COMPENDIUM
ON

MANAGEMENT ACCOUNTING - ENTERPRISE PERFORMANCE MANAGEMENT

ICWAI - FINAL
GROUP – IV

PAPER – 15

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Chapter 1
MANAGEMENT CONTROL SYSTEM

1. What is Management Control System (MCS)?

Ans:

A. Meaning:

1. Management Control System is the process by which the managers assure that resources are obtained and used effectively and efficiently in the accomplishment of organizational objectives.
2. It is a step by which top management ensures that the Company's objectives are achieved.
3. The focus is on implementation of strategic decisions of the management i.e., the process of deciding on objectives of organization, on change in these objectives, policies that are to govern acquisitions, use and disposition of resources etc.

B. Characteristics of a sound Management Control System (MCS):

1. **Pervasive**: MCS should be concerned with all types of forecasts like marketing, production, finance etc. for the next year or even two or three years and then with formulating plans for achieving the objectives of the Firm.
2. **Continuous**: MCS is a continuous exercise and, even as work proceeds, plans are changed in the light of experience gained. Management should engage in the task and work on the information continuously collected, chiefly from internal sources.
3. **Functional areas**: Research, Marketing, Advertising, Production, Personnel Policies must be decided upon and adjusted continuously.
4. **Periodicity**: The MCS activity is regular, disciplined and usually has an annual horizon.
5. **Co-ordination**: Since different departments are involved in the MCS, the flow of information has to be properly organized and channelized.
6. **Planning & Control**: In a MCS, appraisal is constant and is not too difficult. The emphasis is on both planning and control.
7. **Goal Congruence:** MCS should involve middle managers who are engaged to take actions that are in the best interest of the organization. This process may be called as "Goal Congruence" since it should be ensured that the organizational goals coincide with those of managers.
8. **Centralisation Vs. Decentralisation:** Management Control structure is primarily built around the financial structure. In a decentralized set-up targets are set in terms of return on investment or residual income and the manager concerned is expected to meet the targets. In a centralized setup, the budgets are very carefully screened by the top management and the adherence to the budget will be required.
9. **Quantifiable Targets:** Manager's performance may be judged by an effective combination of quantitative and qualitative factors. (i.e., both efficiency and effectiveness should be considered).

2. What is a System? What are various types of systems?

Ans: The term system may be defined as a set of interrelated objects that operate collectively to accomplish some common purpose or goal.

Thus a system can be described by specifying its parts, the way in which they are related, and the goals which they are expected to achieve.

A business is also a system where economic resources such as people, money, material, machines, etc are transformed by various organizational processes (such as production, marketing, finance etc.) into goods and services.

Systems can be abstract or physical. An abstract system is an orderly arrangement of interdependent ideas or constructs. For example, a system of theology is an orderly arrangement of ideas

about good and the relationship of humans to God. A physical system is a set of elements which operate together to accomplish an objective. A physical system may be further defined by examples, transportation system, accounting system, etc…

Open System: A system that interacts freely with its environment by taking input and returning output is termed as an open system. With change of environment, an open system also changes to match itself with the environment. For example, the education system or any business process system will quickly change when the environment changes. To do this an open system will interact with elements that exist and influence from outside the boundary of the system.

Information systems are open systems because they accept inputs from environment and sends outputs to environment. Also with change of environmental conditions they adopt themselves to match the changes.

Closed System: A system that does not interact with the environment nor changes with the change in environment is termed as a closed system. Such systems are inserted from the environment and are not affected with the changes in environment. Closed systems are rare in business area but often available in physical systems that we use in our day to work. For example, consider a 'throw-away' type sealed digital watch, which is a system, composed of a number of components that work in a cooperative fashion designed to perform some specific task. This watch is a closed system as it is completely isolated from its environment for its operation. It works and dies out after some time.

In general the life cycle of a closed system is much shorter compared to that of an open system because it decays faster for not having any input/interaction from environment.

Deterministic and probabilistic system: A deterministic system operates in a predictable manner. The interaction among the parts is known with certainty. If one has a description of the state of the system at a given point in time plus a description of its operation, the next state of the system may be given exactly, without error. An example is a correct computer program, which performs exactly according to a set of instructions.

The probabilistic system can be described in terms of probable behaviour, but a certain degree of error is always attached to the prediction of what the system will do. An inventory system is an example of a probabilistic system.

3.   **What is a control system? What are the types of Control Systems?**

Ans: A control system consists of a set of formal and informal systems that are designed to assist management in steering the organization towards achievement of its goals. These two systems are distinct but closely inter-related, sometimes undistinguishable sub divisions of control systems. They are considered adaptive if the two systems are internally consistent, i.e., consistent with one another and designed to permit learning that is effective in continuously meeting the competitive challenges in the environment.

The formal and informal systems along with the five components of each are explained further.

Formal Control Systems:

Infrastructure:
- ➢ Organization Structure
  - ● Strategy
  - ● Operations
- ➢ Patterns of Autonomy
- ➢ Measurement Methods
  - ● Responsibility Centre
  - ● Transfer pricing

Management Style and Culture:
- ➢ Prevailing Style
  - • External / Internal / Mixed
- ➢ Principal Values
  - • Norms and Beliefs

Formal Control Process:
- ➢ Strategic Planning
  - • Capital Budgeting
- ➢ Operations Planning
  - • Cost Accounting
  - • Budgeting
- ➢ Reporting Systems
  - • Strategy/Project Management
  - • Operations/Variance analysis

Rewards:
- ➢ Individual and Groups
- ➢ Short term and Long term
- ➢ Promotion Policy

Co-ordination:
- ➢ Standing Committees
  - • Strategy
  - • Operations
- ➢ Formal conferences
- ➢ Involvement Techniques

Informal Control Systems:
Infrastructure:
- • Personal Contacts
- • Networks
- • Expertise oriented
- • Minimal Structure
- • Emergent Roles

Management Style and Culture:
- • Prevailing Style
- • External/Internal/Mixed
- • Principle Values
- • Norms and Beliefs

Informal Control Process:
- • Search/alternative generations
- • Adhoc as needed
- • Uncertainty coping
- • Rationlisation/dialogue

Informal Rewards:
- • Recognition
- • Status oriented
- • Intrinsic

- Performance Oriented
- Stature oriented
- Personal Contact

Co-ordination & Integration:
- Based upon trust
- Simple/direct/personal
- Telephone conversation
- Personal memos

4. **What are the basic elements of Control systems?**

Ans:

The term control is used in management parlance in a cybernetic sense, that is to say, as a self-regulating mechanism with the following sequence of actions:

1. Planning
2. Execution
3. Comparison of achievement with plan
4. Assessment of deviations, if any
5. Corrective action to bring back performance in conformity with the plan.

The basic elements of a control system are the following

1. A control object or variable to be controlled
2. A detector or scanning sub-system
3. A comparator/Assessor
4. An effecter or action taking subsystem
5. Communication Network.

