
3–4	6

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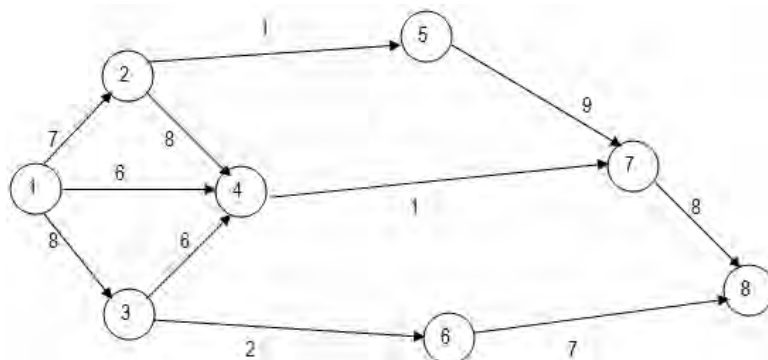
1–4	6
2–5	16
4–7	19
3–6	24
5–7	9
6–8	7
7–8	8

- (i) Draw the network and find the critical paths.
- (ii) After 15 days of working, the following progress is noted:
- Activities 1–2, 1–3 and 1–4 completed as per original schedule.
 - Activity 2–4 is in progress and will be completed in 4 more days.
 - Activity 3–6 is in progress and will need 17 more days to complete.
 - The staff at activity 3–6 are specialised. They are directed to complete 3–6 and undertake an activity 6–7, which will require 7 days. This rearrangement arose due to a modification in a specialisation.
 - Activity 6–8 will be completed in 4 days instead of the originally planned 7 days.
 - There is no change in the other activities.

Update the network diagram after 15 days of start of work based on the assumption given above. Indicate the revised critical paths alongwith their duration.

Answer

(i)



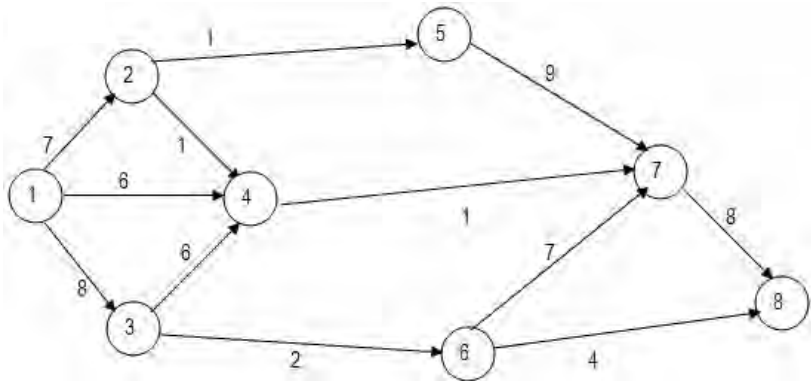
Paths	Duration
1 – 2 – 5 – 7 – 8	$7 + 16 + 9 + 8 = 40$
1 – 2 – 4 – 7 – 8	$7 + 8 + 19 + 8 = 42$
1 – 4 – 7 – 8	$6 + 19 + 8 = 33$
1 – 3 – 4 – 7 – 8	$8 + 6 + 19 + 8 = 41$
1 – 3 – 6 – 8	$8 + 24 + 7 = 39$

Critical path 1 – 2 – 4 – 7 – 8 = 42 days.

Revised Duration of activities 2 – 4 and 3 – 6 after 15 days for updation.

Activity	Preceding Activity	Date of completion	Revised Duration
2 – 4	1 – 2	$15 + 4 = 19$ days	$19 - 7 = 12$ days
3 – 6	1 – 3	$15 + 17 = 32$ days	$32 - 8 = 24$ days
6 – 7 (new activity)	3 – 6		7 days
6 – 8	3 – 6		4 days

(ii)



Paths	Duration
1 – 2 – 5 – 7 – 8	$7 + 16 + 9 + 8 = 40$
1 – 2 – 4 – 7 – 8	$7 + 12 + 19 + 8 = 46$
1 – 4 – 7 – 8	$6 + 19 + 8 = 33$
1 – 3 – 4 – 7 – 8	$8 + 6 + 19 + 8 = 41$
1 – 3 – 6 – 7 – 8	$8 + 24 + 7 + 8 = 47$
1 – 3 – 6 – 8	$8 + 24 + 4 = 36$

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Critical path = 1 – 3 – 6 – 7 – 8 = 47 days.

Question 8

The following table gives the activities in a construction project and the time duration of each activity:

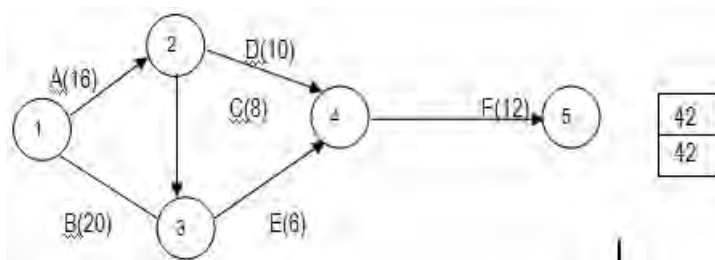
Activity	Preceding activity	Normal Time (Days)
A	–	16
B	–	20
C	A	8
D	A	10
E	B, C	6
F	D, E	12

Required:

- Draw the activity network of the project.
- Find critical path.
- Find the total float and free-float for each activity.

Answer

(i)



$$A \rightarrow D \rightarrow F = 16 + 10 + 12 = 38$$

$$B \rightarrow E \rightarrow F = 20 + 6 + 12 = 38$$

(ii) $A - C - E - F = 16 + 8 + 6 + 12 = 42$ Critical path

(iii) Total float and free float for each activity

Activity	Normal time (Days)	Earliest start	Time finish	Latest start	Time finish	Float total	Free
A	16	0	16	0	16	0	0
B	20	0	20	4	24	4	4

C	8	16	24	16	24	0	0
D	10	16	26	20	30	4	4
E	6	24	30	24	30	0	0
F	12	30	42	30	42	0	0

Question 9

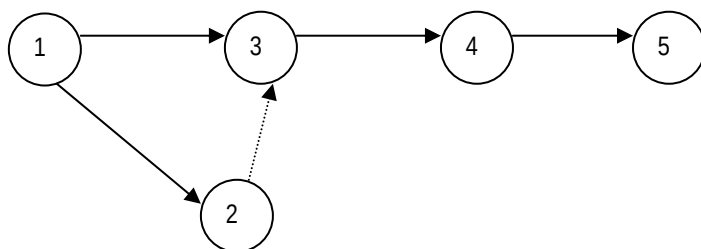
What do you mean by a dummy activity? Why is it used in networking?

Answer

Dummy activity is a hypothetical activity which consumes no resource or time. It is represented by dotted lines and is inserted in the network to clarify an activity pattern under the following situations.

- (i) To make activities with common starting and finishing events distinguishable.
- (ii) To identify and maintain the proper precedence relationship between activities that are not connected by events.
- (iii) To bring all "loose ends" to a single initial and single terminal event.

e.g.



Dummy (2) – (3) is used to convey that can start only after events numbered (2) and (3) are over:

Advanced Management Accounting**EXERCISE****Question 1**

The time schedule for different activities of a project is given below:

Activity (i – j)	Time in days
1-2	8
1-3	10
1-4	8
2-3	10
2-6	16
3-5	17
4-5	18
4-6	14
5-6	9

Construct the PERT network and compute.

- (i) Critical path and its duration.
(ii) Total and free float for each activity.

Answer

The critical path is given by 1 – 2 – 3 – 5 – 6. The path represents the minimum possible time to complete the project.

The project duration = 8 + 10 + 17 + 9 = 44 days.

Question 2

A project has the following time schedule:

Activity	Time in weeks	Activity	Time in weeks
1-2	4	5-7	8
1-3	1	6-8	1
2-4	1	7-8	2
3-4	1	8-9	1
3-5	6	8-10	8
4-9	5	9-10	7
5-6	4		

Construct a PERT network and compute:

- (i) T_E and T_L for each event;
- (ii) Float for each activity; and
- (iii) Critical path and its duration.

Answer

Critical path is given by all those activities which have zero floats. Along the zero float activities, there are two such critical paths:

- (i) $1 \rightarrow 3 \rightarrow 5 \rightarrow 7 \rightarrow 8 \rightarrow 9 \rightarrow 10$
- (ii) $1 \rightarrow 3 \rightarrow 5 \rightarrow 7 \rightarrow 8 \rightarrow 10$

The project duration is 25 weeks.

Question 3

Given the following information:

Activity:	0-1	1-2	1-3	2-4	2-5	3-4	3-6	4-7	5-7	6-7	
Duration:	2	8	10	6	3	3	7	5	2	8	(in days)

- (i) Draw the arrow diagram.
- (ii) Identify critical path and find the total project duration.
- (iii) Determine total, free and independent floats.

Answer

The critical path is - $0 \rightarrow 1 \rightarrow 3 \rightarrow 6 \rightarrow 7$

Total project duration = 27 days.

PROGRAM EVALUATION AND REVIEW TECHNIQUE

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Program Evaluation and Review Technique

PERT is more relevant for handling such projects which have a great deal of uncertainty associated with the activity durations.

2. Types of Times Estimates

To take these uncertainty into account, three kinds of times estimates are generally obtained. These are:

2.1 The Optimistic Time Estimate

This is the estimate of the shortest possible time in which an activity can be completed under ideal conditions. For this estimate, no provisions for delays or setbacks are made. We shall denote this estimate by t_o .

2.2 The Pessimistic Time Estimate

This is the maximum possible time which an activity could take to accomplish the job. If everything went wrong and abnormal situations prevailed, this would be the time estimate. It is denoted by t_p .

2.3 The Most Likely Time Estimate

This is a time estimate of an activity which lies between the optimistic and the pessimistic time estimates.

The variance is $S_{t2} = \left(\frac{t_p - t_o}{6} \right)^2$

3. Expected time

The expected time (t_e) is the average time taken for the completion of the job. By using beta-distribution, the expected time can be obtained by following formula.

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$$t_e = \frac{t_o + 4t_m + t_p}{6}$$

4. Probability estimate in PERT

The probability of completing the project by scheduled time is assessed with normal variate Z given by

$$Z = \frac{T_1 - T_{cp}}{S.D.}$$

Where T_1 denotes the duration in which we wish to complete the project and T_{cp} represents the duration on the critical path, S.D. stands for standard deviation of the earliest finish of a network.

5. Project Crashing

It means reduction in project duration. Reduction in duration involves application of additional resources which involves additional cost and at the same time reduction in indirect cost per day. We identify the activities which can be crashed and compare the activity cost slope with indirect cost per day so as to arrive at project duration at optimum cost.

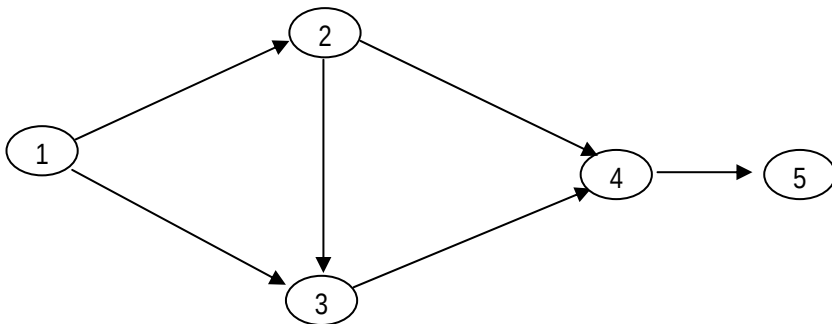
Activity cost slope = (Crash cost – Normal Cost) / (Normal time – Crash time)

6. Resource smoothing

It is used for smoothening the peak resource requirement during different periods of project duration. It is a time scaled diagram of various activities and their float along with resource requirement. Float gives the option of balancing the resources over longer period so that resource requirement is smoothened without much affecting the project duration.

Question 1

The normal time, crash time and crashing cost per day are given for the following network:



Program Evaluation and Review Technique

Activity	Normal time (days)	Crash time (days)	Crashing cost (Rs./day)
1-2	18	14	40
1-3	23	22	20
2-3	8	5	60
2-4	10	6	40
3-4	3	2	80
4-5	8	6	50

- (i) Crash the project duration in steps and arrive at the minimum duration. What will be the critical path and the cost of crashing?
- (ii) If there is an indirect cost of Rs. 70 per day, what will be the optimal project duration and the cost of crashing?

Answer

- (i) Critical path

1 - 2 - 3 - 4 - 5

37 days

Paths:

	Normal	Crash
1 - 2 - 4 - 5	36	26
1 - 2 - 3 - 4 - 5	37	27
1 - 3 - 4 - 5	34	30

	Crash Activity	Days,	Cost
Step I	1 - 2	1	40
II	1 - 2	1	40
III	4 - 5	1	50
IV	4 - 5	1	50
V	2 - 3	1	60
VI	1 - 2 & 1 - 3	<u>1</u>	<u>60</u> (40 + 20)
		<u>6</u>	300

Revised critical paths : $\left. \begin{array}{l} 1-2-4-5 \\ 1-2-3-4-5 \\ 1-3-4-5 \end{array} \right\} 31 \text{ days}$

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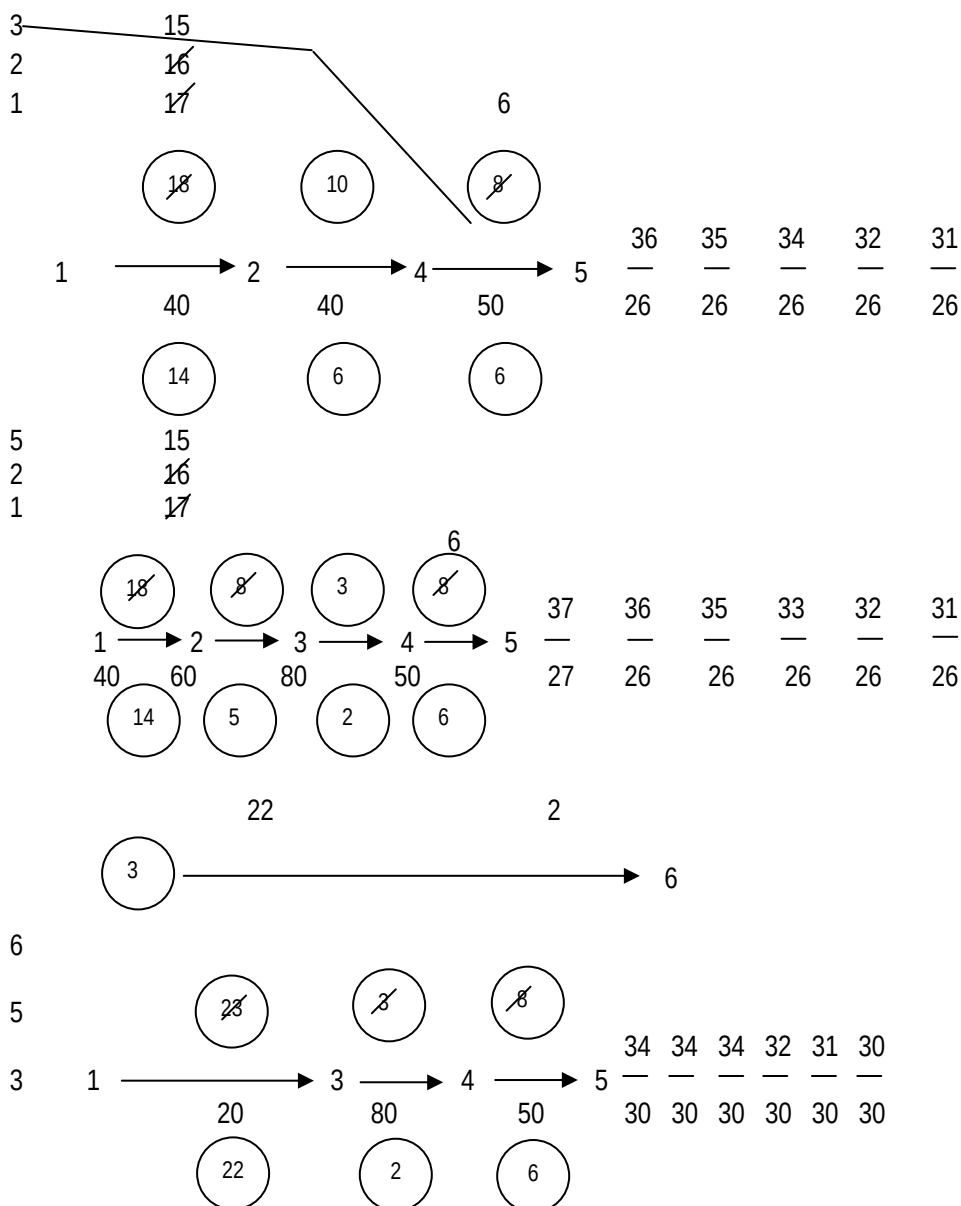
VII

1 – 2 & 3 – 4

 $(40 + 80) \frac{120}{420}$ 30 days

But VII is not done if indirect cost = 70, which is < 120.

(ii) Project duration is 31 days and cost of crashing is 300.

Workings of Crashing:

Critical Path : 1 – 2 – 3 – 4 – 5 (37 days) Crashing cost

(1)	1 – 2	1 day	40
(2)	1 – 2	1 day	40
(3)	4 – 5	2 days	100
(4)	2 – 3	1 day	60
(5)	1 – 2 & 1 – 3	1 day (40 + 20)	<u>60</u>
			<u>300</u>

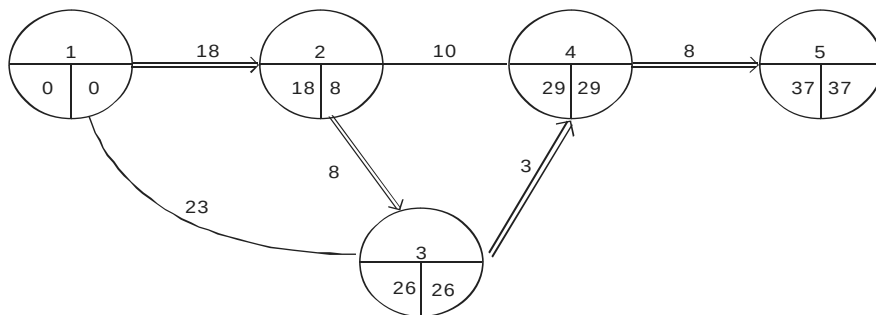
Revised critical Path: 1 – 2 – 4 – 5
 1 – 2 – 3 – 4 – 5
 1 – 3 – 4 – 5

Duration 31 days

(Note: After each crashing a networking diagram has to be drawn and critical path has to be decided).

Alternative Solution:

(i) Network Diagram:



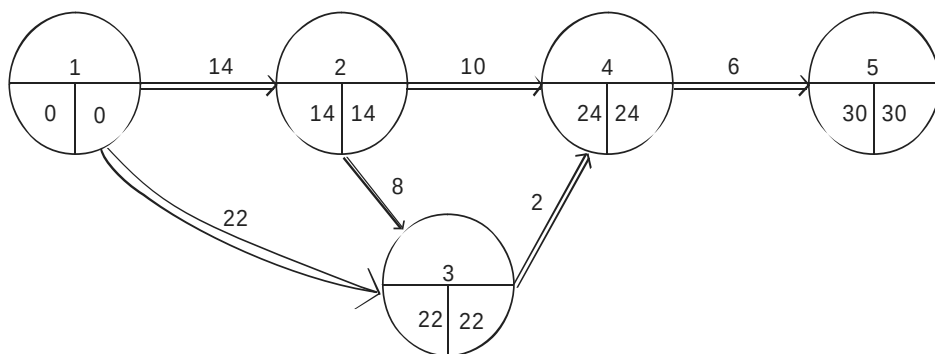
Project duration = 37 days.

Critical Paths :

- (i) 1 → 3 → 4 → 5
- (ii) 1 – 2 – 3 – 4 – 5

Advanced Management Accounting**Crashing by Steps**

Step : 1	Crash activity	Crashing No. of days	Crash cost per day (Rs.)	Crashing cost (Rs.)
	1–2	3	40	120
Step : 2	1–2	1	40	40
	1–3	1	20	20
Step : 3	4–5	2	50	100
Step : 4	3–4	1	80	<u>80</u>
				<u>360</u>

Revised Network

Effective crashing days = 7

Critical Paths:

- (i) 1 – 2 – 4 – 5
- (ii) 1 – 3 – 4 – 5
- (iii) 1 – 2 – 3 – 4 – 5

Project duration = 30 days

Crashing cost = Rs. 360

- (ii) For optimal project duration, we have to consider indirect cost per day i.e., Rs. 70. The crashing cost of activity 3–4 is Rs. 80 which is higher than indirect cost per day. Hence, we may opt it out (Step 4).

In that case, project duration = 31 days.

Crashing cost = Rs. 280.

Saving in indirect cost = $6 \times \text{Rs. } 70 = \text{Rs. } 420$.

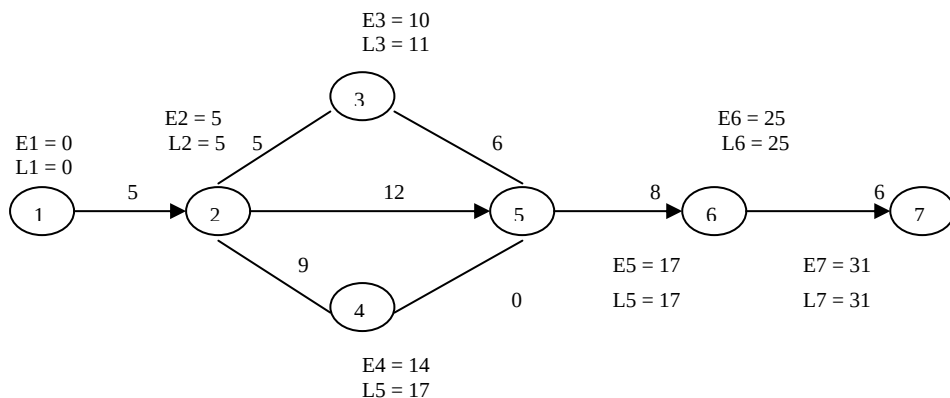
Question 2

A project with normal duration and cost along with crash duration and cost for each activity is given below:

Activity	Normal Time (Hrs.)	Normal Cost (Rs.)	Crash Time (Hrs.)	Crash Cost (Rs.)
1-2	5	200	4	300
2-3	5	30	5	30
2-4	9	320	7	480
2-5	12	620	10	710
3-5	6	150	5	200
4-5	0	0	0	0
5-6	8	220	6	310
6-7	6	300	5	370

Required:

- Draw network diagram and identify the critical path.
- Find out the total float associated with each activity.
- Crash the relevant activities systematically and determine the optimum project completion time and corresponding cost.

Answer**(i) Net work diagram**

Path are 1-2-5-6-7 = 31 hours, this is critical path
 1-2-3-5-6-7 = 30 hours
 1-2-4-5-6-7 = 28 hours

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(ii) Total floats

Activity	Duration hours	Early start	Latest start	Early finish	Latest finish	Total float
1-2	5	0	0	5	5	0
2-3	5	5	6	10	11	1
2-4	9	5	8	14	17	3
2-5	12	5	5	17	17	0
3-5	6	10	11	16	17	1
4-5	0	14	17	14	17	3
5-6	8	17	17	25	25	0
6-7	6	25	25	31	31	0

(iii) Calculation of crashing

Activity	Nt	Nc	Ct	Cc	Slop = $(Cc - Nc) / (Nt - Ct)$
1-2	5	200	4	300	100
2-3	5	30	5	30	0
2-4	9	320	7	480	80
2-5	12	620	10	710	45
3-5	6	150	5	200	50
4-5	0	0	0	0	0
5-6	8	220	6	310	45
6-7	6	300	5	370	70

The critical path activities are 1-2 2-5 5-6 6-7

Slope 100 45 45 70

Two activities cost slope cost is minimum (2-5 and 5-6) but activity 5-6 is common and critical, it also continuing so reduce by 2 hours, then reduce activity 2-5 by one hour.

	Activity	From-to	Project durations	Cost
I	5-6	8-6 hours	31-2 = 29	$1840 + (2 \times 45) + (29 \times 50) = 3380$
II	2-5	12-11	29-1 = 28	$1840 + 90 + (1 \times 45) + 28 \times 50 = 3375$

After this reduction now two paths are critical 1-2-3-5-6-7 = 28 and 1-2-5-6-7 = 28

Program Evaluation and Review Technique

So	1-2	3-5	6-7
	2-5		
Slope cost	100	50+45=95	70

As cost per hour for every alternative is greater than Rs.50 (overhead cost per hour). Therefore, any reduction in the duration of project will increase the cost of project completion. Therefore, time for projects is 28 weeks, minimum cost is Rs.3375.

Question 3

An Engineering Project has the following activities, whose time estimates are listed below:

Activity (i – j)	Estimated duration (in months)		
	Optimistic	Most likely	Pessimistic
1-2	2	2	14
1-3	2	8	14
1-4	4	4	16
2-5	2	2	2
3-5	4	10	28
4-6	4	10	16
5-6	6	12	30

- Draw the project network and find the critical path.
- Find the expected duration and variance for each activity. What is the expected project length?
- Calculate the variance and standard deviation of the project length.
- What is the probability that the project will be completed at least eight months earlier than expected time?
- If the project due date is 38 months, what is the probability of not meeting the due date? Given:

Z :	0.50	0.67	1.00	1.33	2.00
Prob. :	0.3085	0.2514	0.1587	0.0918	0.0228

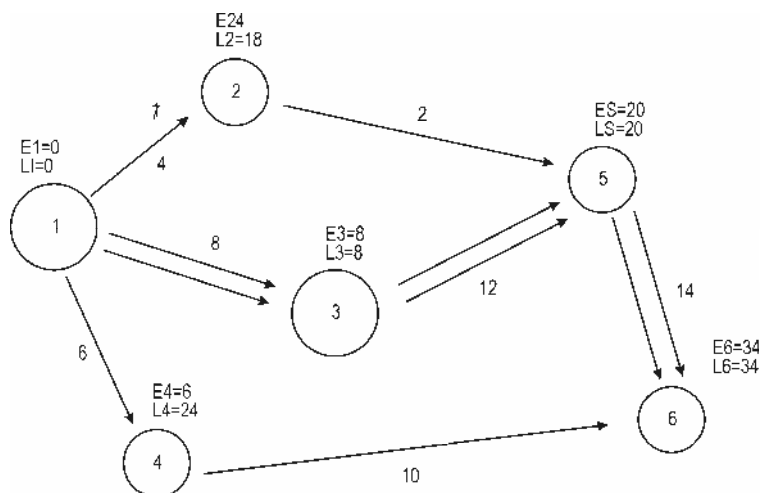
Answer

The earliest and latest expected time for each event is calculated by considering the expected time of each activity as shown in the table below:

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Activity (i - j)	t_0	t_m	t_p	$t_e = (t_0 + 4t_m + t_p) / 6$	$\sigma^2 = \left(\frac{t_p - t_0}{6} \right)^2$
1-2	2	2	14	4	4
1-3	2	8	14	8	4
1-4	4	4	16	6	4
2-5	2	2	2	2	0
3-5	4	10	28	12	16
4-6	4	10	16	10	4
5-6	6	12	30	14	16

(a) The project network is drawn below:



(i) Critical Path is : 1 – 3- 5 – 6

(ii) The expected duration and variance of each activity is shown in the table above.

The expected project length is the sum of the duration of critical activities.
Hence,

Expected project Length = 8 + 12 + 14 = 34 months

(iii) Variance of the project length is the sum of the variances of critical activities.

Variance of project length = $\sigma^2 = 4 + 16 + 16 = 36$ months

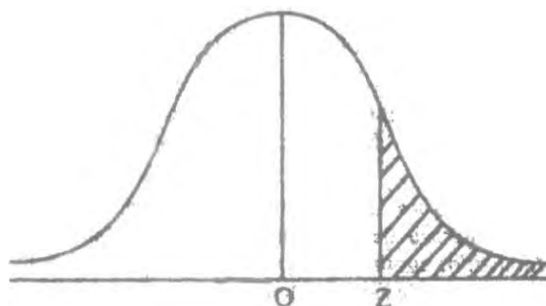
Therefore, Standard Deviation = $\sigma = \sqrt{36} = 6$

(iv) Probability that the project will be completed at least 8 months earlier than the expected time of 34 months is given by

$$\text{Prob.} \left[Z \leq \frac{T_s - T_e}{\sigma_e} = \frac{(34 - 8) - 34}{6} \right] = \text{Prob.}[Z \leq -1.33]$$

But $Z = -1.33$ from the normal distribution table is 0.0918.

Students may please note that the values for the Prob. For a Z value correspond to the shaded area as shown in the diagram below:



Thus, the probability of completing the project within 26 months is 9.18%.

- (v) If the project due date is 38 months, then the probability of not meeting the due date is given by

$$\text{Prob.} \left[Z > \frac{T_s - T_e}{\sigma_e} = \frac{(38 - 34)}{6} \right] = \text{Prob.}[Z > 0.67]$$

But $Z = 0.67$ from the normal distribution is 0.2514.

Thus, the probability of not meeting the due date is 25.14%.

Question 4

A small project consists of jobs as given in the table below. Each job is listed with its normal time and a minimum or crash time (in days). The cost (in Rs. per day) of each job is also given:

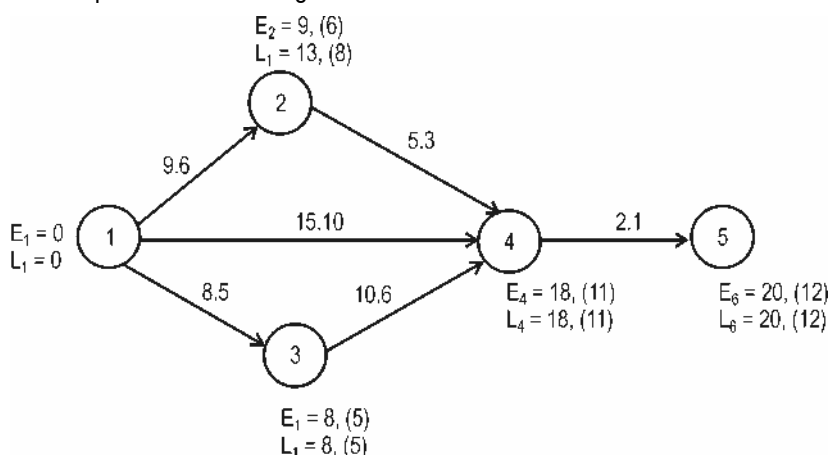
Job (i - j)	Normal duration (in days)	Minimum (crash) Duration (in days)	Cost of Crashing (Rs. per day)
1-2	9	6	20
1-3	8	5	25
1-4	15	10	30
2-4	5	3	10
3-4	10	6	15
4-5	2	1	40

Advanced Management Accounting

- (i) What is the normal project length and the minimum project length?
- (ii) Determine the minimum crashing cost of schedules ranging from normal length down to, and including the minimum length schedule. That is, if L = Length of the schedule, find the costs of schedules which are L , $L - 1$, $L - 2$ and so on.
- (iii) Overhead costs total Rs.60 per day. What is the optimum length schedule in terms of both crashing and overhead cost? List the schedule duration of each job for your solution.