Control Object

A control object is the variable of the systems behavior chosen for monitoring and control. The choice of the control object is the most important consideration in studying and designing a control system. Variations in the status of control object i.e., its behavior become the stimuli which trigger the functioning of the control system. Without these variations the system has no reasons for existence.

Detector

The detector tracks the performance and can be visualized as a scanning system and it feeds on information. In fact the detector is another name for Management Information System(MIS).

Comparator/Assessor

The output of the scanning system constitutes the energizing input of the comparator. Its function is to compare deviation of the control object from the pre-determined standard or norm the deviation become input to the activating system.

Effectors

The effectors are a true decision maker. It evaluates alternative course of corrective action in the light of the significance of the deviations transmitted by the comparator. On the basis of this comparison, the systems output is classified as being in control. If out of control it initiates corrective action.

Communication Network

These are devices that transmit information between the detector and the assessor and between the assessor and the effectors.

5. What are the different types of organization structures?

Ans:

Organization Structure

A firm's strategy has a major influence on its structure. The type of structure in turn influences the design of the organization's management control system. Organization structure can be grouped into three general categories.

1. Functional Structure
2. Divisional Structure
3. Matrix Structure

Functional Structure

In this structure, each manager is responsible for a specified function as Finance or Marketing. The diagrammatic representation of this structure is as follows:

This structure is based on the principle of division of labour and achieving excellence in each function. The drawback is the coordination problems that may arise to ensure optimization at the corporate level.

Divisional Structure:

In this structure each of the decentralized division operates as a complete business unit in itself, like a semi-independent part of the company. The diagrammatic representation of this structure is as follows:

This structure helps the firms to be more market/customer-focused when the firm is engaged in unrelated product businesses. Full authority and accountability is given to the head of divisions as a separate profit and/or investment responsibility center. Structure produces greater managerial motivation to run their own business within broad company policies, thus acting as a good training ground for leadership.

Matrix Structure

Matrix Organisation Structure combines the coordination and control of the decentralized structure with the technical excellence of economies of scale of the functional structures to reap the benefits of both. While managing complex programs as in large high-technology programs, complex products and services and multinational business, organization face several coordination problems. A matrix avoids such problems as the total responsibility for achieving the goals and objective of the program lies with Program Manager but must share resources from the various functional heads. The functional managers assigned to the projects are administratively reporting to the Project Manager but functionally to the Function Head.

The distinguishing feature of the matrix structure is thus, the dual dimensions of management embodied in it. The structure of a Matrix Organization is given below:
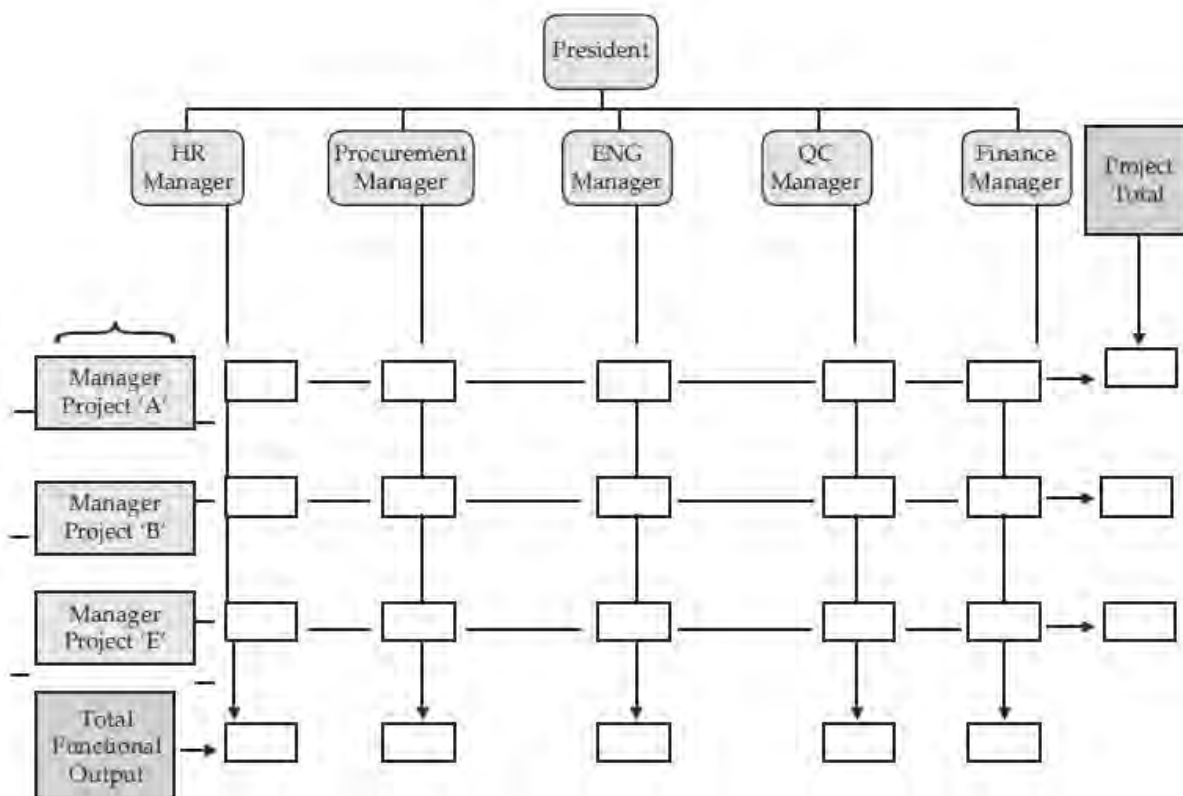
6. **What is meant by management culture? And state its importance.**

Ans:

Management Culture

Culture consists of shared values, beliefs and norms of organization which grew over time based upon the assumptions of what it takes to be successful. While management style is associated with individual managers, corporate culture is pervasive and is an organizational concept.

Culture facilitates cooperation & communication within the organization; however, if the beliefs are not consistent with the needs of business, dysfunctional consequences may follow.

A shared belief also ensures greater commitment of the employee to the organization.
BSNL's complacent culture in a monopolized environment had to undergo a radical shift to a market oriented approach when the telecom sector was de-regulated.

Key themes or dominant values shape the organization culture
    a)   A belief in the importance of people as individuals
        and in their ability to make   Infosys
        a strong and effective contribution   Intel
    b)   A belief in superior quality and service   I.B.M
    c)   A belief in cleanliness & quality   M.T.R
                                          McDonald
    d)   Belief in innovation   3M

7.   Advantages and Dis-advantages of matrix – Organisation Structure?
Ans:
Matrix Organization structure combines the coordination and control of the decentralized structure with the technical excellence of economies of scale of the functional structures to reap the benefits of both. While managing complex programmes as in large high technology programmes complex products and services and multinational business. Organization faces several coordination problems. A Matrix avoids such problems as the total responsibility for achieving the goals and objectives of the programme lies with the programme manager but must share resources from the various functional heads. The functional managers assigned to the projects are administratively reporting to the Project manager but functionally to Function Head.