Answer

- (i) The required network is given below:



The various paths in the network are:

1 – 2 – 4 – 5 with project duration = 16 days

1 – 4 – 5 with project duration = 17 days

1 – 3 – 4 – 5 with project duration = 20 days

The critical path is 1 → 3 → 4 → 5. The normal length of the project is 20 days and minimum project length is 12 days.

- (ii) Since the present schedule consumes more time than the minimum project length, the duration can be reduced by crashing some of the activities. Also, since the project duration is controlled by the activities lying on the critical path, the duration of some of the activities lying on critical path can be reduced. It is given that overhead cost is Rs.60 per day.

Step I: First, the crashing cost of activity (3, 4) being minimum, the duration of this activity can be compressed from 10 days to 9 days. The total cost for 19 day's schedule = Rs.15 + Rs.19 × 60 = Rs.1,155

Step II: Since the critical path remains unchanged, the duration of activity (3, 4) can be further reduced from 9 days to 8 days resulting in an additional cost of Rs.15 so that total cost for 18 days schedule = Rs.30 + Rs.60 × 18 = Rs.30 + Rs.1,080 = Rs.1,110.

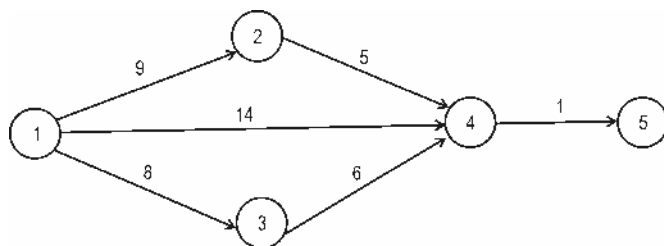
Step III: Continue this procedure till the minimum project length schedule. The calculations are given below:

Normal Project length (days)	Job crashed	Crashing Cost (Rs.)	Overhead cost @ Rs.60 / day	Total Cost. (Rs.)
20	--	--	20×60	1,200
19	3-4	1 × 15 = 15	19×60	1,155
18	3-4	2 × 15 = 30	18×60	1,110
17	3-4	3 × 15 = 45	17×60	1,065
16	4-5	3×15+1×40 = 85	16×60	1,045
15	3-4, 1-4	4×15+1×40+1×30= 130	15×60	1,030
14	1-3, 1-4, 2-4	130+1×30+1×25+1×10=195	15×60	1,035
13	1-3, 1-4, 2-4	195+1×25+1×30+1×10=260	13×60	1,040
12	1-3, 1-4, 1-2	260+25+30+20=335	12×60	1,055

- (iii) Since the total cost starts increasing from 14 days duration onwards, the minimum total cost of Rs.1,030 for the optimum project duration of 15 days occurs for optimum duration of each job as given below:

Job:	(1,2)	(1,3)	(1,4)	(2,4)	(3,4)	(4,5)
Optimum:	9	8	14	5	6	1

Duration (day)



Path 1 → 2 → 4 → 5 = 9 + 5 + 1 = 15 days

Path 1 → 4 → 5 = 14 + 1 = 15 days

Path 1 → 3 → 4 → 5 = 8 + 6 + 1 = 15 days.

Hence, the optimum duration of the project is 15 days.

Advanced Management Accounting

Question 5

Write short notes on Distinction between PERT and CPM.

Answer

Distinction between PERT and CPM: The PERT and CPM models are similar in terms of their basic structure, rationale and mode of analysis. However, there are certain distinctions between PERT and CPM networks which are enumerated below:

- (1) CPM is activity oriented i.e. CPM network is built on the basis of activities. Also results of various calculations are considered in terms of activities of the project. On the other hand, PERT is even oriented.
- (2) CPM is a deterministic model i.e. it does not take into account the uncertainties involved in the estimation of time for execution of a job or an activity. It completely ignores the probabilistic element of the problem. PERT, however, is a probabilistic model. It uses three estimates of the activity time; optimistic, pessimistic and most likely, with a view to take into account time uncertainty. Thus, the expected duration for each activity is probabilistic and expected duration indicates that there is fifty per probability of getting the job done within that time.
- (3) CPM laces dual emphasis on time and cost and evaluates the trade-off between project cost and project item. By deploying additional resources, it allows the critical path project manager to manipulate project duration within certain limits so that project duration can be shortened at an optimal cost. On the other hand, PERT is primarily concerned with time. It helps the manger to schedule and coordinate various activities so that the project can be completed on scheduled time.
- (4) CPM is commonly used for those projects which are repetitive in nature and where one has prior experience of handling similar projects. PERT is generally used for those projects where time required to complete various activities are not known as prior. Thus, PERT is widely used for planning and scheduling research and development project.

Question 6

A small project is composed of seven activities, whose time estimates are listed below. Activities are identified by their beginning (i) and ending (j) node numbers.

Activity (I-j)	Estimated durations (in days)		
	Optimistic	Most likely	Pessimistic
1-2	2	2	14
1-3	2	8	14
1-4	4	4	16

Program Evaluation and Review Technique

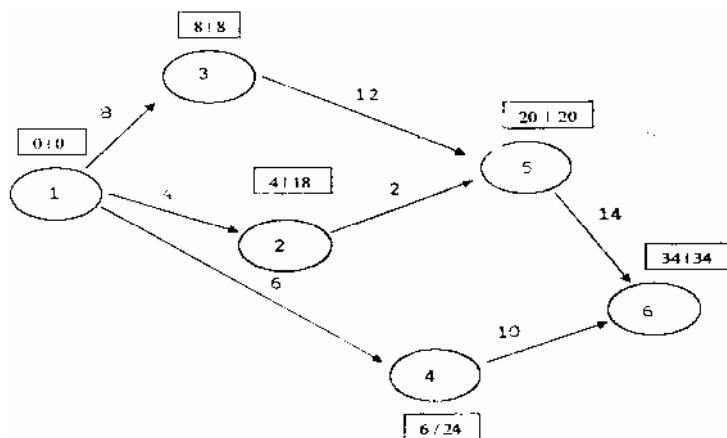
2-5	2	2	2
3-5	4	10	28
4-6	4	10	16
5-6	6	12	30

- (a) Draw the project network.
- (b) Find the expected duration and variance for each activity. What is the expected project length?
- (c) If the project due date is 38 days, what is the probability of meeting the due date ?

Given:	z	0.50	0.67	1.00	1.33	2.00
	P	0.3085	0.2514	0.1587	0.0918	0.0228

Answer

Activity	Estimated durations (in days) = $\frac{a + 4m + b}{6}$			$\sigma^2 = \left(\frac{b-a}{6}\right)^2$	
(i - j)	a	m	b		
1-2	2	2	14	4	4
1-3	2	8	14	8	4
1-4	4	4	16	6	4
2-5	2	2	2	2	0
3-5	4	10	28	12	16
4-6	4	10	16	10	4
5-6	6	12	30	14	16



The critical path is 1-----3-----5-----6

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(b) The expected duration of the project $8+12+14 = 34$ days

(c) Variance of project length is $\sigma^2 = 4 + 16 + 16 = 36$

The standard normal deviate is:

$$Z = \frac{\text{due date} - \text{expected date of completion}}{\sqrt{\text{variance}}}$$

$$Z = \frac{26 - 34}{6} = \frac{8}{6} = -1.33 \text{ probability of meeting the due date is } 0.0918 \text{ or } 9.18\%$$

(d) When due date is 38 days

$$Z = \frac{38 - 34}{6} = \frac{4}{6} = 0.67 \text{ Probability meeting the date is } 0.2514 \text{ or } 25.14\%.$$

Question 7

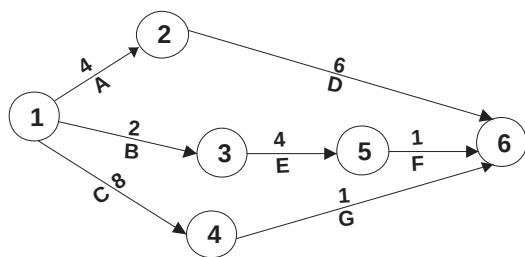
The following information is available:

	Activity	No. of days	No. of men required per day
A	1—2	4	2
B	1—3	2	3
C	1—4	8	5
D	2—6	6	3
E	3—5	4	2
F	5—6	1	3
G	4—6	1	8

(i) Draw the network and find the critical path.

(ii) What is the peak requirement of Manpower? On which day(s) will this occur?

(iii) If the maximum labour available on any day is only 10, when can the project be completed?

Answer

Program Evaluation and Review Technique

Path	Days
AD	10 CP →
BEF	7
CG	9

Critical Path = 1– 2 – 6

i.e. AD = 10 days.

Peak requirement is 11 men, required on days 7 and 9.

If only 10 men are available on any day, shift F,G to days 10 and 11 and the project can be completed in 11 days.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	A ₂	A ₂	A ₂	A ₂										
					D ₃	D ₃	D ₃	D ₃	D ₃	D ₃				
	B ₃	B ₃	E ₂	E ₂	E ₂	E ₂								
							F ₃							
	C ₅	C ₅	C ₅	C ₅	C ₅	C ₅	C ₅	C ₅						
									G ₈					
	10	10	9	9	10	10	11	8	11	3				
If s/o shift										F ₃	G ₈			
New	10	10	9	9	10	10	8	8	3	6	8			

Question 8

A project consists of seven activities and the time estimates of the activities are furnished as under:

Activity	Optimistic Days	Most likely Days	Pessimistic Days
1–2	4	10	16
1–3	3	6	9
1–4	4	7	16
2–5	5	5	5
3–5	8	11	32
4–6	4	10	16
5–6	2	5	8

Advanced Management Accounting*Required:*

- (i) Draw the network diagram.
- (ii) Identify the critical path and its duration.
- (iii) What is the probability that the project will be completed in 5 days earlier than the critical path duration?
- (iv) What project duration will provide 95% confidence level of completion ($Z_{0.95} = 1.65$)?

Given

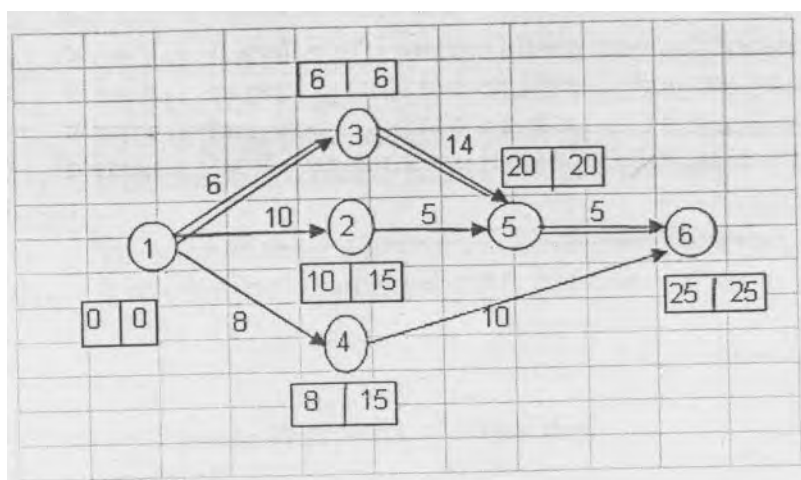
<i>Z</i>	1.00	1.09	1.18	1.25	1.33
<i>Probability</i>	0.1587	0.1379	0.1190	0.1056	0.0918

Answer

Calculation of expected time and variance of each activity:

Activity	Optimistic Days	Most likely Days	Pessimistic Days	Expected Duration	Variance
1-2	4	10	16	10	4
1-3	3	6	9	6	1
1-4	4	7	16	8	4
2-5	5	5	5	5	0
3-5	8	11	32	14	16
4-6	4	10	16	10	4
5-6	2	5	8	5	1

The network diagram is as under:



Program Evaluation and Review Technique

Critical Path:	1–3	3–5	5–6			
Duration (days)	6	14	5	= 25 days		
Standard deviation:	1	+	16	+	1	= 18
						$\sqrt{18} = 4.24$

Probability that the project will be completed five days earlier:

$$Z = \frac{20 - 25}{4.24} = -1.18.$$

According to probability values given in the question probability is 11.9%

To obtain 95% confidence level:

$$1.65 = \frac{X - 25}{4.24}$$

$$X - 25 = 6.996$$

$$X = 32 \text{ days}$$

Advanced Management Accounting**EXERCISE****Question 1**

A small maintenance project consists of the following twelve jobs whose precedence relations are identified with their node numbers.

Job (i, j)	(1, 2)	(1, 3)	(1, 4)	(2, 3)	(2, 5)	(2, 6)
Duration (in days)	10	4	6	5	12	9
Job (i, j)	(3, 7)	(4, 5)	(5, 6)	(6, 7)	(6, 8)	(7, 8)
Duration (in days)	12	15	6	5	4	7

- (i) Draw an arrow diagram representing the project.
- (ii) Calculate earliest start, earliest finish, latest start and latest finish time for all the jobs.
- (iii) Find the critical path and project duration.
- (iv) Tabulate total float, free float and independent float.

Answer

- (iii) The critical path is $1 \rightarrow 2 \rightarrow 5 \rightarrow 6 \rightarrow 7 \rightarrow 8$ and the project is 40 days.
- (iv) Total float, free float and independent float for various activities are calculated in the above table.

Question 2

A project has the following time schedule:

	Time in Weeks	Activity	Time in Weeks
1-2	2	4-6	3
1-3	2	5-8	1
1-4	1	6-9	5
2-5	4	7-9	4
3-6	8	8-9	3
4-7	5		

Construct PERT network and compute:

- (i) total float for each activity; and
- (ii) critical path and its duration.

Answer

The critical path is given by 1-3-6-9 and the project duration is 15 weeks.

Question 3

The following information is given:

Activity	(1-2)	(2-3)	(2-4)	(3-5)	(4-6)	(5-6)	(5-7)	(6-7)
Pessimistic time (in weeks)	3	9	6	8	8	0	5	8
Most likely time (in weeks)	3	6	4	6	6	0	4	5
Optimistic time (in weeks)	3	3	2	4	4	0	3	2

Draw the Network diagram for the above. Calculate:

- Variance to each activity.
- Critical path and expected project length.
- The probability that the project will be completed in 23 weeks.

Given that:

Z value :	1.90	1.91	1.92	1.93	1.94
Probability :	0.9713	0.9719	0.9726	0.9732	0.9738

Answer

- Critical path is given by 1 – 2 – 3 – 5 – 6 – 7 and the expected project length is 20 weeks.

- Variance of the critical path = $\sigma^2 = 0 + 1 + 4/9 + 0 + 1 = 22/9 = 2.444$

Thus, the probability that the project will be completed in 23 weeks is 97.26%.

Question 9

A project consists of eight activities with the following relevant information:

Activity	Immediate Predecessor	Estimated Duration (Days)		
		Optimistic	Most Likely	Pessimistic
A	—	1	1	7
B	—	1	4	7

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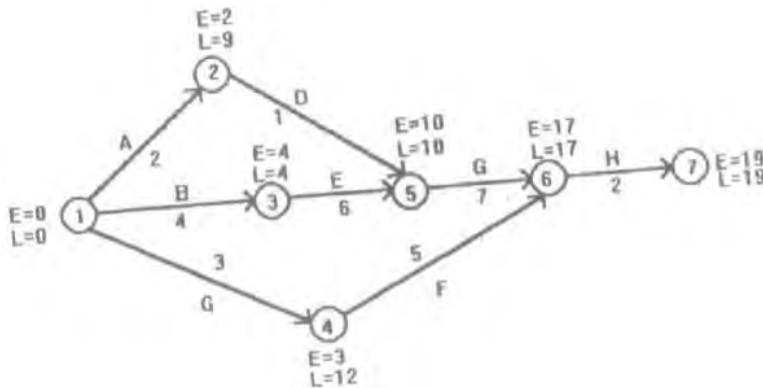
C	—	2	2	8
D	A	1	1	1
E	B	2	5	14
F	C	2	5	8
G	D, E	3	6	15
H	F, G	1	2	3

- (i) Draw the PERT network and find out the expected project completion time.
- (ii) What duration will have 95% confidence for project completion?
- (iii) If the average duration for activity F increases to 14 days, what will be its effect on the expected project completion time which will have 95% confidence?