Advantages:
1. Ensures better coordination and control of the decentralized structure along with achieving technical excellence and economies of scale of the technical organizations.
2. Fosters creativity and multiple sources of diversity.
3. Broader middle-management exposure to strategic issues of the business.
4. Acts as a good ground for future leaders.

Disadvantages:
1. Dual accountability which creates confusion.
2. Necessities tremendous horizontal and vertical coordination.
3. Difference in orientation between Programme and Functional personnel.
4. As responsibility is distributed between programme and functional personnel, it becomes difficult to administer system of accountability, leading to potential conflict.
5. The design of reward structure for programme and functional personnel is a ticklish issue which should be worked out in a fair and transparent manner to satisfy all.

8.   Discuss Mckinsey's 7s framework?

Ans:

The frame work is shown as follows:

```
                    Structure


    Strategy                        System



              Shared
              Value



    Skills                          Style




                    Staff
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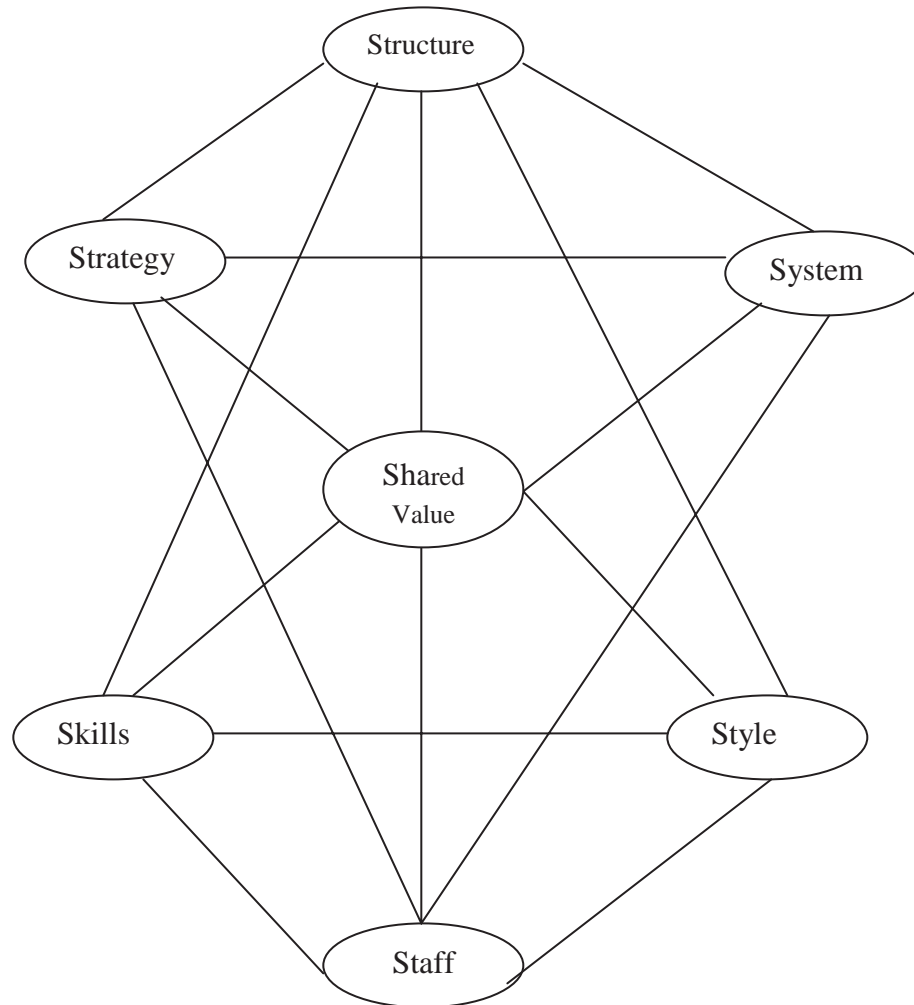
McKinsey's 7s framework

The model considers the criteria in success of a business organisation and forms an interconnected framework of seven elements:

- Structure
- Strategy
- Skills
- Systems
- Staff
- Style; and
- Shared values

Of these, the first two, strategy and structure form the hardware of the organisation, the remaining components constituting the software. The hard components are easily recognised as important, the soft ones, often barely recognised, are equally important and critical for the success of a firm.

Of these, shared values, system style all relate to behavioural patterns involving staff (people) and their skill. These behavioural patterns act as the binding fabric that successfully holds the company's cohesive activities and strategies together. Four major aspects of the behavioural fabric are of crucial importance. They are: Power; leadership; culture and risk.

The successful implementation of a strategy requires the right align of various activities and processes within the organisation.

The McKinsey's consultants call strategy and structure, the hardware of the organisation and suggest that the other five-S; are the software and are often ignored by corporate strategists. While strategy and structure are important to the organisation, they by themselves cannot assure success which comes about by corporate commitment. It is the other five-S which play an important role in creating a climate of commitment. The better the alignment between and among all the seven levers of the organisation, the better are likely to be the results.

9. **The impact of control system on human behaviour can be better explained by Budgetary Control. Explain.**

Ans:

Control System exerts a considerable influence on an individual's behaviour in an organization. The impact of Control System on human behaviour is better explained with the aid of examining budgetary control.

The Budget Process affects behaviour in three ways:

i. **Budget Formulation**: A Bottom-up approach, instead of top-down, involving employees, makes them committed towards meeting the budget.

ii. **Fixing Budgets**: Sales, Production and other targets that are determined/fixed are challenging, so as to bring out best of individual's efforts

iii. **Performance Evaluation**: This should be done in a constructive manner rather than in a vindictive manner. To ensure proper accountability, an appropriate evaluation with a positive outlook is a necessity.

Budgetary exercise is not simply a tool for planning in control but more importantly a means of achieving coordination between different departments of an enterprise. Cooperation and coordination between employees and the management and among the employees themselves through the Budgetary Control System i.e., involving all in the process, will yield better results.

Objective and Bit Questions

10. The Basic elements of a control system includes _____
    a) Control object   b) Detectors / scanning sub – system   c) Comparator
       d) All the above.

11. Mr. Stafford Beer principles of control system are _____
    a) Continuous and automatic comparison of actual with standard
    b) Control is synonymous with communication
    c) Control is in the act of and by the act of going out of control
    d) All the above

12. 2+2 = 5 is:
    a) Aggregative relationship   b) Redundant relationship c) synergistic relationship d)   none
       of the above

13. _____ consists of shared values, beliefs and norms of organization.
    a) Management style   b) Management culture   c) organizational structure c) All the
       above

14. The Board lays down the major policies and broad guide lines, so the professional divisional
    managers are given total freedom to attain the organizational goals. It is-
    a) Theory x style   b) theory y style   c) Mixed style   d) both a) and b)

15. The main consideration in design of organization structure are
    a) Functional Dimensions   b) product dimensions   c)   Geographical   area
       Dimensions   d) All the above

16. Nucor provided employees four compensation plans they are _____
    a) Production Incentive plan   b) Department manager incentive plan   c)Senior
       officers incentive plan   d) All the above

17. Which of the following are not soft elements of 7's Framework
    a) Strategy and structure   b) skills, style   c) style, staff   d) systems, shared values

18. Match the correct pairs.

Strategic planning (a)	Management control (b)
On one output at a time	Leads to desired results
Un structured and Irregular; each problem different	Integrated; More internal and historical; More accurate
Tailor made for the problems: More external and predictive; Less accurate	Rhythmic; Prescribed procedures
Show expected results	Emphasis on both planning and control
Planning dominant, but some control	On whole organization

    a) 1a 5b,   2a 1b,   3a 2b,   4a 3b,   5a 4b.
    b) 1a 5b,   2a 3b,   3a 2b,   4a 1b,   5a 4b.
    c) 1a 4b,   2a 3b,   3a 2b,   4a 1b,   5a 5b.
    d) 1a 2b,   2a 3b,   3a 5b,   4a 4b,   5a 1b.

19. _____ is the variable of systems behavior chosen for monitoring and control.

20. _____ tracks the performance and can be visualized as a scanning system and it feeds
    on information and is also another name for MIS.

21. _____ is a true decision maker of a system.

22. Elements of a system are _____, _____, _____.

23. M C S is set of inter related _____.

24. Maciareillo and korby include both _____, _____ in the definition of M C S.
25. _____ consists of shared values, beliefs and norms of organization.
26. _____ is associated with individual managers.
27. _____ facilitates cooperation and communication within the organization.

State True or False:

28. Symbiotic relationship is one in which the connected systems can not function alone.
29. In functional organization structure, each manager is responsible for a specified function.
30. In Divisional organization structure each of the decentralized division not operates as a complete business unit in it self.
31. Strategy formulation, Management control, Task control are called "Three tier planning and control frame work".
32. **Match the following**:

1.	Control object	a)	Formal procedures
2.	Redundant relationship	b)	That duplicates others
3.	M C S	c)	Participative
4.	External Style	d)	Variable of a system
5.	Internal style	e)	Coordination of parts of organization

33. M I S
34. M C S

Answers to Objective and Bit Questions

10. D	13. B	16. D
11. D	14. C	17. A
12. C	15. D	18. B

19. Control Object
20. Detector or Scanning subsystem.
21. Effectors
22. Inputs, Processes, Output
23. Communication Structures.
24. Control of Strategy, Control of operations
25. Culture
26. Management style
27. Culture
28. T
29. T
30. F
31. T
32.
       1. (d)
       2. (b)
       3. (e)
       4. (a)
       5. (c)
33. Management Information System
34. Management Control System

2
OPERATIONS MANAGEMENT

1. Define Material Requirement Planning (MRP)

Ans:

1. Material Requirement Planning is a computerized Production Scheduling System providing a basis for production decisions.
2. It Progressively translates the forward schedule of final product requirements (the master production schedule) into the numbers of sub-assemblies, components and raw materials required at each stage of the manufacturing cycle. (In other words, MRP involves input planning based on output budget).

2. List the aims / objectives and benefits of Material Requirement Planning

Ans:

1. To determine quantity and timing of Finished Goods Production as per the Master Production schedule.
2. To ascertain quantity of Raw Materials, Sub-Assemblies and Components required for budgeted production, based on Bill of Materials.
3. To compute the Inventories, Work-In-Progress, Batch Sizes and manufacturing & packaging Lead Times.
4. To control inventory by ordering bought-in Components and Raw materials in relation to the orders received or forecast.
5. To forecast the inventory position period – by – period for a future time period of a manufacturing operation.
6. To serve as an inventory information system helpful in planning for Raw materials and Component Parts.
7. To generate Purchase Requisition Notes and Purchase orders through computer system automatically.

3. List the requirement for operation of a MRP system

Ans: The prominent data requirements for a MRP system are –

1. **Master Production Schedule**: This specifies the quantity of each finished product to be produced and the time at which such items will be required for dispatch to customers.
2. **Bill of Materials (BOM)**: This specifies the consumption requirements of sub-assemblies, components and materials, for each unit of finished goods.
3. **Inventory File/Stores Ledger:** This contains the inventory details of each sub-assembly, components and materials required for each item of finished Goods.
4. **Routing File:** This provides details on the sequence of operations required to manufacture Components, Sub-Assemblies and Finished Goods.
5. **Master Parts File:** This contains information on the production time of Sub-Assemblies and Components produced internally and lead times for externally acquired items.

MRP pre-supposes the use of computers and hence the above information will be required as system data files.

4. Differentiate between MRP and MRP-II?

Ans:

a)   Material requirements planning (MRP) is a production planning and inventory control system used to manage manufacturing processes. Manufacturing resource planning (MRP II) is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer "what-if" questions and is on extension of closed-loop MRP.

b)   While MRP allows for the coordination of raw materials purchasing, MRPII facilitates the development of a detailed production schedule that accounts for machine and labour capacity, scheduling the production runs according to the arrival of materials. MRPII was concerned with the integration of all aspects of the manufacturing process, including materials, finance and human relations

c)   Manufacturing resource planning (MRP II) can provide better control of the following, compared to the Material Requirement planning (MRP)

- Better control of inventories
- Improved scheduling
- Productive relationships with suppliers
- Improved design control
- Better quality and quality control
- Reduced working capital for inventory
- Improved cash flow through quicker deliveries
- Accurate inventory records

5. Write short notes on JIT Philosophy.

Ans:

"Just-in-Time" is a time management philosophy that seeks to utilize the most important resource, i.e., time, in an efficient and effective manner. JIT Philosophy/concept operates under –

a) Identify significant activities in the Firm, and classify into VA (Value-Added) and NVA (Non-Value-Added) activities.

b) Simplify VA activities so as to improve productivity / efficiency / output.

c) Eliminate NVA activities so that time earlier spent on NVA activities can now be used for V A activities.

d) Achieve significant cost reduction by eliminating time – related and NVA activity –related costs.

6. What are the objectives of JIT Production methods?

Ans:

a) Waste Reduction

b) Time Reduction

c) Elimination of NVA items/activities

d) Zero Inventory

e) Zero Defects

f) Zero Break-downs

g) Economical Batch Sizes

h) Product Quality

i) Timely delivery to customer

7. Explain how JIT eliminates wastage of resources?

Ans:

a)   **Reduction in Inventory Levels**: Unnecessary piling up of Raw Materials, WIP and finished goods are avoided. The focus is on production and purchase as per the Firm's requirements.

b) **Reduction in Wastage of Time**: Wastage of time in various ways like Inspection Time, Machinery Set-Up Time, Storage Time, Queue Time, Defectives Rework Time etc. are reduced.

c) **Reduction in Scrap Rates**: There will be sharp reductions in the rate of defectives or scrapped units. The workers themselves identify defects and take prompt action to avoid their recurrence.

d) **Reduction in OH Costs**: By reducing unnecessary (non-value-added) activities and the associated time and cost-drivers, OH can be greatly reduced e.g. material handling costs, rework costs, facility costs etc.

8. **Write a brief note on impact of JIT on Product Prices.**

Ans:

The impact of a JIT system on product pricing is primarily driven by – a) Customer's perceived need for higher product quality and reliable delivery times and b) Presence of Competitors with a similar JIT system, the same installation and operational base. These are explained below –

a) **Customers' Needs:** When a Company achieves a higher level of product quality, along with ability to deliver products on the dates required, customers may be willing to pay a premium. If customers are highly sensitive to quality or delivery reliability (which are the benefit of JIT), it may be possible to increase prices substantially. However, if customers place a higher degree of importance on other factors, then there will be no opportunity for a price increase.

b) **Competitors Effect:** In case all firms in an industry adopt JIT, they will offer the same level of quality and service. JIT philosophy, in such cases, will be helpful to every company from losing sales to its competitors. The Company has to continuously be quality – conscious in order to retain its customers.

9. **What is lean manufacturing? Briefly describe the lean/JIT system.**

Ans:

Just-in-time (JIT) is a system adopted in a business process engineering. The aim of business process re-engineering is to improve the key business processes in an organization by focusing on simplification, cost reduction, improved quality and enhanced customer satisfaction.

JIT is a mechanism for reducing non-value added costs and long-run costs.

JIT production (also called 'Lean Production' in the west) is a "demand-pull" manufacturing system introduced by Toyota in Japan. Manufacturing activity at any particular work station is prompted by the need for that station's output at the immediately following station.

Material movements between operations are minimized by eliminating space between work stations and grouping dissimilar machines into manufacturing cells on the basis of product groups and functioning like an assembly line. In the work place visible signaling system (know as Kanbans) are installed to authorize production and movement of the part of the using locations.

The aims of JIT are to produce the required items, at the required quality and in the required quantities, at the precise time they are required. In particular, JIT seeks to achieve the following goals:

- Elimination of non-value added activities