(For standard normal $Z = 1.645$, area under the standard normal curve from 0 to $Z = 0.45$)

Answer

- (i) The required network is drawn below:



The expected time for each activity shown in the network above is calculated in the following table:

Activity	Estimated Duration (Days)			Expected duration $\bar{t}$	Variance σ^2
	Optimistic a	Most likely m	Pessimistic b		
A 1-2	1	1	7	2	1
B 1-3	1	4	7	4	1
C 1-4	2	2	8	3	1
D 2-5	1	1	1	1	0
E 3-5	2	5	14	6	4

Program Evaluation and Review Technique

F 4-6	2	5	8	5	1
G 5-6	3	6	15	7	4
H 6-7	1	2	3	2	1/9

The critical path is given by 1 – 3 – 5 – 6 – 7 or B – E – G – H and the expected project completion time is 19 days.

- (ii) The variance for critical path is $1 + 4 + 4 + 1/9 = 82/9$

Standard deviation of critical path = $\sigma_1 = 3.02$ (approx.).

To calculate the project duration which will have 95% chances of its completion, we utilise the given value of Z corresponding to 95% confidence which is 1.645.

Thus, $\sigma = 1.645$

or $X = 1.645 \times 3.02 + 19 = 23.97$ days = 24 days

Hence, 24 days of project completion time will have 95% probability of its completion.

- (iii) If the average duration for activity F increases to 14 days, then the path 1 – 4 – 6 – 7 i.e. C – F – H will also become critical path with expected project completion time of 19 days. Now, activities C and F are also critical activities. Since we are given only the average duration for activity F, It is assumed that the variance for this activity is zero. Further, since PERT analysis is based on the assumption that the activities are independent in terms of their variance, therefore, standard deviation of critical paths can be computed as:

$$\sigma = \sigma_1$$

We now wish to calculate the expected project completion time that will have 95% confidence level,

$$P(9Z < 1.645) = 0.95$$

$$\text{or } X = 19 + 1.645 \times 3.18 = 24.23 \text{ days.}$$

Hence the project duration of 24.23 days will have 95% confidence of completion.

Question 10

A small project consists of seven activities for which the relevant data are given below:

Activity	Preceding activities	Activity Duration (Days)
A	--	4
B	--	7
C	--	6

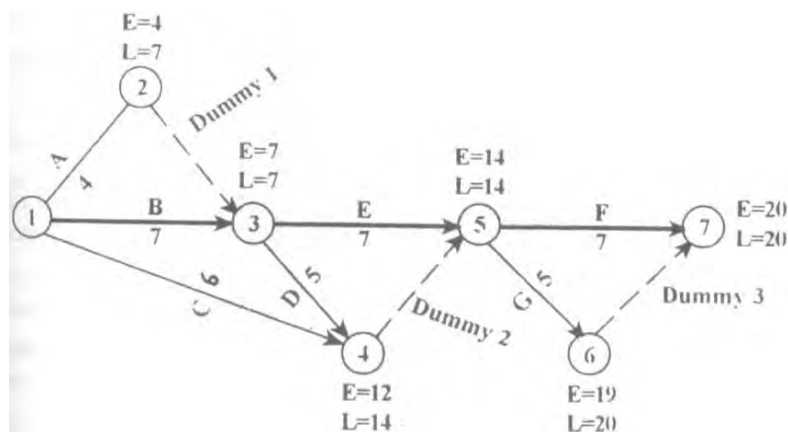
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D	A, B	5
E	A, B	7
F	C, D, E	6
G	C, D, E	5

- (i) Draw the network and find the project completion time.
(ii) Calculate total float for each of the activities.
(iii) Draw the time scaled diagram.

Answer

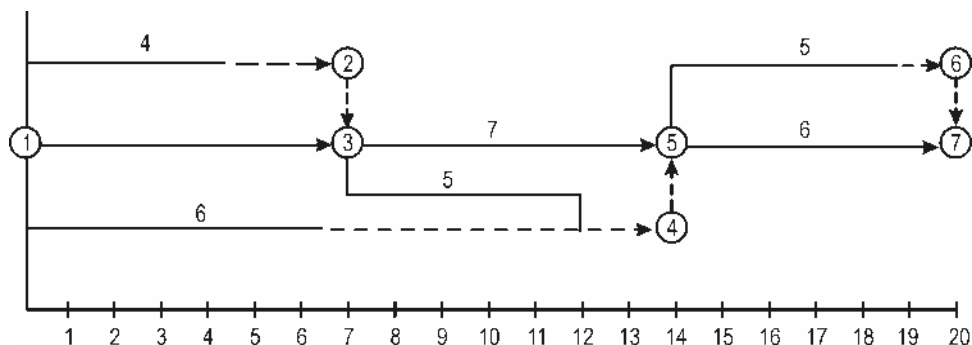
- (i) The required network is given below:



- (ii) The total float for various activities is calculated as below:

Activity		Duration	Start		Finish		Total float
			Earliest	Latest	Earliest	Latest	
A	1-2	4	0	3	4	7	3
B	1-3	7	0	0	7	7	0
Dummy 1	2-3	0	4	7	4	7	3
D	3-4	5	7	9	12	14	2
E	3-5	7	7	7	14	14	0
Dummy 2	4-5	0	12	14	12	14	2
F	5-7	6	14	14	20	20	10
G	5-6	5	14	15	19	20	1
Dummy 3	6-7	0	19	20	19	20	1

(iii) The required time scale diagram is drawn below:



Question 13

Define a project and briefly explain the four common implications which characterize a project, and state the five steps of the working methodology of critical path analysis. (May 1997)

Answer

A project can be defined as a set of activities or jobs that are performed in a certain sequence determined logically or technologically and it has to be completed within (i) a specified time, (ii) a specified cost and (iii) meeting the performance standards. Examples of a project from fairly diverse fields could be cited. Some of them are given below:

1. Introducing a new product in the market.
2. Construction of a new bridge over a river or construction of a 25 – storied building.
3. Executing a large and complex order on jobbing production.
4. Sending a spacecraft to the mars.

All these projects are characterized by the following set of common implications, although they pertain to widely different fields.

- (i) The Large-scale characteristic: These projects are generally unusually large and complex. Thousands of suppliers, workers and other categories of persons are involved and their efforts have to be coordinated for completion of the project.
- (ii) The non-recurring characteristic: These projects are generally of a one-time nature. Neither in the past, nor in the future they are likely to undertaken substantially in the same form.
- (iii) Uncertain and critical dates: During of the various activities involved in such projects are usually uncertain. Further in such type of projects, many critical dates exits by which operations must be completed in order to complete the entire project on schedule.

Advanced Management Accounting

- (iv) Completion dead line: The fourth distinct feature of these projects is that there is dead line for the completion of the entire project. In case of any delay in the completion of the project, some penalty is levied for such delay beyond the dead line.

The working methodology of Critical Path Analysis (CPA) which includes both CPM and PERT, consists of following five steps:

1. Analyse and breakdown the project in terms of specific activities and / or events.
2. Determine the interdependence and sequence of specific activities and prepare a network,
3. Assign estimates of time, cost or both to all the activities of the network.
4. Identify the longest or critical path through the network.
5. Monitor, evaluate and control the progress of the project by re-planning, rescheduling and reassignment of resources.

SIMULATION

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Simulation

Simulation is a quantitative procedure which describes a process by developing a model of that process and then conducting a series of organised trial and error experiments to predict the behaviour of the process over time.

2. Steps In The Simulation Process

1. Define the problem or system you intend to simulate.
2. Formulate the model you intend to use.
3. Test the model; compare its behaviour with the behaviour of the actual problem environment.
4. Identify and collect the data needed to test the model.
5. Run the simulation.
6. Analyze the results of the simulation and, if desired, change the solution you are evaluating.
7. Rerun the simulation to test the new solution.
8. Validate the simulation, that is, increase the chances that any inferences you draw about the real situation from running the simulation will be valid.

3. Monte Carlo Simulation

The Monte Carlo method employs random numbers and is used to solve problems that depend upon probability, where physical experimentation is impracticable and the creation of a mathematical formula impossible. In other words, it is method of Simulation by the sampling technique.

First of all, the probability distribution of the variable under consideration is determined; then a set of random numbers is used to generate a set of values that have the same distributional characteristics as the actual experience it is devised to simulate.

Advanced Management Accounting**4. Steps in Monte Carlo Simulation**

The steps involved in carrying out Monte Carlo Simulation are:

- (i) Select the measure of effectiveness of the problem.
- (ii) Identify the variables which influence the measure of effectiveness significantly.
- (iii) Determine the proper cumulative probability distribution of each variable selected under step (ii). Plot these, with the probability on the vertical axis and the values of variables on horizontal axis.
- (iv) Get a set of random numbers.
- (v) Consider each random number as a decimal value of the cumulative probability distribution. With the decimal, enter the cumulative distribution plot from the vertical axis. Project this point horizontally, until it intersects cumulative probability distribution curve. Then project the point of intersection down into the vertical axis.
- (vi) Record the value (or values if several variables are being simulated) generated in step (v) into the formula derived from the chosen measure of effectiveness. Solve and record the value. This value is the measure of effectiveness for that simulated value.
- (vii) Repeat steps (v) and (vi) until sample is large enough for the satisfaction of the decision maker.

Question 1

A Car Manufacturing Company manufactures 40 cars per day. The sale of cars depends upon demand which has the following distribution:

<i>Sales of Cars</i>	<i>Probability</i>
37	0.10
38	0.15
39	0.20
40	0.35
41	0.15
42	0.05

The production cost and sale price of each car are Rs.4 lakh and Rs.5 lakh respectively. Any unsold car is to be disposed off at a loss of Rs.2 lakh per car. There is a penalty of

Re.1 lakh per car, if the demand is not met. Using the following random numbers, estimate total profit/ loss for the company for the next ten days:

9, 98, 64, 98, 94, 01, 78, 10, 15, 19

If the company decides to produce 39 cars per day, what will be its impact on profitability?

Answer

First of all random numbers 00-99 are allocated in proportion to the probabilities associated with the sales of cars as given below:

Table 1

Sales of Car	Probability	Cumulative probability	Range for random numbers
37	0.10	0.10	00-99
38	0.15	0.25	10-24
39	0.20	0.45	25-44
40	0.35	0.80	45-79
41	0.15	0.95	80-94
42	0.05	1.00	95-98

Based on the given random numbers, we simulate the estimated sales and calculate the profit / loss on the basis of specified units of production.

Table 2

Day	Random Numbers	Estimated Sale	Profit (Production 40 cars / day) (Rs. Lakh)	Profit (Production 39 cars / day) (Rs. Lakhs)
1	9	37	$37 \times 1 - 3 \times 2 = 31$	$37 \times 1 - 2 \times 2 = 33$
2	98	42	$40 \times 1 - 2 \times 1 = 38$	$39 \times 1 - 3 \times 1 = 36$
3	64	40	$40 \times 1 = 40$	$39 \times 1 - 1 \times 1 = 38$
4	98	42	$40 \times 1 - 2 \times 1 = 38$	$39 \times 1 - 3 \times 1 = 36$
5	94	41	$40 \times 1 - 1 \times 1 = 39$	$39 \times 1 - 2 \times 1 = 37$
6	01	37	$37 \times 1 - 3 \times 2 = 31$	$37 \times 1 - 2 \times 2 = 33$
7	78	40	$40 \times 1 = 40$	$39 \times 1 - 1 \times 1 = 38$
8	10	38	$38 \times 1 - 2 \times 2 = 34$	$38 \times 1 - 1 \times 2 = 36$
9	15	38	$38 \times 1 - 2 \times 2 = 34$	$38 \times 1 - 1 \times 2 = 36$
10	19	38	$38 \times 1 - 2 \times 2 = 34$	$36 \times 1 - 1 \times 2 = 36$

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There is no additional profit or loss if the company decides to reduce production to 39 cars per day.

Question 2

An investment company wants to study the investment projects based on market demand, profit and the investment required, which are independent of each other. Following probability distributions are estimated for each of these three factors:

Annual Demand							
(Units in thousands)	25	30	35	40	45	50	55
Probability	0.05	0.10	0.20	0.30	0.20	0.10	0.05
Profit per Unit:		3.00	5.00	7.00	9.00	10.00	
Probability:		0.10	0.20	0.40	0.20	0.10	
Investment required							
(in thousands of Rupees):		2,750		3,000		3,500	
Probability:		0.25		0.50		0.25	

Using simulation process, repeat the trial 10 times, compute the investment on each trail taking these factors into trail. What is the most likely ret

Use the following random numbers:urn?

(30, 12, 16); (59, 09, 69); (63, 94, 26); (27, 08, 74);

(64, 60, 61); (28, 28, 72); (31, 23, 57); (54, 85, 20);

(64, 68, 18); (32, 31, 87).

In the bracket above, the first random number is for annual demand, the second one is for profit and the last one is for the investment required.

Answer

The yearly return can be determined by the formula:

$$\text{Return (\%)} = \frac{\text{Profit} \times \text{Number of units demanded}}{\text{Investment}} \times 100$$

First of all, random number 00-99 are allocated in proportion to the probabilities associated with each of the three variables as given under:

Annual Demand

<i>Units in thousands</i>	<i>Probability</i>	<i>Cum. Probability</i>	<i>Random Number assigned</i>
25	0.05	0.05	00-04
30	0.10	0.15	05-14
35	0.20	0.35	15-34
40	0.30	0.65	35-64
45	0.20	0.85	65-84
50	0.10	0.95	85-94
55	0.05	1.00	95-99

Profit per unit

<i>Profit</i>	<i>Probability</i>	<i>Cum. Probability</i>	<i>Random Number assigned</i>
3.00	0.10	0.10	00-09
5.00	0.20	0.30	10-29
7.00	0.40	0.70	30-69
9.00	0.20	0.90	70-89
10.00	0.10	1.00	90-99

Investment required (in thousands of Rupees)

<i>Units</i>	<i>Probability</i>	<i>Cum. Probability</i>	<i>Random Number assigned</i>
2,750	0.25	0.25	00-24
3,000	0.50	0.75	25-74
3,500	0.25	1.00	75-99

Let us now simulate the process for 10 trails. The results of the simulation are shown in the tables given below:

<i>Trails</i>	<i>Random Number of Demand</i>	<i>Simulated demand ('000) units</i>	<i>Random No for profit per unit</i>	<i>Simulated profit per unit</i>	<i>Random Number for investment</i>	<i>Simulated investment ('000) Rs.</i>	<i>Simulated return (%) (Demand × profit per unit × 100) + investment</i>
1	30	35	12	5.00	16	2,750	6.36

Advanced Management Accounting

2	59	40	09	3.00	69	3,000	4.00
3	63	40	94	10.00	26	3,000	13.33
4	27	35	08	3.00	74	3,000	3.50
5	64	40	60	7.00	61	3,000	9.33
6	28	35	28	5.00	72	3,000	5.83
7	31	35	23	5.00	57	3,000	5.83
8	54	40	85	9.00	20	2,750	13.09
9	64	40	68	7.00	18	2,750	10.18
10	32	35	31	7.00	87	3,500	7.00

The above table shows that the highest likely return is 13.33% which is corresponding to the annual demand of 40,000 units resulting a profit of Rs.10/- per unit and the required investment will be Rs.30,00,000.