- Zero inventory
- Zero defects
- Batch size of one
- Zero breakdowns
- A 100% on-time delivery service

The above goals represent perfections and are most unlikely to be achieved in practice. They do, however, offer targets and create a climate for continuous improvement and excellence, thereby securing a competitive advantage.

10. Define JIT and state the advantages and disadvantages of Just-in-Time approach in the context of inventory control.

Ans:

Bromwich and Bhimani define JIT as "a workflow organization technique to allow rapid, high quality, flexible production whilst minimizing stock Jevel and manufacturing waste." In practice, this means producing components only when they are needed and in the quantity that is needed.

In fact, JIT is not just a technique but is more of a philosophy or approach to management since it encompasses a commitment to continuous improvement and the search for excellence in the design and operation of the production management system.

Advantages of JIT approach:
   i)   Substantial savings in stockholding costs
   ii)   Elimination of waste
   iii)   Saving in factory and warehouse space
   iv)   Reduction in obsolete stocks
   v)   Reduction in ordering costs

Disadvantages of JIT approach:
   i)   Additional investment in new machinery and layout
   ii)   Difficulty in predicting the daily/weekly demand
   iii)   Increased risk of stock-out.

11. What do you mean by ERP?

Ans:

   a)   ERP refers to a software, which integrates all departments and functions across a company into a single computer system that can serve all those needs of different departments.

   b)   ERP combines all computerized departments together with the help of a single integrated software progress that uses a single database so that various departments can more easily share information and communicate with each other.

12. Why do Companies implement ERP? OR Bring out the need for ERP.

Ans:

a)   **Complete Automation and Faster Service**: ERP automates the tasks involved in performing a business process faster and with fewer errors than befor. Major business processes like handling Customer Orders, Employee benefits (payroll) or Financial Reporting can be speeded up.

b)   **Standardized Processes**: Manufacturing Companies find that multiple business units (departments) across the company adopt different methods and computer systems, for the same product. Standardizing these using a single integrated computer system can save time and increase productivity.

c)   **Integrated Financial Data**: ERP creates a single version of the financial position and performance, which is very useful in analyzing the performance and deviations of different business units (Responsibility Centers) rather than obtaining individual reports from each such business unit.

d)   **Standardized HR Information:** HR may not have a unified, simple method for tracking employee time and communicating with them about benefits and services. ERP can help companies with multiple business units in this regard.

e)   **Tailor – made**: ERP systems are designed as per the requirements of individual companies based on the nature, scale and methods of operations. It is superior to other standardized application packages (software), which may not be fully useful to a multi-faceted Company.

f)   **Information Management**: A good MIS should avoid information overload. ERP helps proper information management since all data are made available at one place, accessible to different users based on their individual requirements.

13. List a few components of ERP
Ans:
The following may be identified as the primary components (sub-systems) of ERP system –
a)   Sales and Marketing
b)   Master Scheduling
c)   Material Requirement Planning
d)   Capacity Requirement Planning
e)   Bill of Materials
f)   Purchasing
g)   Shop-Floor control
h)   Accounts Payable/Receivable
i)   Logistics
j)   Asset Management
k)   Financial Accounting

14. What are the benefits of ERP?
Ans: The benefits arising from ERP are –
a)   **Product Costing**: ERP system supports advanced costing methods like Standard Costing, Actual Costing, Activity Based Costing, thereby helping in determination of cost of products accurately.
b)   **Cost Monitoring and Control**: ERP can integrate all costing methods and information with finance. This provides the company with essential financial information for monitoring and controlling costs.
c)   **Planning and Managing**: ERP system simplifies complicated logistics and helps in planning for and managing different divisions in different locations as a single unit.
d)   **Information Flow:** The advanced utility of the ERP system helps in processing the flow of product and financial information in several different ways.
e)   **Efficient Database Management:** ERP system aids in the efficient managing of data on warehouses, suppliers, customers etc. required to run an organization effectively and profitably.
f)   **Inventory Management:** Inventory reporting supports all reporting of specific and general types of stock transactions like stock transfers, re-classifications, ID changes and physical inventory results. Also ERP can manage stock and purchase requisitions, selection of appropriate locations for receipts, inventory valuation, warehouse management and cost accounting.
g)   **Customer Satisfaction:** ERP system defines the logistics processes flexibly and efficiently to deliver the right product from the right warehouse to the right customer at the right time – every time, thereby satisfying the customers. It also supports planning, transportation, confirmation, dispatch and proof of delivery processing. Additionally, it ensures better after sales service.
h)   **Competitive Edge:** ERP system helps a company to gain competitive edge by – a) enabling the company to respond quickly and accurately to change in market conditions, b) improving business process, c) ensuring quality control, d) improved and objective production planning, and e) Offering Internet, Intranet and Extract Solutions.

15. Write a note on ERP.
Ans:
Enterprise Resource Planning (ERP) is the planning of how business resources (materials, employees, customers etc.) are acquired and moved from one state to another.

An ERP system supports most of the business system that maintains in a single database the data needed for a variety of business functions such as Manufacturing, Supply Chain Management, Financials, Projects, Human resources and customer relationship management.

An ERP system is based on a common database and a modular software design. The common database can allow every department of a business to store and retrieve information in real-time. The information should be reliable, accessible, and easily shared. The modular software design should mean a business can select the modules they need, mix and match modules from different vendors and add new modules of their own to improve business performance.

Ideally, the data for the various business functions are integrated. In practice the ERP system may comprise a set of discrete applications, each maintaining a discrete data store within one physical database.

16. **Define Intranet? Discuss the advantages of the intranet in management?**

Ans: **Intranet:**

An intranet is a private computer network that uses Internet protocols and network connectivity to securely share part of an organization's information or operations with its employees. Sometimes the term refers only to the most visible service, the internal website. The same concepts and technologies of the Internet such as clients and servers running on the Internet protocol suite are used to build an intranet. HTTP and other Internet protocols are commonly used as well, such as FTP. There is often an attempt to use Internet technologies to provide new interfaces with corporate "legacy" data and information systems.

Briefly, an intranet can be understood as "a private version of an Internet," or as a version of the internet confined to an organization. Through such devices and systems off-site employees can access company information, computing resources and internal communications.

Intranets (also called Enterprise Portals) differ from "Extranets" in that the former are generally restricted to employees of the organization while extranets can generally be accessed by customers, suppliers or other approved parties.

Advantages of Intranets:

a) **Workforce Productivity:**

   a. Intranets can help users to locate and view information faster and use applications relevant to their roles and responsibilities. Users can access data held in any database the organization wants to make available, anytime and – subject to security provisions – from anywhere within the company workstations.

b) **Time:**

   a. With intranets, organizations can make more information available to employees on a "pull" basis (i.e. employees can link to relevant information at a time which suits them) rather than being deluged indiscriminately by emails.

c) **Communication:**

   a. Intranets can serve as powerful tools for communication within an organization, vertically and horizontally. From a communications standpoint, intranets are useful to communicate strategic initiatives that have a global reach throughout the organization. The type of information that can easily be conveyed is the purpose of the initiative and what the initiative is aiming to achieve, who is driving the initiative, results achieved to

date and who to speak to form more information. By providing this information on the intranet, staff have the opportunity to keep up-to-date with the strategic focus on the organization.

d) **Knowledge Management:**

   a. Web publishing allows 'cumbersome' corporate knowledge to be maintained and easily accessed throughout the company using hypermedia and web technologies. Examples include: employee manuals, benefits documents, company policies, business standards, news feeds, and even training, can be accessed using common Internet Standards (Acrobat Files, Flash Files, CGI applications). Because each business unit can update the online copy of a document, the most recent version is always available to employees using the intranet.

e) **Business operations and Management:**

   a. Intranets are also being used as a platform for developing and deploying applications to support business operations and decisions across the internetworked enterprise.

f) **Cost-effective**

   a. Users can view information and data via web-browser rather than maintaining physical documents such as procedure manuals, internal phone list and requisition forms.

g) **Promote common corporate culture**

   a. Every user is viewing the same information within the Intranet.

h) **Enhance Collaboration:**

   a. With information easily accessible by all authorized users, teamwork is enabled.

17. **Define the term "Capacity"? Write a note on strategies for balancing the capacity?**

Ans: Capacity is the maximum rate of output for a process. The operations manager must provide the capacity to meet current and future demand; otherwise, the organization will miss opportunities for growth and profits.

No single capacity measure is applicable to all types of situations. A retailer measures capacity as annual sales dollars generated per square foot; an airline measures capacity as available seat-miles (ASMs) per month; a theater measures capacity as number of seats; and a job shop measures capacity as number of machine hours.   In general, capacity can be expressed in one or two ways output measures or input measures

Output measures are the usual choice for high-volume processes. Nissan Motor Company states capacity of its Tennessee plant to be 450,000 vehicles per year. Here that plant produces only one type of vehicle, making capacity easy to measure. However, many organizations produce more than one product or service. For example, a restaurant may be able to handle 100 take-out customers or 50 sit-down customers per hour.

Input measures are the usual choice for low-volume, flexible processes. For example, in a photocopy shop, capacity can be measured in machine hours or number of machines. Just as product mix can complicate output capacity measures, so too can demand complicate input measures. Demand, which invariable is expressed as an output rate, must be converted to an input measure.

Capacity planning requires a knowledge of the current capacity of a process and its utilization. Utilization, or the degree to which equipment, space, or labour is currently being used, is expressed as a percent:

$$Utilization = \frac{Average\ output\ rate}{Maximum\ Capacity}\ x\ 100\%$$

The average output rate and the capacity must be measured in the same terms – that is, time, customers, units or dollars. The utilization rate indicates the need for adding extra capacity or eliminating unneeded capacity. The greatest difficulty in calculating utilization lies in defining maximum capacity, the denominator in the ratio. Two definitions of maximum capacity are useful: peak capacity and effective capacity.

Peak Capacity:
The maximum output that a process or facility can achieve under ideal conditions is called peak capacity. When capacity is measured relative to equipment alone, the appropriate measure is rated capacity i.e., an engineering assessment of maximum annual output, assuming continuous operation except for an allowance for normal maintenance and repair downtime. Peak capacity can be sustained for only a short time, such as a few hours in a day or a few days in a month.

Effective Capacity:
The maximum output that a process or firm can economically sustain under normal conditions is its effective capacity. In some organizations, effective capacity implies a one-shift operation; in others, it implies a three-shift operation. For this reason, Census Bureau surveys define capacity as the greatest level of output the firm can reasonably sustain by using realistic employee work schedules and the equipment currently in place.

The two utilization measures are:

$$Utilization_{peak} = \frac{Average\ output\ rate}{Peak\ Capacity}$$

$$Utilization_{effective} = \frac{Average\ output\ rate}{Effective\ Capacity}$$

18. Define Benchmarking. Outline the different types of Bench-marking.
Ans:
Benching Marking: Traditionally control involves comparison of the actual results with an established standard or target. The practice of setting targets using external information is known as 'Bench marking'.

Benching marking is the establishment - through data gathering of targets and comparatives, with which performance is sought to be assessed.

After examining the firm's present position, benchmarking may provide a basis for establishing better standards of performance. It focuses on improvement in key areas and sets targets which are challenging but evidently achievable. Bench marking implies that there is one best way of doing business and orients the firm accordingly. It is a catching-up exercise and depends on the accurate information about the comparative company – be it inside the group or an outside firm.

Benchmark is the continuous process of enlisting the best practices in the world for the process, goals and objectives leading to world-class levels of achievement.
Types of Benchmarking:
The different types of Benchmarking are:
   i.   Product Benchmarking (Reverse Engineering)
   ii.   Competitive Benchmarking
   iii.   Process Benchmarking

iv.   Internal Benchmarking
v.   Strategic Benchmarking
vi.   Global Benchmarking

i.   **Product Benchmarking (Reverse Engineering)**: is an age old practice of product oriented reverse engineering. Every organization buys its rival's products and tears down to find out how the features and performances etc., compare with its products. This could be the starting point for improvement.