Question 3

A Publishing house has bought out a new monthly magazine, which sells at Rs. 37.5 per copy. The cost of producing it is Rs. 30 per copy. A Newsstand estimates the sales pattern of the magazine as follows:

<i>Demand Copies</i>	<i>Probability</i>
<i>0 < 300</i>	<i>0.18</i>
<i>300 < 600</i>	<i>0.32</i>
<i>600 < 900</i>	<i>0.25</i>
<i>900 < 1200</i>	<i>0.15</i>
<i>1200 < 1500</i>	<i>0.06</i>
<i>1500 < 1800</i>	<i>0.04</i>

The newsstand has contracted for 750 copies of the magazine per month from the publisher.

The unsold copies are returnable to the publisher who will take them back at cost less Rs. 4 per copy for handling charges.

The newsstand manager wants to simulate of the demand and profitability. The of following random number may be used for simulation:

27, 15, 56, 17, 98, 71, 51, 32, 62, 83, 96, 69.

You are required to-

- (i) Allocate random numbers to the demand pattern forecast by the newsstand.
- (ii) Simulate twelve months sales and calculate the monthly and annual profit/loss.
- (iii) Calculate the loss on lost sales.

Answer

- (i) Allocation of random numbers

<i>Demand</i>	<i>Probability</i>	<i>Cumulative probability</i>	<i>Allocated RN</i>
0 < 300	0.18	0.18	00—17
300 < 600	0.32	0.50	18—49
600 < 900	0.25	0.75	50—74
900 < 1200	0.15	0.90	75—89
1200 < 1500	0.06	0.96	90—95
1500 < 1800	0.04	1.00	96—99

- (ii) Simulation: twelve months sales, monthly and annual profit/loss

<i>Month</i>	<i>RN</i>	<i>Demand</i>	<i>Sold</i>	<i>Return</i>	<i>Profit on sales (Rs.)</i>	<i>Loss on return (Rs.)</i>	<i>Net (Rs.)</i>	<i>Loss on lost units</i>
1	27	450	450	300	3375	12000	2175	
2	15	150	150	600	1125	2400	-1275	
3	56	750	750	--	5625	--	5625	
4	17	150	150	600	1125	2400	-1275	
5	98	1650	750	--	5625	---	5625	900
6	71	750	750	--	5625	--	5625	
7	51	750	750	--	5625	--	2175	
8	32	450	450	300	3375	1200	5625	
9	62	750	750	--	5625	--	5625	300
10	83	1050	750	--	5625	--	5625	900
11	96	1650	750	--	5625	--	5625	
12	69	750	750	--	5625		5625	
					54000	7200	46800	2100

- (iii) Loss on lost sale $2100 \times 7.5 = \text{Rs}15750$.

Advanced Management Accounting

Question 4

- (i) *What is simulation?*
- (ii) *What are the steps in simulation?*

Answer

- (i) Simulation is a quantitative procedure which describes a process by developing a model of that process and then conducting a series of organized trial and error experiments to product the behaviour of the process over time.
- (ii) Steps in the simulation process:
 - (i) Define the problem and system you intend to simulate.
 - (ii) Formulate the model you intend to use.
 - (iii) Test the model, compare with behaviour of the actual problem environment.
 - (iv) Identify and collect data to test the model.
 - (v) Run the simulation.
 - (vi) Analyse the results of the simulation and, if desired, change the solution you are evaluating.
 - (vii) Rerun the simulation to tests the new solution.
 - (viii) Validate the simulation i.e., increase the chances of valid inferences.

Question 5

How would you use the Monte Carlo Simulation method in inventory control?

Answer

The Monte Carlo Simulation:

It is the earliest mathematical Model of real situations in inventory control:

Steps involved in carrying out Monte Carlo simulation are:

- Define the problem and select the measure of effectiveness of the problem that might be inventory shortages per period.
- Identify the variables which influence the measure of effectiveness significantly for example, number of units in inventory.
- Determine the proper cumulative probability distribution of each variable selected with the probability on vertical axis and the values of variables on horizontal axis.
- Get a set of random numbers.

- Consider each random number as a decimal value of the cumulative probability distribution with the decimal enter the cumulative distribution plot from the vertical axis. Project this point horizontally, until it intersects cumulative probability distribution curve. Then project the point of intersection down into the vertical axis.
- Then record the value generated into the formula derived from the chosen measure of effectiveness. Solve and record the value. This value is the measure of effectiveness for that simulated value. Repeat above steps until sample is large enough for the satisfaction of the decision maker.

Question 6

A single counter ticket booking centre employs one booking clerk. A passenger on arrival immediately goes to the booking counter for being served if the counter is free. If, on the other hand, the counter is engaged, the passenger will have to wait. The passengers are served on first come first served basis. The time of arrival and the time of service varies from one minute to six minutes. The distribution of arrival and service time is as under:

<i>Arrival / Service Time (Minutes)</i>	<i>Arrival (Probability)</i>	<i>Service (Probability)</i>
1	0.05	0.10
2	0.20	0.20
3	0.35	0.40
4	0.25	0.20
5	0.10	0.10
6	0.05	—

Required:

- (i) *Simulate the arrival and service of 10 passengers starting from 9 A.M. by using the following random numbers in pairs respectively for arrival and service. Random numbers 60 09 16 12 08 18 36 65 38 25 07 11 08 79 59 61 53 77 03 10.*
- (ii) *Determine the total duration of*
 - (1) *Idle time of booking clerk and*
 - (2) *Waiting time of passengers.*

Advanced Management Accounting**Answer**

Random allocation tables are as under:

<i>Time (Mts)</i>	<i>Arrival (Probability)</i>	<i>Arrivals Cumulative Probability</i>	<i>Random No. allocated</i>	<i>Time (Mts)</i>	<i>Service (Probability)</i>	<i>Service Cumulative (Probability)</i>	<i>Random No. allocated</i>
1	0.05	0.05	00-04	1	0.10	0.10	00-09
2	0.20	0.25	05-24	2	0.20	0.30	10-29
3	0.35	0.60	25-59	3	0.40	0.70	30-69
4	0.25	0.85	60-84	4	0.20	0.90	70-89
5	0.10	0.95	85-94	5	0.10	1.00	90-99
6	0.05	1.00	95-99				

Simulation of ten trails:

<i>R. No.</i>	<i>Arrival Mts.</i>	<i>Time</i>	<i>Start</i>	<i>R. No.</i>	<i>Time Mts.</i>	<i>Finish Time</i>	<i>Waiting Time</i>	
							<i>Clerk</i>	<i>Passenger</i>
60	4	9.04	9.04	09	1	9.05	4	
16	2	9.06	9.06	12	2	9.08	1	
08	2	9.08	9.08	18	2	9.10	—	
36	3	9.11	9.11	65	3	9.14	1	
38	3	9.14	9.14	25	2	9.16	—	
07	2	9.16	9.16	11	2	9.18	—	
08	2	9.18	9.18	79	4	9.22	—	
59	3	9.21	9.22	61	3	9.25	—	1
53	3	9.24	9.25	77	4	9.29		1
03	1	9.25	9.29	10	2	9.31	—	<u>4</u>
Total							<u>6</u>	<u>6</u>

In half an hour trial, the clerk was idle for 6 minutes and the passengers had to wait for 6 minutes.

Question 7

State major reasons for using simulation technique to solve a problem and also describe basic steps in a general simulation process.

Answer**Reasons:**

- (i) It is not possible to develop a mathematical model and solutions with out some basic assumptions.
- (ii) It may be too costly to actually observe a system.
- (iii) Sufficient time may not be available to allow the system to operate for a very long time.
- (iv) Actual operation and observation of a real system may be too disruptive.

Steps:

- (i) Define the problem or system which we want to simulate.
- (ii) Formulate an appropriate model of the given problem.
- (iii) Ensure that model represents the real situation/ test the model, compare its behaviour with the behaviour of actual problem environment.
- (iv) Identify and collect the data needed to list the model.
- (v) Run the simulation
- (vi) Analysis the results of the simulation and if desired, change the solution.
- (vii) Return and validate the simulation.

Question 8

At a small store of readymade garments, there is one clerk at the counter who is to check bills, receive payments and place the packed garments into fancy bags. The arrival of customer at the store is random and service time varies from one minute to six minutes, the frequency distribution for which is given below:

<i>Time between arrivals (minutes)</i>	<i>Frequency</i>	<i>Service Time (in minutes)</i>	<i>Frequency</i>
1	5	1	1
2	20	2	2
3	35	3	4
4	25	4	2

Advanced Management Accounting

5	10	5	1
6	5	6	0

The store starts work at 11 a.m. and closes at 12 noon for lunch and the customers are served on the "first come first served basis".

Using Monte Carlo simulation technique, find average length of waiting line, average waiting time, average service time and total time spent by a customer in system.

You are given the following set of random numbers, first twenty for arrivals and last twenty for service:

64	04	02	70	03	60	16	18	36	38
07	08	59	53	01	62	36	27	97	86
30	75	38	24	57	09	12	18	65	25
11	79	61	77	10	16	55	52	59	63

Answer

From the frequency distribution of arrivals and service times, probabilities and cumulative probabilities are first worked out as shown in the following table:

<i>Time between arrivals</i>	<i>Frequency</i>	<i>Probability</i>	<i>Cum. Prob.</i>	<i>Service Time</i>	<i>Frequency</i>	<i>Prob.</i>	<i>Cum. Prob.</i>
1	5	0.05	0.05	1	1	0.10	0.10
2	20	0.20	0.25	2	2	0.20	0.30
3	35	0.35	0.60	3	4	0.40	0.70
4	25	0.25	0.85	4	2	0.20	0.90
5	10	0.10	0.95	5	1	0.10	1.00
6	5	0.05	1.00	6	0	0.00	1.00
Total	100				10		

The random numbers to various intervals have been allotted in the following table:

<i>Time between arrivals</i>	<i>Probability</i>	<i>Random numbers allotted</i>	<i>Service Time</i>	<i>Probability</i>	<i>Random numbers allotted</i>
1	0.05	00-04	1	0.10	00-09
2	0.20	05-24	2	0.20	10-29
3	0.35	25-59	3	0.40	30-69

Simulation

4	0.25	60-84	4	0.20	70-89
5	0.10	85-94	5	0.10	90-99
6	0.05	95-99	6	0.00	-

Simulation Work Sheet

Random Number	Time till next arrival	Arrival Time a.m.	Service begins a.m.	Random number	Service time	Service Ends a.m.	Clerk Waiting time	Customer waiting Time	Length of waiting line
64	4	11.04	11.04	30	3	11.07	04	-	-
04	1	11.05	11.07	75	4	11.11	-	2	1
02	1	11.06	11.11	38	3	11.14	-	5	2
70	4	11.10	11.14	24	2	11.16	-	4	2
03	1	11.11	11.16	57	3	11.19	-	5	2
60	4	11.15	11.19	09	1	11.20	-	4	2
16	2	11.17	11.20	12	2	11.22	-	3	2
18	2	11.19	11.22	18	2	11.24	-	3	2
36	3	11.22	11.24	65	3	11.27	-	2	1
38	3	11.25	11.27	25	2	11.29	-	2	1
07	2	11.27	11.29	11	2	11.31	-	2	1
08	2	11.29	11.31	79	4	11.35	-	2	1
59	3	11.32	11.35	61	3	11.38	-	3	1
53	3	11.35	11.38	77	4	11.42	-	3	1
01	1	11.36	11.42	10	2	11.44	-	6	2
62	4	11.40	11.44	16	2	11.46	-	4	2
36	3	11.43	11.46	55	3	11.49	-	3	2
27	3	11.46	11.49	52	3	11.52	-	3	1
97	6	11.52	11.52	59	3	11.55	-	-	-
86	5	11.57	11.57	63	3	12.00	2	-	-
20	57				54		6	56	26

$$\text{Average queue length} = \frac{\text{Number of customers in waiting line}}{\text{Number of arrivals}} = \frac{26}{20} = 1.3$$

$$\text{Average waiting time per customer} = \frac{56}{20} = 2.8 \text{ minutes}$$

Advanced Management Accounting

$$\text{Average service time} = \frac{54}{20} = 2.7 \text{ minutes}$$

Time a customer spends in system = $2.8 + 2.7 = 5.5$ minutes.

Question 9

Write a short note on the advantages of simulation.

Answer

Advantages of simulation are enumerated below:

1. Simulation techniques allow experimentation with a model of the system rather than the actual operating system. Sometimes experimenting with the actual system itself could prove to be too costly and, in many cases too disruptive. For example, if you are comparing two ways of providing food service in a hospital, the confusion that would result from operating two different systems long enough to get valid observations might be too great. Similarly, the operation of a large computer central under a number of different operating alternatives might be too expensive to be feasible.
2. The non-technical manager can comprehend simulation more easily than a complex mathematical model. Simulation does not require simplifications and assumptions to the extent required in analytical solutions. A simulation model is easier to explain to management personnel since it is a description of the behaviour of some system or process.
3. Sometimes there is not sufficient time to allow the actual system to operate extensively. For example, if we were studying long-term trends in world population, we simply could not wait the required number of years to see results. Simulation allows the manager to incorporate time into an analysis. In a computer simulation of business operation the manager can compress the result of several years or periods into a few minutes of running time.
4. Simulation allows a user to analyze these large complex problems for which analytical results are not available. For example, in an inventory problem if the distribution for demand and lead time for an item follow a standard distribution, such as the poisson distribution, then a mathematical or analytical solution can be found. However, when mathematically convenient distributions are not applicable to the problem, an analytical analysis of the problem may be impossible. A simulation model is a useful solution procedure for such problems.

EXERCISE**Question 1**

An investment company wants to study the investment projects based on market demand profit and the investment required, which are independent of each other. Following probability distributions are estimated for each of these three factors.

Annual demand

(units in thousands)	25	30	35	40	45	50	55
Probability	0.05	0.10	0.20	0.30	0.20	0.10	0.05
Profit per unit	3.00	5.00	7.00	9.00	10.00		
Probability	0.10	0.20	0.40	0.20	0.10		

Investment Required

(In thousand of rupees)	2,750	3,000	3,500
Probability	0.25	0.50	0.25

Using simulation process, repeat the time 10 times, compute the investment on each that taking these factors into trial. What is the most likely return?

Use the following random numbers:

(30, 12, 16)	(50, 09, 69)	(63, 94, 26)	(27, 08, 74)
(64, 60, 61)	(28, 28, 72)	(31, 23, 57)	(54, 85, 20)
(64, 68, 18)	(32, 31, 87)		

In the bracket above, the first random number is for annual demand, the second one is for profit and the last one is for the investment required.

Answer

Highest likely return is 13.33% which is corresponding to the annual demand of 40,000 units resulting a profit of Rs.10/- per unit and the required investment will be Rs.30,00,000.

Advanced Management Accounting**Question 2**

A retailer deals in a perishable commodity. The daily demand and supply are variables. The data for the past 500 days show the following demand and supply:

Supply		Demand	
Availability (kg.)	No. of days	Demand (kg.)	No. of days
10	40	10	50
20	50	20	110
30	190	30	200
40	150	40	100
50	70	50	40

The retailer buys the commodity at Rs.20 per kg and sells it at Rs.30 per kg. Any commodity remains at the end of the day, has no saleable value. Moreover, the loss (unearned profit) on any unsatisfied demand is Rs.8 per kg. Given the following pair of random numbers, simulate 6 days sales, demand and profit.

(31, 18); (63, 84); (15, 79); (07, 32) (43, 75); (81, 27)

The first random number in the pair is for supply and the second random number is for demand viz. in the first pair (31, 18), use 31 to simulate supply and 18 to simulate demand.