ii.   **Competitive Benchmarking:** This has moved beyond product-oriented comparisons to include comparisons of process with those of competitors. In this type, the process studied may include marketing, finance, HR, R&D etc.,

iii.   **Process Benchmarking:** is the activity of measuring discrete performance and functionality against organization through performance in excellent analoguous business process e.g. for supply chain management – the best practice would be that of Mumbai Dubbawallas.

iv.   **Internal Benchmarking:** is an application of process benchmarking, within an organization by comparing the performance of similar business units or business process.

v.   **Strategic Benchmarking:** differs from operational benchmarking in its scope. It helps to develop a vision of the changed organizations. It will develop core competencies that will help sustained competitive advantage.

vi.   **Global Benchmarking:** is an extension of Strategic Benchmarking to include benchmarking partners on a global scale. E.g. Ford Co. of USA benchmarked its A/c payable functions with that of Mazada in Japan and found to its astonishment that the entire function was managed by 5 persons as against 500 in Ford.

19. What is Bench trending and how does it differ from Bench Marking?

Ans:

Bench Trending: Continuous monitoring of specific process performance with a selected group of benchmarking is a systematic and continuous measurement process of comparing through measuring an organization business processes against business leaders (role models) anywhere in the world, to gain information that will help organization take action to improve its performance. The continuous process of enlisting the best practices in the world for the processes, goals and objectives leading to world class levels of achievement.

Benchmarking is the process of comparing the cost, time or quality of what one organization does against what another organization does. The result is often a business case for making changes in order to make improvements.

Benchmarking is a powerful management tool because it overcomes "paradigm blindness". Paradigm Blindness can be summed up as the mode of thinking, "the way we do it is the best because this is the way we've always done it". Bench Marking opens organizations to new methods, ideas and tools to improve their effectiveness. It helps crack through resistance to change by demonstrating other methods of solving problems than the one currently employed and demonstrating that they work, because they are being used by others.

a)   Identify your problem areas.
b)   Identify other industries that have similar processes.
c)   Identify organizations that are leaders in these areas.
d)   Survey companies for measures and practices
e)   Visit the "best practice" companies to identify leading edge practices.
f)   Implement new and improved business practices.

20. What are the stages in the process of Bench Marking?

Ans:

The process of benchmarking involves the following stages:

Stage	Description
1	Planning -
	a) Determination of Benchmarking goal statement,
	b) Identification of best performance
	c) Establishment of the benchmarking or process improvement team, and
	d) Defining the relevant benchmarking measures
2	Collection of Data and Information
3	Analysis of the findings based on the data collected in Stage 2
4	Formulation and implementation of recommendations
5	Constant monitoring and reviewing

21. Explain the various stages in the process of Bench Marking?

Ans:

Stage 1: Planning

a) **Determination of benchmarking goal statement**: This requires identification of areas to be benchmarked, which uses the following criteria –

Benchmark for Customer Satisfaction	Benchmark for improving Bottom line (Profit)
• Consistency of product or service	• Waste and reject levels
• Process cycle time	• Inventory levels
• Delivery performance	• Work-in-progress
• Responsiveness to customer requirements	• Cost of Sales
• Adaptability to special needs	• Sales per employee

b) **Identification of best performance**: The next step is seeking the "best". To arrive at the best is both expensive and time consuming, so it is better to identify a Company which has recorded performance success in a similar area.

c) **Establishment of the benchmarking or process improvement team**: This should include persons who are most knowledgeable about the internal operations and will be directly affected by changes due to benchmarking.

d) **Defining the relevant benchmarking measures**: Relevant measures will not be restricted to include the measures used by the Firm today, but they will be refined into measures that comprehend the true performance differences. Developing good measurement is key or critical to successful benchmarking.

Stage 2: Collection of data and information: This involves the following steps –

a) Compile information and data on performance. They may include mapping processes.

b) Select and contact partners.

c) Develop a mutual understanding about the procedures to be followed and, if necessary, prepare a Benchmarking Protocol with partners.

d) Prepare questions and agree terminology and performance measures to be used.

e) Distribute a schedule of questions to each partner.
f) Undertake information and data collection by chosen method for example, interviews, site-visits, telephone tax and e-mail.
g) Collect the findings to enable analysis.

Stage 3: Analysis of findings:
a) Review the findings and produce tables, charts and graphs to support the analysis
b) Identify gaps in performance between out Firm and better performers.
c) Seek explanations for the gaps in performance. The performance gaps can be positive, negative or zero.
d) Ensure that comparisons are meaningful and credible
e) Communicate the findings to those who are affected.
f) Identify realistic opportunities for improvements. The negative performance gap indicates an undesirable competitive position and provides a basis for performance improvement. If there is no gap it may indicate a neutral position relative to the performance being benchmarked. The zero position should be analysed for identifying means to transform its performance to a level of superiority or positive gap.

Stage 4: Recommendations:

Making recommendations	Implementing recommendations
• Deciding the feasibility of making the improvements in the light of conditions that apply within own Firm	Implement the action plans
• Agreement on the improvements that are likely to be feasible	Monitor performance
• Producing a report on the Benchmarking in which the recommendations are included	Reward and communicate success.
• Obtaining the support of owners/management for making the changes needed.	Keep owners/management informed of progress
• Developing action plan(s) for implementation.	

Stage 5: Monitoring and reviewing: This involves –
a) Evaluating the benchmarking process undertaken and the results of the improvements against objectives and success criteria plus overall efficiency and effectiveness.
b) Documenting the lessons learnt and make them available to others.
c) Periodically re-considering the benchmarks for continuous improvement.

22. What are the pre-requisites of Bench Marking?
Ans:
a) **Commitment**: Senior Managers should support benchmarking fully and must be omitted to continuous improvements.
b) **Clarity of Objectives**: The objectives should be clearly defined at the preliminary stage. Benchmarking teams have a clear picture of their Firm's performance before approaching others for comparisons.
c) **Appropriate Scope**: The scope of the work should be appropriate in the light of the objectives, resources, time available and the experience level of those involved.
d) **Resources**: Sufficient resources must be available to complete projects within the required time scale.

e) **Skills**: Benchmarking teams should have appropriate skills and competencies.
f) **Communication**: Stakeholders, and also staff and their representatives, are to be kept informed of the reasons for benchmarking.