Answer

net profit of the retailer = Rs.400

Question 3

A book-store wishes to carry Systems Analysis and Design in stock. Demand is probabilistic and replenishment of stock takes 2 days (i.e., if an order is placed in March 1, it will be delivered at the end of the day on March 3). The probabilities of demand are given below:

Demand (daily):	0	1	2	3	4
Probability:	0.05	0.10	0.30	0.45	0.10

Each time an order is placed, the store incurs an ordering cost of Rs.10 per order. The store also incurs a carrying cost of Rs.0.50 per book per day. The inventory carrying cost is calculated on the basis of stock at the end of each day. The manager of the book-store wishes to compare two options for his inventory decision:

- A. Order 5 books, when the inventory at the beginning of the day plus orders outstanding is less than 8 books.
- B. Order 8 books, when the inventory at the beginning of the day plus orders outstanding is less than 8 books.

Currently (beginning of the 1st day) the store has stock of 8 books plus 6 books plus 6 books ordered 2 days ago and expected to arrive next day. Using Monte-Carlo simulation for 10 cycles, recommend which option the manager should choose?

The two digits random numbers are given below:

89, 34, 78, 63, 81, 39, 16, 13, 73

Answer

Option A: Carrying Cost = $39 \times 0.50 = \text{Rs.}19.50$

Ordering Cost = $4 \times 10 = \text{Rs.}40.00$

Total Cost = Rs.59.50

Option B: Carrying Cost = $45 \times 0.50 = \text{Rs.}22.50$

Ordering Cost = $2 \times 10 = \text{Rs.}20.00$

Total Cost = Rs.42.50

Since Option B has lower cost, Manager should order 8 books.

Question 4

A bakery shop keeps stock of a popular brand of cake. Previous experience indicates the daily demand as given here:

Daily demand:	0	10	20	30	40	50
Probability:	0.01	0.20	0.15	0.50	0.12	0.02

Consider the following sequence of random numbers;

R. No. 48, 78, 19, 51, 56, 77, 15, 14, 68, 09

Using this sequence, simulate the demand for the next 10 days. Find out the stock situation if the owner of the bakery decides to make 30 cakes every day. Also, estimate the daily average demand for the cakes on the basis of simulated data.

Answer

Daily average demand of the basis of simulated data = 220

Advanced Management Accounting**Question 5**

A company trading in motor vehicle spares wishes to determine the level of stock it should carry for the item in its range. Demand is not certain and replenishment of stock takes 3 days. For one item X, the following information is obtained: (7 Marks)

Demand (unit per day)	Probability
1	.1
2	.2
3	.3
4	.3
5	.1

Each time an order is placed, the company incurs an ordering cost of Rs. 20 per order. The company also incurs carrying cost of Rs. 2.50 per unit per day. The inventory carrying cost is calculated on the basis of average stock.

The manager of the company wishes to compare two options for his inventory decision.

- (A) Order 12 units when the inventory at the beginning of the day plus order outstanding is less than 12 units.
- (B) Order 10 units when the inventory at the beginning of the day plus order outstanding is less than 10 units.

Currently (on first day) the company has a stock of 17 units. The sequence of random number to be used is 08, 91, 25, 18, 40, 27, 85, 75, 32, 52 using first number for day one.

You are required to carry out a simulation run over a period of 10 days, recommended which option the manager should choose.

Answer**Option I**

Carrying cost (94.5×2.50) = Rs.236.25

Ordering cost (2×20) = Rs.40.00

Rs.276.25

Option 11

Day	Random no.	Opening Stock	Demand	Closing Stock	Order placed	Order in	Average stock
1	08	17	1	16	-	-	16.5
2	91	16	5	11	-	-	13.5

Simulation

3	25	11	2	09	10	-	10.0
4	18	09	2	07	-	-	8.00
5	40	07	3	04	-		5.50
6	27	04	2	02	-	10	3.00
7	85	12	4	08	10	-	10.00
8	75	08	4	04	-	-	6.00
9	32	04	3	01	-	-	2.50
10	52	01	3	-	-	10	0.50
							75.5

Carrying cost (75.5×2.50) = Rs.118.75

Ordering cost (2×20) = Rs. 40.00

Rs.228.75

Option II is better.

- (ii) Assuming Karam must wait until Param completes the first item before starting work. Will he have to wait to process any of the other eight items? Explain your answer, based upon your simulation.

Answer

Cumulative frequency distribution for Param is derived below. Also fitted against it are the eight given random numbers. In parentheses are shown the serial numbers of random numbers.

10	4	01 (2)	00 (7)	03 (8)
20	10			
30	20	14 (1)		
40	40			
50	80	44 (4)	61 (5)	
60	91	82 (6)		
70	96	95 (3)		
80	100			

Thus the eight times are: 30, 10, 70, 50, 60, 10 and 10 respectively.

Advanced Management Accounting

Like wise we can derive eight times for Karam also.

Col-1	Col-2	Col-3	(2× Col-2)		
10	4	8			
20	9	18	13 (7)		
30	15	30	25 (4)		
40	22	44	36 (1)	34 (8)	41 (6)
50	32	64	55 (3)		
60	40	80	76 (2)		
70	46	92			
80	50	100	97 (5)		

(Note that cumulative frequency has been multiplied by 2 in column 3 so that all the given random numbers are utilized).

Thus, Karam's times are: 40, 60, 50, 30, 80 40, 20 and 40 seconds respectively.

Param's and Karam's times are shown below to observe for waiting time, if any.

1	2	3	4
Param	Cum. Times	Karam Initial	Karam's cumulative time with 30 seconds included
30	30	40	70
10	40	60	130
70	110	50	180
50	160	30	210
50	210	80	290
60	270	40	330
10	280	20	350
10	290	40	390

Since col. 4 is consistently greater than Co.2, no subsequent waiting is involved.

LEARNING CURVE THEORY

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Learning Curve

Learning curve is a geometrical progression, which reveals that there is steadily decreasing cost for the accomplishment of a given repetitive operation, as the identical operation is increasingly repeated. The amount of decrease will be less and less with each successive unit produced. The slope of the decision curve is expressed as a percentage. The other names given to learning curve are Experience curve, Improvement curve and Progress curve.

2. The Learning Curve Ratio

In the initial stage of a new product or a new process, the learning effect pattern is so regular that the rate of decline established at the outset can be used to predict labour cost well in advance. The effect of experience on cost is summaries in the learning ratio or improvement ratio:

$$\frac{\text{Average labour cost of first } 2N \text{ units}}{\text{Average labour cost of first } N \text{ units}}$$

3. Learning Curve Equation

Mathematicians have been able to express relationship in equations. The basic equation

$$Y_x = KX^s$$

...(1)

where,

X is the cumulative number of units or lots produced

Y is the cumulative average unit cost of those units X or lots. K is the average cost of the first unit or lots is the improvement exponent or the learning coefficient or the index of learning which is calculated as follows:

$$s = \log \text{ of learning ratio} / \log 2$$

Advanced Management Accounting

Question 1

Discuss the application of the learning curve.

Answer

Application of Learning curve: Learning curve helps to analyse cost-volume profit relationships during familiarisation phase of product or process to arrive at cost estimates.

It helps in budgeting and profit planning.

It helps in pricing and consequent decision making – e.g. acceptance of an order, negotiations in establishing contract prices etc. with the advantage of the knowledge of decreasing unit cost.

It helps in setting standards in the learning phase.

Question 2

What are the distinctive features of learning curve theory in manufacturing environment? Explain the learning curve ratio.

Answer

As the production quantity of a given item is doubled, the cost of the item decreases at a fixed rate. This phenomenon is the basic premise on which the theory of learning curve has been formulated. As the quantity produced doubles, the absolute amount of cost increase will be successively smaller but the rate of decrease will remain fixed. It occurs due to the following distinctive features of manufacturing environment:

- (i) Better tooling methods are developed and used.
- (ii) More productive equipments are designed and used to make the product.
- (iii) Design bugs are detected and corrected.
- (iv) Engineering changes decrease over time.
- (v) Earlier teething problems are overcome.
- (vi) Rejections and rework tend to diminish over time.

In the initial stage of a new product or a new process, the learning effect pattern is so regular that the rate of decline established at the outset can be used to predict labour cost well in advance. The effect of experience on cost is summarized in the learning curve ratio or improvement ratio.

$$\text{Learning curve ratio} = \frac{\text{Average labour cost of first } 2N \text{ units}}{\text{Average labour cost of first } N \text{ units}}$$

For example, if the average labour cost for the first 500 units is Rs. 25 and the average labour cost for the first 1,000 units is Rs. 20, the learning curve ratio is (Rs. 20/25) or 80%. Since the average cost per unit of 1,000 units is Rs. 20, the average cost per unit of first 2,000 units is likely to be 80% of Rs. 20 or Rs. 16.

Question 3

M Ltd. Manufactures a special product purely carried out by manual labour. It has a capacity of 20,000 units. It estimates the following cost structure:

<i>Direct material</i>	<i>30 Rs. / unit</i>
<i>Direct labour (1 hour / unit)</i>	<i>20 Rs. / unit</i>
<i>Variable overhead</i>	<i>10 Rs. / unit</i>

Fixed overheads at maximum capacity is Rs. 1,50,000.

It is estimated that at the current level of efficiency, each unit requires one hour for the first 5,000 units. Subsequently it is possible to achieve 80% learning rate. The market can absorb the first 5,000 units at Rs.100 per unit. What should be the minimum selling price acceptable for an order of 15,000 units for a prospective client?

Answer

	5,000 units	20,000 units
Material	1,50,000	6,00,000
Direct Labour	1,00,000	2,56,000
		Refer to W Note i
Variable Overhead	<u>50,000</u>	<u>2,00,000</u>
Total Variable Cost	3,00,000	10,56,000
Fixed Cost	<u>1,50,000</u>	<u>1,50,000</u>
Total Cost	4,50,000	12,06,000
Total cost / unit	90	60.3
Sales $100 \times 5,000$	5,00,000	<u>5,00,000</u>
$15,000 \times x$ (assumed selling price)		15,000 x
(Total Sales less Total Cost) = Profit	50,000	$15,000 x - 7,06,000$

Or minimum selling price = 50.4(refer to Working Note ii)

Advanced Management Accounting

Working Note: I

<i>Units</i>	<i>Hours</i>
5,000	5,000
10,000	$10,000 \times 1 \times .8 = 8,000$ hours
20,000	$20,000 \times 1 \times .8 \times .8 = 12,800$ hours

Working Note: II

$$15,000x - 7,06,000 > 50,000$$

$$15,000x > 7,56,000$$

$$\text{or } x > 50.4$$

Alternative Solution:

$$\text{Total cost / unit of capacity } 20,000 = 60.3$$

$$\text{Weighted average selling price} > 80.4$$

$$\text{i.e. } \frac{5,000 \times 100 + 15,000x}{20,000} > 60.3$$

$$= 5,00,000 + 15,000x > 60.3 \times 20,000$$

$$= 15,000x > 12,06,000 - 5,00,000$$

Or

$$15,000x > 7,06,000$$

$$x > 47.06$$

$$\text{Minimum price to cover production Cost} = 47.06$$

$$\text{Minimum price to cover same amount of profit} = 50.40 \text{ (refer to Working Note 1)}$$

Working Note 1

$$(-47.06 + 50.04) \times 15,000 \text{ units}$$

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

Question 4

A company which has developed a new machine has observed that the time taken to manufacture the first machine is 600 hours. Calculate the time which the company will take to manufacture the second machine if the actual learning curve rate is (i) 80% and (ii) 90%. Explain which of the two learning rates will show faster learning.

Answer

- (i) Actual learning curve rate is 80%.

Time taken to produce the first machine = 600 hours

Average time taken to produce two machines = $600 \times 80\%$ hours
= 480 hours.Cumulative time taken to produce two machines = 480×2 hours
= 960 hours.Time taken to produce the second machine = $(960 - 600)$ hours
= 360 hours.

- (ii) Actual learning curve rate is 90%.

Time taken to produce the first machine = 600 hours

Average time taken to produce two machines = $600 \times 90\%$ hours
= 540 hours.Cumulative time taken to produce two machines = 540×2 hours
= 1080 hours.Time taken to produce the second machine = $(1080 - 600)$ hours
= 480 hours.

The time taken to produce the second machine is lower at 80% learning rate and hence 80% learning rate shows faster learning rate.

Question 5

The Gifts Company makes mementos for offering chief guests and other dignitaries at functions. A customer wants 4 identical pieces of hand-crafted gifts for 4 dignitaries invited to its function.

For this product, the Gifts Company estimates the following costs for the 1st unit of the product

	Rs./unit
Direct variable costs (excluding labour)	2,000
Direct labour (20 hours @ Rs. 50 hour)	1,000

90 % learning curve ratio is applicable and one labourer works for one customer's order.

Advanced Management Accounting

- (i) What is the price per piece to be quoted for this customer if the targeted contribution is Rs.1,500 per unit?
- (ii) If 4 different labourers made the 4 products simultaneously to ensure faster delivery to the customer, can the price at (i) above be quoted? Why?

Answer

(i)

		Rs/u
	1 st unit	Avg/u after 4 th at
Variable Cost	2000	2000
Labour	1000	810
Target Contribution		1500
Price to be quoted		4310 (Rs./u)

- (ii) No, the company cannot quote this price for varying products because the learning curve Ratio does not apply to non-repeated jobs. Each product will carry a different price according to its direct labour hours.

Question 6

The following information is provided by a firm. The factory manager wants to use appropriate average learning rate on activities, so that he may forecast costs and prices for certain levels of activity.

- (i) A set of very experienced people feed data into the computer for processing inventory records in the factory. The manager wishes to apply 80% learning rate on data entry and calculation of inventory.
- (ii) A new type of machinery is to be installed in the factory. This is patented process and the output may take a year for full fledged production. The factory manager wants to use a learning rate on the workers at the new machine.
- (iii) An operation uses contract labour. The contractor shifts people among various jobs once in two days. The labour force performs one task in 3 days. The manager wants to apply an average learning rate for these workers.

You are required to advise to the manager with reasons on the applicability of the learning curve theory on the above information.

Answer

The learning curve does not apply to very experienced people for the same job, since time taken can never tend to become zero or reduce very considerably after a certain range of output. This is the limitation of the learning curve.

- (i) Data entry is a manual job so learning rate theory may be applied. Calculation of inventory is a computerized job. Learning rate applies only to manual labour.
- (ii) Learning rate should not be applied to a new process which the firm has never tried before.
- (iii) The workers are shifted even before completion of one unit of work. Hence learning rate will not apply.

Question 7

PQ Ltd. makes and sells a labour-intensive product. Its labour force has a learning rate of 80%, applicable only to direct labour and not to variable overhead.

The cost per unit of the first product is as follows:

<i>Direct materials</i>	<i>10,000</i>
<i>Direct labour</i>	<i>8,000 (@Rs.4 per hour)</i>
<i>Variable overhead</i>	<u><i>2,000</i></u>
<i>Total variable cost</i>	<u><i>20,000</i></u>

PQ Ltd. has received an order from X Ltd. for 4 units of the product. Another customer, Y Ltd. is also interested in purchasing 4 units of the product. PQ Ltd. has the capacity to fulfill both the orders. Y Ltd. presently purchases this product in the market for Rs.17,200 and is willing to pay this price per unit of PQ's product. But X Ltd. lets PQ choose one of the following options:

- (i) *A price of Rs.16,500 per unit for the 4 units it proposes to take from PQ.*

Or

- (ii) *Supply X Ltd.'s idle labour force to PQ, for only 4 units of production, with PQ having to pay only Re. 1 per labour hour to X Ltd.'s workers. X Ltd.'s workers will be withdrawn after the first 4 units are produced. In this case, PQ need not use its labour for producing X Ltd.'s requirement. X Ltd. assures PQ that its labour force also has a learning rate of 80%. In this option, X Ltd. offers to buy the product from PQ at only Rs.14,000 per unit.*

X and Y shall not know of each other's offer.

Advanced Management Accounting

If both orders came before any work started, what is the best option that PQ may choose?

Present suitable calculations in favour of your argument.

Answer

Units	Average/ hrs/u.
1	2,000
2	1,600
4	1,280
8	1,024

Material Cost / u = 10,000

Variable cost = 2,000

Variable Cost = 12,000

Option I

If both the orders came together, learning rate 80% applies and 8 units can be made, with average time of 1,024 hours per unit.

Cost to PQ:

Variable cost excl. labour = Rs.12,000

Labour cost 1,024 hrs × 4 Rs./hr = Rs. 4,096

= Rs. 16,096

In this case,

	Y	X	
Selling Price p. u.	Rs.17,200	Rs.16,500	→ (under option I)
Variable Cost p. u.	<u>Rs.16,096</u>	<u>Rs.16,096</u>	
Contribution p. u.	Rs.1,104	Rs.404	
No. of units	4	4	
Contribution (Rs.)	4416	1616	6032

Option II

If X Ltd supplies its labour. 80% learning curve will apply to 4 units each of PQ & X.

Hence: hrs/ u = 1280

	Y	X	
Selling Price	Rs.17,200	Rs.14,000	
Variable Cost (excl. labour)	Rs.12,000	Rs.12,000	
Labour cost:			
1280 × 4	Rs.5,120		
1280 × 1	<u>—</u>	<u>Rs.1280</u>	
Total Variable Cost	<u>Rs.17,120</u>	<u>Rs.13,280</u>	
Contribution	Rs.80	Rs.720	
Units	4	4	
Contribution (Rs.)	320	2,880	3,200

PQ should not take labour from X Ltd. It should choose option I.

Advanced Management Accounting

EXERCISE**Question 1**

An electronics firm which has developed a new type of fire-alarm system has been asked to quote for a prospective contract. The customer requires separate price quotations for each of the following possible orders:

<i>Order</i>	<i>Number of fire-alarm systems</i>
<i>First</i>	<i>100</i>
<i>Second</i>	<i>60</i>
<i>Third</i>	<i>40</i>

The firm estimates the following cost per unit for the first order:

<i>Direct materials</i>	<i>Rs. 500</i>
<i>Direct labour</i>	
<i>Deptt. A (Highly automatic) 20 hours at Rs. 10 per hour</i>	
<i>Deptt. B (Skilled labour) 40 hours at Rs. 15 per hour</i>	
<i>Variable overheads</i>	<i>20% of direct labour</i>
<i>Fixed overheads absorbed:</i>	
<i>Deptt. A</i>	<i>Rs. 8 per hour</i>
<i>Deptt. B</i>	<i>Rs. 5 per hour</i>

Determine a price per unit for each of the three orders, assuming the firm uses a mark up of 25% on total costs and allows for an 80% learning curve. Extract from 80% Learning curve table:

<i>X</i>	<i>1.0</i>	<i>1.3</i>	<i>1.4</i>	<i>1.5</i>	<i>1.6</i>	<i>1.7</i>	<i>1.8</i>	<i>1.9</i>	<i>2.0</i>
<i>Y%</i>	<i>100.0</i>	<i>91.7</i>	<i>89.5</i>	<i>87.6</i>	<i>86.1</i>	<i>84.4</i>	<i>83.0</i>	<i>81.5</i>	<i>80.0</i>

X represents the cumulative total volume produced to date expressed as a multiple of the initial order.

Y is the learning curve factor, for a given X value, expressed as a percentage of the cost of the initial order.

Answer**(i) Price per unit for first order of 100 units**

Selling price per unit = Rs. 2,275.00

(ii) Price per unit for second order of 60 units

Selling price per unit = Rs. 1,848.64

(iii) Price per unit for third order of 40 units

Selling price per unit = Rs. 1,764.40

Question 2

Explain the concept 'Learning curve'. How can it be applied for Cost management?

Answer

Chapter 17: Paragraph 17.5

TESTING OF HYPOTHESIS

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Testing Of Hypothesis Or Test Of Significance

It is a statistical procedure to assess the significance of

- (i) Difference between a statistic and corresponding population parameter.
- (ii) Difference between two independent statistics, known as test of significance.

2. Null Hypothesis (H_0)

It asserts that there is no real difference between the sample statistic and sample parameter or between two independent sample statistics.

3. Alternative Hypothesis (H_1)

Any hypothesis complementary to null hypothesis.

4. Possible Errors in Test of Significance

Four possible errors in test of significance:

Type of error	Actual	Decision from sample	Probability of error
1	H_0 is true	Reject H_0	α
2	H_0 is false	Accept H_0	β

5. One-tailed Test

A hypothesis test in which rejection of the null hypothesis occurs for values of test statistic in one tail of the sampling distribution.

6. Two-way Test

A hypothesis test in which rejection of the null hypothesis occurs for values for test statistic in either tail of its sampling distribution.

7. Critical Value

A value that is compared with the test statistic to determine whether H_0 should be rejected.

Advanced Management Accounting**8. Procedure for Large Sample Test (t-test)**

Step 1: Set up Null hypothesis H_0 and alternative hypothesis 1 +1.

Step2: Compute $Z = \frac{t - E(t)}{SE(t)}$

Step 3: Testing significance at desired level, usually 5% & 1%

	At 1% Level	At 5% Level	
Significant values of $ Z $	2.58	1.96	Two tailed test
Significant values of $ Z $	2.33	1.645	One tailed test

9. Analysis of Variance (ANOVA): Test Analysis of variance can be used for testing equality of k population means.

$H_0: \mu_1 = \mu_2 = \dots = \mu_k$

H_1 : Not all population means are equal.

Where m_j = mean of j^{th} population

Let x_{ij} = value of observation i for treatment j

n_j = No. of observation for treatment j

$\bar{x}_j$ = sample mean for treatment j

s_j^2 = sample variance for treatment j

$\bar{x}$ = overall sample mean n_t = Total Sample Size

Sum of Square due to treatment

$$SSTR = \sum_{j=1}^k n_j (\bar{x}_j - \bar{x})^2$$

Mean Square due to treatment

$$MSTR = \frac{SSTR}{k-1}$$

Sum of Square due to error

$$SSE = \sum_{j=1}^k (n_j - 1) s_j^2$$

$$\text{Mean of square due to error MSE} = \frac{\text{SSE}}{n_t - k}$$

Test Statistic for equality of k population mean

$$F = \frac{\text{MSTR}}{\text{MSE}}$$

ANOVA Table

Source of Variation	Sum of Squarely	Degree of freedom	Mean Square
Treatment	SSTR	$k - 1$	$\text{MSTR} = \frac{\text{SSTR}}{k-1}$
Error	SSE	$n_t - k$	$\text{MSE} = \frac{\text{SSE}}{n_T - k}$
Total	SST	$n_T - 1$	$F = \frac{\text{MSTR}}{\text{MSE}}$

9.1 ANOVA For Randomized Block Design (2- ways classification)

k = No. of treatments

b = No. of blocks

n_T = Total sample size = kb

r = replications

x_{ij} = Value of observation responding to treatment j in block j

$\bar{x}_j$ = sample mean of j^{th} treatment

$\bar{x}_i$ = sample means of i^{th} stock

$\bar{\bar{x}}$ = overall sample mean

Total Sum of Square

$$\text{SST} = \sum_{i=1}^b \sum_{j=1}^k (x_{ij} - \bar{\bar{x}})^2$$

Sum of Square due to treatments

$$\text{SSTR} = b \sum_{j=1}^k (\bar{x}_j - \bar{\bar{x}})^2$$

Advanced Management Accounting

Sum of Square due to blocks

$$SSBL = k \sum_{i=1}^b (\bar{x}_i - \bar{x})^2$$

Sum of Square due to error SSE = SST –SSTR –SSBL

ANOVA TABLE

Source of Variation	Sum of Square	Degree of freedom	Mean Square	F
Treatment (TR)	SSTR	K – 1	$MSTR = \frac{SSTR}{K - 1}$	$\frac{MSTR}{MSE}$
Block (BL)	SSBL	b - 1	$MSBL = \frac{SSBL}{b - 1}$	$\frac{MSBL}{MSE}$
TR x BL	SSTB	(k-1) (b-1)	$\frac{MSTB}{\frac{SSTB}{(k-1)(b-1)}}$	$\frac{MSTB}{MSE}$
Error	SSE	Kb (r – 1)	$MSE = \frac{SSE}{kb (r - 1)}$	
Total	SST	n _T - 1		

Basic Formulas

1. Test Statistic for Hypothesis Test, about a Population Mean is known

$$Z = \frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}$$

μ = population mean
n = sample size

2. Test Statistic for Hypothesis Test, about a population Mean; is unknown

$$t = \frac{\bar{x} - \mu_0}{s / \sqrt{n}}$$

s = sample mean

3. Test Statistic for Hypothesis Tests about a Population Proportion

$$Z = \frac{p - p_0}{\sqrt{\frac{p_0 (1 - p_0)}{n}}}$$

Question 1

Write a short note on the procedure in hypothesis testing.

Answer

Procedure in Hypothesis Testing: Following procedure is followed in hypothesis testing:

1. Formulate the hypotheses: Set up a null hypothesis stating, for e.g. $H_0: \theta = \theta_0$ and an alternative hypothesis H_1 , which contradicts H_0 . H_0 and H_1 cannot be done simultaneously. If one is true, the other is false.
2. Choose a level of significance, i.e. degree of confidence. This determines the acceptance rejection region. For example, $Z_{.05}$ in a 2 tailed 'Z' test is.
3. Select test statistic: For $n > 30$, Z statistic is used, implying normal distribution for large samples. For small samples, we use t_1 , F_1 and χ^2 distribution.
4. Compute the sample values according to the test statistic.
5. Compare with the table value of the statistic and conclude.

Question 2

A factory manager contends that the mean operating life of light bulbs of his factory is 4,200 hours. A customer disagrees and says it is less. The mean operating life for a random sample of 9 bulbs is 4,000 hours, with a sample standard deviation of 201 hours. Test the hypothesis of the factory manager, given that the critical value of the test statistic as per the table is (-) 2.896.

Answer

Manager's Hypothesis	H_0	$\mu_0 = 4,200$
	H_1	$\mu < 4,200$ (Left Tail test)

$$t = \frac{\bar{X} - \mu_0}{\sigma}$$

$$\text{where } \sigma = \frac{s}{\sqrt{n}} = \frac{201}{\sqrt{9}} = \frac{201}{3} = 67$$

$$t = \frac{4,000 - 4,200}{67} = \frac{-200}{67} = -2.985$$

Calculated $t = 2.985$, < table value of $t_{.01}$ (sdf) which is -2.896

Hence reject the null hypothesis H_0 . i.e. Accept H_1

The customer's claim is correct.

Question 3

Advanced Management Accounting

In the past, a machine has produced pipes of diameter 50 mm. To determine whether the machine is in proper working order, a sample of 10 pipes is chosen, for which mean diameter is 53 mm and the standard deviation is 3 mm. Test the hypothesis that the machine is in proper working order, given that the critical value of the test statistic from the table is 2.26.

Answer

Null Hypothesis H_0 : $\mu = 50$ mm i.e. the M/c works properly.

H_1 : $\mu \neq 50$ mm. i.e. the M/c does not work properly

Sample Size = 10, small.

use 't' statistic

$$t = \frac{\bar{x} - \mu}{S / \sqrt{n-1}}$$

$$\bar{x} = 53$$

$$\mu = 50$$

$$n = 10; \sqrt{n-1} = \sqrt{9} = 3$$

$$S = \text{std dev} = 3$$

$$T = \frac{53-50}{3/3} = \frac{3}{1} = 3$$

Table Value = 2.26

Calculated t > table value

Reject H_0

i.e. The M/c is not working properly.

Question 4

A manufacturer claimed that at least 95% of the equipment which he supplied to a factory conformed to specifications. An examination of a sample of 200 pieces of equipment revealed that 18 were faulty. Test this claim at a significance level of (i) 0.05 (ii) 0.01.

Answer

In the usual notations, we are given $n = 200$. x = No. of pieces conforming to specifications in the sample = $200 - 18 = 182$.

$$\therefore P = \text{Proportion of pieces conforming to specifications in the sample} = \frac{182}{200} = 0.91.$$

Null hypothesis. H_0 : $P \geq 0.95$, i.e., the proportion of pieces conforming to specifications in the lot is at least 95%.

Alternative Hypothesis. H_1 ; $P < 0.95$ (Left-tailed alternative).

It will suffice to test $H_0 : P = 0.95 \Rightarrow Q = 1 - P = 0.05$

Level of significance (i) $\alpha = 0.05$, (ii) $\alpha = 0.01$

Test statistic. Under H_0 , the test statistic is $Z = \frac{P - E(P)}{SE(P)} = \frac{P - P}{\sqrt{PQ/n}} \sim N(0,1)$,

Since sample is large

$$= \frac{0.91 - 0.95}{\sqrt{0.95 \times 0.05/200}} = \frac{-0.04}{\sqrt{0.00237}} = \frac{-0.04}{0.0154} = -2.6.$$

(i) Significance at 5% level of significance.

Since the alternative hypothesis is one-sided (left-tailed), we shall apply left-tailed test for testing significance of Z . The significant value of Z at 5% level significance for left-tail test is -1.645 .

Since computed value of $Z = -2.6$ is less than -1.645 (or since $|z| > 1.645$), we say Z is significant (as it lies in the critical region) and we reject the null hypothesis at 5% level of significances. Hence, the manufacturer's claim is rejected at 5% level of significance.

(ii) Significance at 1% level of significance. The critical value of Z at 1% level of significance for single-tailed (left-tailed) test is -2.33 . Since the computed value $Z = -2.6$ is less than -2.33 (is $|z| > 2.33$),

$\therefore H_0$ is rejected at 1% level of significance also.

Question 5

For the following data representing the number of units of production per day turned out by five workers using from machines, set-up the ANOVA table (Assumed Origin at 20).

Workers	Machine Type			
	A	B	C	D
1.	4	-2	7	-4
2.	6	0	12	3
3.	-6	-4	4	-8
4.	3	-2	6	-7
5.	-2	2	9	-1

Advanced Management Accounting**Answer**

Null Hypothesis

- (a) The machines are homogenous

i.e., $\mu_A = \mu_B = \mu_C = \mu_D$

- (b) The workers are homogeneous

i.e., $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

Alternative Hypothesis

- (a) At least two of the machines differ significantly

- (b) At least two of the workers differ significantly

In the usual notation, we have:

$K = 5, H = 4, N = KH = 5 \times 4 = 20$

$G = \sum \sum X_{ij} = 20;$

Calculation for Various S.S

Workers	Machine Type				Total
	A	B	C	D	
I	4	-2	7	-4	$R_1 = 5$
II	6	0	12	3	$R_2 = 21$
III	-6	-4	4	-8	$R_3 = -14$
IV	3	-2	6	-7	$R_4 = 0$
V	-2	2	9	-1	$R_5 = 8$
Total	$C_1 = 5$	$C_2 = -6$	$C_3 = 38$	$C_4 = -17$	$G = 20$

$$\text{Corrector Factor (CF)} = \frac{G^2}{n} = \frac{20^2}{20} = 20$$

$$\begin{aligned} \text{Raw S.S (RSS)} &= \sum \sum X_{ij}^2 \\ &= [(16+4+49+16)+(36+0+144+9) + (36+16+16+64) + (9+4+36+49) \\ &\quad + (4+4+81+1)] \\ &= 594 \end{aligned}$$

$$\text{Total S.S} = \text{RSS} - \text{CF} = 594 - 20 = 574$$

$$\begin{aligned}
 \text{S.S Rows (Workers)} &= \frac{R_1^2 + R_2^2 + R_3^2 + R_4^2 + R_5^2}{4} - CF \\
 &= \frac{5^2 + 21^2 + (-14)^2 + 0 + 8^2}{4} - 20 \\
 &= \frac{25 + 441 + 196 + 64 - 80}{4} = \frac{646}{4} = 161.5
 \end{aligned}$$

$$\begin{aligned}
 \text{S.S Columns (Machine Type)} &= \frac{C_1^2 + C_2^2 + C_3^2 + C_4^2}{5} - CF \\
 &= \frac{5^2 + (-6)^2 + 38^2 + (-17)^2}{5} - 20 \\
 &= \frac{25 + 36 + 1,444 + 289 - 100}{5} \\
 &= \frac{1694}{5} = 338.8
 \end{aligned}$$

$$: \text{SSE} = \text{Error S.S} = \text{TSS} - \text{SSR} - \text{SSC}$$

$$= 574 - 161.5 - 338.8$$

$$= 73.7$$

Since the various sum of the squares are not affected by change of origin, the ANOVA table for the original data and the given data obtained on changing the origin to 20 will be same and is given in following table.

Degrees of Freedom for various S.S

$$\text{d.f for TSS} = n - 1 = 20 - 1 = 19$$

$$\text{d.f for Rows (Workers)} = 5 - 1 = 4$$

$$\text{d.f for Column (Machines)} = 4 - 1 = 3$$

$$\text{d.f for SSE} = 19 - (4 + 3) = 12$$

$$\text{OR d.f for SSE} = (\text{d.f for Rows}) \times (\text{d.f for columns})$$

$$= (3 \times 4) = 12$$

ANOVA TABLE

Advanced Management Accounting

Sources of variation	d.f	S.S	$MSS = \frac{S.S}{d.f}$	Variance Ratio (F)
Rows (Workmen)	4	161.5	40.38	$\frac{40.38}{6.14} = 6.58 \sim F(4,12)$
Columns (Machine)	3	33.8	112.93	$\frac{112.93}{6.14} = 18.39 \sim F(3,12)$
Errors	12	73.7	6.14	
Total	19	574		

Question 6

Given below in the contingency table for production is three shifts and the number of defective good turn out- Find the value of C. It is possible that the number defective goods depends on the shifts then by them, No of Shifts:

Shift	I Week	II Week	III Week	Total
I	15	5	20	40
II	20	10	20	50
III	25	15	20	60
	60	30	60	150

Answer

Let H_0 : Defective is good does not depend upon the shift run by the factory the first Expected value is

$$= E = \frac{40 \times 60}{150} = 16$$

O	E	O-E	$(O-E)^2$	$(O-E)^2/E$
15	16	-1	1	0.063
20	20	0	0	0
25	24	1	1	0.042
5	8	-3	9	1.125
10	10	0	0	0
15	12	3	9	0.750
20	16	4	16	1.0

Testing of Hypothesis

20	20	0	0	0
20	24	-4	16	0.667
				3.647

$$D: F = V = (r - 1)(c - 1) = (3 - 1)(3 - 1) = 4$$

$$: \Psi^2(4, 0.05) = 9.488$$

Here, the calculated value of Ψ^2 is less than of table value.

Hence, the hypothesis is accepted.

i.e., the number of defective does not depend on shift run by the factory.

Advanced Management Accounting

EXERCISE**Question 1**

The contingency table below summarize the results obtained in a study conducted by a research organization with respect to the performance of four competing brands of tooth paste among the users

	Brand A	Brand B	Brand C	Brand D	Total
No. of Cavities	9	13	17	11	50
One of five	63	70	85	82	300
More than five	28	37	48	37	150
Total	100	120	150	130	500

Test the hypothesis that incidence of cavities is independent of the brand of the tooth paste used. Use level of significance 1% and 5%.

Answer

Incidence of cavities is independent of the brand of the tooth paste used.

Question 2

Below are given the yield (in kg.) per acre for 5 trial plots of 4 varieties of treatment. Carry out an analysis of variance and state conclusion

	Treatment			
Plot no.	1	2	3	4
1	42	48	68	80
2	50	66	52	94
3	62	68	76	78
4	34	78	64	82
5	52	70	70	66

Answer

∴ The null hypotheses is rejected

∴ The treatment does not have same effect.

Question 3

The sales data of an item in six shops before and after a special promotional campaign are as under

Testing of Hypothesis

Shops	A	B	C	D	E	F
Before Campaign	53	28	31	48	50	42
After Campaign	58	29	30	55	56	45

Can the campaign be judged to be a success?

Test at 5% level of significance using t-test.

Answer

H_0 is rejected at 5% level of significance and we conclude that the special promotional campaign has been effective in increasing the sales.

TIME SERIES ANALYSIS & FORECASTING

BASIC CONCEPTS AND FORMULA

Basic Concepts

1. Time Series Analysis

The term 'Time Series' means a set of observations concurring any activity against different periods of time. In order to describe this flow of economic activity, the statistician uses a time series.

2. Examples of Time Series Data

Following are few examples of time series data:

- a) Profits earned by a company for each of the past five years.
- b) Workers employed by a company for each of the past 15 years.
- c) Number of students registered for CA examination in the institute for the past five years.
- d) The weekly wholesale price index for each of the past 30 week.
- e) Number of fatal road accidents in Delhi for each day for the past two months.

3. Components of a Time Series:

A time series may contain one or more of the following four components:

1. Secular trend (T): (Long term trend) It is relatively consistent movement of a variable over a long period.
2. Seasonal variation (S): Variability of data due to seasonal influence.
3. Cyclical variation (C): Recurring sequence of points above and below the trend line lasting over more than one year.
4. Irregular variation (I): (random movements) Variations due residual factors that accounts for deviations of the actual time series values from those expected, given the effect of trend, seasonal and seasonal components. Example, erratic movements that do not have any pattern and are usually caused by unpredictable reason like earthquake, fire etc.

Advanced Management Accounting

4. Approaches for the Relationship amongst Components of a Time Series

There are two approaches for the relationship amongst these components.

(a) $Y = T \times S \times C \times I$ (multiplicative model)

(b) $Y = T + S + C + I$ (additive model)

Note: In multiplicative models S, C and I indexes are expressed as decimal percents

Where Y is the result of the four components.

5. Trend

The trend is the long-term movement of a time series. Any increase or decrease in the values of a variable occurring over a period of several years gives a trend. If the values of a variables remain statutory over several years, then no trend can be observed in the time series.

6. Methods of Fitting a Straight Line to a Time Series

- i. Free hand method,
- ii. The method of semi-averages,
- iii. The method of moving averages
- iv. The method of least squares.

7. Methods of Finding Short Period Variations

Other Methods of finding short period variations

7.1 Simple Average:

Simple Average: The method is very simple: average the data by months or quarters or years and then calculate the average for the period. Then find out, what percentage it is to the grand average.

$$\text{Seasonal Index} = \frac{\text{Monthly or Quarterly Average}}{\text{Grand Average of the months or the quarters}} \times 100$$

Same results are obtained if the totals of each month or each quarter are obtained instead of the average of each month or each quarter.

7.2 Ratio-to-Trend Method

This method is an improvement over the previous method because this assumes that seasonal variation for a given month is a constant fraction of trend. This method presumably isolates the seasonal factor in the following manner:

$$S \times C \times I = \frac{T \times S \times C \times I}{T}$$

Random elements (I) are supposed to disappear when the ratios are averaged. Further, a carefully selected period of years used in computation is expected to eliminate the influence of cyclical fluctuations (C).

8. Deseasonalization

The process of eliminating seasonal fluctuations or deseasonalization of data consists of dividing each value in the original series by the corresponding value of the seasonal index.

9. Forecasting

Time series forecasting methods involve the projection of future values of a variable based entirely on the past and present observation of that variable.

10. Various Forecasting Methods Using Time Series.

10.1 Mean Forecast

The simplest forecasting method in which for the time period t , we forecast the value of the series to be equal to the mean of the series. This method is not adequate as trend effects and the cyclical effects are not taken into account in this.

10.2 Naïve forecast

In this method, by taking advantage of the fact that there may be high correlation between successive pairs of values in a time series, we forecast the value, for the time period t , to-be equal to the actual value observed in the previous period t that is, time period $(t - 1)$:

$$Y_t = Y_{t-1}$$

10.3 Linear Trend Forecast

In this method, a linear relationship between the time and the response value has been found from the linear relationship.

$$y_t = a + bX$$

where X will be found from the value of t and a and b are constants.

10.4 Non-linear Trend Forecast

In this method, a non-linear relationship between the time and the response value has been found again by least-squares method. Then the value, for the

Advanced Management Accounting

time period t , will be calculated from the non-linear equation . i.e.,

$$y_t = a + bX + cX^2$$

where X -value will be calculated from the value of t .

10.5 Forecasting with Exponential Smoothing

In this method, the forecast value for the time period t is found using exponential smoothing of time series. Specifically, at the time period t .

$$y_t = y_{t-1} + \alpha(y_t - y_{t-1})$$

where the forecasted value for time period $t + 1$;

y_{t-1} = the forecasted value for time period t .:

y_t = the observed value for time period t .

Question 1

What is trend? What are the various methods of fitting a straight line to a time series?

Answer

Trend is the long term movement of a time series. Any increase or decrease in the values of a variable occurring over a period of several years gives a trend.

The various methods of fitting a straight line to a time series are:

- (i) Free hand method.
- (ii) The method of semi-averages.
- (iii) The method of moving averages.
- (iv) The method of least squares.

Question 2

Name the various methods of fitting a straight line to a time series and briefly explain any two of them.

Answer

The various methods of fitting a straight line are:

- (i) Free hand method
- (ii) Semi-average
- (iii) Moving average
- (iv) Least square

Freehand method:

First the time series figures are plotted on a graph. The points are joined by straight lines. We get fluctuating straight lines, through which an average straight line is drawn. This method is however, inaccurate, since different persons may fit different trend lines for the same set of data.

Method of Semi Averages:

The given time series is divided into two parts, preferably with the same number of years. The average of each part is calculated and then a trend line through these averages is fitted.

Moving Average Method:

A regular periodic cycle is identified in the time series. The moving average of n years is got by dividing the moving total by n . The method is also used for seasonal and cyclical variation.

Method of Least Squares:

The equation of a straight line is $Y = A + bX$, where X is the time period, say year and Y is the value of the item measured against time, a is the Y intercept and b , the co-efficient of X , indicating the slope of the line. To find a and b , the following 'normal' equations are solved.

$$\sum Y = an + b \sum X$$

$$\sum XY = a \sum X + b \sum X^2$$

Where n is the no. of observation in the series or n = no. of data items.

Question 3

Apply the method of link relatives to the following data and calculate seasonal indices.

Quarter	Quarterly Figures				
	1995	1996	1997	1998	1999
I	6.0	5.4	6.8	7.2	6.6
II	6.5	7.9	6.5	5.8	7.3
III	7.8	8.4	9.3	7.5	8.0
IV	8.7	7.3	6.4	8.5	7.1

Answer

Calculation of seasonal indices by the method of link relatives.

Advanced Management Accounting

Year	Quarter			
	I	II	III	IV
1995	—	108.3	120.0	111.5
1996	62.1	146.3	106.3	86.9
1997	93.2	95.6	143.1	68.8
1998	112.5	80.6	129.3	113.3
1999	77.5	110.6	109.6	88.8

$$\text{Arithmetic average} = \frac{345.4}{4} = 86.35$$

$$\frac{541}{5} = 108.28$$

$$\frac{608.3}{5} = 121.66$$

$$\frac{469.3}{5} = 93.86$$

Chain relatives 100

$$\frac{100 \times 108.28}{100} = 108.28$$

$$\frac{121.66 \times 108.28}{100} = 131.73$$

$$\frac{93.86 \times 131.73}{100} = 123.65$$

Corrected chain relatives 100

$$108 - 1.675 = 106.605$$

$$131.73 - 3.35 = 128.38$$

$$123.64 - 5.025 = 118.615$$

$$\text{Seasonal indices} \frac{100 \times 100}{113.4} \frac{106.605}{113.4} \times 100$$

$$\frac{128.38}{113.4} \times 100$$

$$\frac{118.615}{113.4} \times 100$$

$$= 88.18$$

$$= 94.01$$

$$= 113.21$$

$$= 104.60$$

The calculation in the above table are explained below:

Chain relative of the first quarter (on the basis of first quarter = 100)

Chain relative of the first quarter (on the basis of the last quarter)

$$= \frac{86.35 \times 123.64}{100} = 106.7$$

The difference between these chain relatives = $106.7 - 100 = 6.7$

$$\text{Difference per quarter} = \frac{6.7}{4} = 1.675$$

Adjusted chain relatives are obtained by subtracting 1×1.675 , 2×1.675 , 3×1.675 from the chain relatives of the 2nd, 3rd and 4th quarters respectively.

Average of corrected chain relatives

$$= \frac{100 + 106.605 + 128.38 + 118.615}{4} = \frac{453.6}{4} = 113.4$$

$$\text{Seasonal variation index} = \frac{\text{Correct chain relatives}}{113.4} \times 100$$

Question 4

The following table relates to the tourist arrivals during 1990 to 1996 in India:

Years : 1990 1991 1992 1993 1994 1995 1996

Tourists arrivals: 18 20 23 25 24 28 30

(in millions)

Fit a straight line trend by the method of least squares and estimates the number of tourists that would arrive in the year 2000.

Answer

Fitting straight line Trend by the Method of Least square

Year	Tourist Arrivals (in millions) Y	X	XY	X ²
1990	18	-3	-54	9
1991	20	-2	-40	4
1992	23	-1	-23	1
1993	25	0	0	0
1994	24	1	24	1
1995	28	2	56	4
1996	30	3	90	9

Advanced Management Accounting

$$N = 7 \quad \Sigma y = 168 \quad \Sigma x = 0 \quad \Sigma xy = 53 \quad \Sigma x^2 = 28$$

The equation of the straight line trend is:

$$Y = a + bx$$

$$\text{Since } \Sigma x = 0, a = \frac{\Sigma y}{N} = \frac{168}{7} = 24$$

$$\text{And } b = \frac{\Sigma xy}{\Sigma x^2} = \frac{53}{28} = 1.893$$

$$\text{Hence } Y = 24 + 1.893x$$

Estimated Number of tourists that would arrive in 2000

$$Y = 24 + 1.893 (7) = 24 + 13.251 = 37.251 \text{ million.}$$

EXERCISE**Question 1**

Below are given the figures of production (in thousand quintals) of a sugar factory.

Year	Production (thousand quintals)
1993	77
1995	88
1996	94
1997	85
1998	91
1999	98
2002	90

- (i) Fit a straight line by the 'least squares' method and tabulate the trend values.
- (ii) Eliminate the trend. What components of the series are thus left over?
- (iii) What is monthly increase in the production of sugar?

Answer

- (i) equation of straight line trend is $Y = 88.803 + 1.38 X$
- (ii) After eliminating the trend we are left with cyclical and irregular variations.
- (iii) The monthly increase in the production of sugar is
 $b/12$, i.e. $1.38 / 12 = 0.115$ thousand quintal.

Question 2

Calculate 5 yearly and 7 yearly moving averages for the following data of the numbers of commercial and industrial failure in a country during 1987 to 2002.

Year	No. of failures
1987	23
1988	26
1989	28
1990	32
1991	20
1992	12

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1993	12
1994	10
1995	9
1996	13
1997	11
1998	14
1999	12
2000	9
2001	3
2002	1

Also plot the actual and trend values on a graph.

Answer

Calculation of 5 – yearly and 7 – yearly moving Averages

Year	5 – yearly moving average	7 – yearly moving average
1987	–	–
1988	–	–
1989	25.8	–
1990	23.6	21.9
1991	20.8	20.0
1992	17.2	17.6
1993	12.6	15.4
1994	11.2	12.4
1995	11.0	11.6
1996	11.4	11.6
1997	11.8	11.1
1998	11.8	10.1
1999	13.8	9.0
2000	7.8	–
2001	–	–
2002	–	–