23. Define difficulties in implementation of Bench Marking?

Ans:
a) **Time consuming**: Benchmarking is time consuming and at times difficult. It has significant requirement of staff time and Company resources. Companies may waste time in benchmarking non-critical functions.
b) **Lack of management Support**: Benchmarking implementation requires the direct involvement of all managers. The drive to be best in the industry or world cannot be delegated.
c) **Resistance from employees**: It is likely that their maybe resistance from employees.
d) **Paper Goals**: Companies can become pre-occupied with the measures. The goal becomes not to improve process, but to match the best practices at any cost.
e) **Copy-paste attitude:** The key element in benchmarking is the adaptation of a best practice to tailor it to a company's needs and culture. Without that step, a company merely adopts another company's process. This approach condemns benchmarking to fail leading to a failure of bench marking goals.

24. What is Business Process Re-engineering?

Ans:
Business Process Re-engineering (BPR) refers to the fundamental rethinking and redesign of business processes to achieve improvement in critical measures of performance such as cost, quality, service, speed and customer satisfaction. In contrast the concept of Kaizen, which involves small, incremental steps towards gradual improvement, re-engineering involves a giant leap. It is the complete redesign of a process with an emphasis on finding creative new way to accomplish an objective. It has been described as taking a blank piece of paper and starting from scratch to redesign a business process. Rather than searching continually for minute improvement, re-engineering involves a radical shift in thinking about how an objective should be met. Re-engineering prescribes radical, quick and significant change. Admittedly, it can entail high risks, but it can also bring big rewards. These benefits are most dramatic when new models are discovered for conducting business.

25. What are the characteristics and Principles of Re-engineering Process?

Ans:
   i. Several jobs are combined into one
   ii. Often workers make decisions
  iii. The steps in the process are performed in a logical order
   iv. Work is performed, where it makes most sense
   v. Quality is built in.
   vi. Manager provides a single point of contact
  vii. Centralized and decentralized operations are combined.

Seven Principles of BPR:
a) Processes should be designed to achieve a desired outcome rather than focusing on existing tasks.
b) Personnel who use the output from a process should perform the process
c) Information processing should be included in the work, which produces the information

d) Geographically dispersed resources should be treated, as if they are centralized
e) Parallel activities should be linked rather than integrated.
f) Doers should be allowed to be self-managing.
g) Information should be captured once at source.

26. What is aggregate planning and briefly explain its techniques?

Ans:

Aggregate Planning is the process of developing, analyzing and maintaining a preliminary approximate schedule of the overall operations of an organisation. The Aggregate Plan generally contains targeted sales forecasts, production levels, inventory levels and customer backlogs. This schedule is intended to satisfy the demand forecast at a minimum cost. In simple terms aggregate planning is an attempt to balance capacity and demand in such a way that costs are minimized. Generally this activity covers for a period of 2 to 18 months.

Aggregate planning has certain prerequisite inputs which are inevitable. They include
- Information about the resources and the facilities available.
- Forecast for the period for which planning has to be done.
- Cost of various alternatives and resources. This includes cost of holding inventory, ordering cost, cost of production through various production alternatives like subcontracting and overtime.
- Organizational policies regarding the usage of above alternatives.

"Aggregate Planning is concerned with matching supply and demand of output over the medium time range, upto approximately 12 months into the future. Term aggregate implies that the planning is done for a single overall measure of output or, at the most, a few aggregated product categories. The aim of aggregate planning is to set overall output levels in the near to medium future in the well as to supply". Schroeder, R.G. (2007), Operations management.

The following procedure is generally adopted in the process of aggregate planning
1. Determine demand for each period.
2. Determine capacity for each period.
3. Identify company, departmental and union policy.
4. Determine unit cost of production
5. Develop alternative plans and compute costs.
6. If satisfactory plans emerge, select the one that best satisfies objectives…. frequently this is the best plan for the least cost …. else return to step 5 above.

27. Write short notes on Theory of Constraints.

Ans:

Theory of Constraint: It describes methods to maximize operating income when faced with some bottleneck and some on-bottleneck operations. It defines three measurements:

a) Throughput contribution, equal to sales revenue minus direct materials cost.
b) Investments (inventory), equal to the sum of material cost of direct materials inventory. W.I.P. inventory and finished good inventory; R & D costs and costs of equipment and buildings.
c) Operating costs, equal to all operating costs (other than direct materials) incurred to earn throughput contribution. Operating costs include salaries and wages, rent, utilities and depreciation.

Increasing throughput and / or decreasing inventory or operating expenses should lead to the accomplishment of the firm's goal; to make money now and in future as well. Anything that prevents a firm from reaching this goal is labelled as a constraint (in the form of capacity, material, the market (demand), behavior or even management policy).

Theory of Constraint thinking regards all progress toward the goal of making money as relating directly to management attention towards the constraint(s).

Step1. Identify the system's constraints.
Step2. Decide how to exploit the system's constraints.
Step3. Subordinate everything else to the decisions made in step2.
Step4. Elevate the system's constraints.
Step5. If a constraint is broken in step 4, go back to step 1, but do not allow inertia to cause a new constraints.

28. Write Short Notes on Optimized Production Technology (OPT).
Ans:
a) Goldratt and Core advocated a new approach to production management called "Optimised Production Technology" (OPT)
b) OPT is based on the principle that profits are expanded by increasing the throughput of the plant i.e., rate at which raw material are turned into sales.
c) The OPT approach determines what prevents throughput being higher by distinguishing between – a) Bottleneck and b) Non-Bottleneck Resources.
d) This approach advocates that bottleneck resources/activities should be fully utilized while non-bottleneck resources/activities should not be utilized to 100% of their capacity since it would result in increase in inventory.
e) The most widely recognized management accounting system developed for this purpose is known as Throughput Accounting (TA).

29. Explain the theory of Constraints
Ans:
1. TOC focuses its attention on constraints and bottlenecks within the Firm that hinder speedy production. The main concept is to maximize the rate of manufacturing output i.e., the Throughput of the Firm.
2. This requires examination of the bottlenecks and constraints, which are defined as under-
   a) **Bottleneck**: It is an activity within the firm where the demand for the resource is more than its capacity to supply.
   b) **Constraint**: It is a situational factor, which makes the achievement of objectives/throughput more difficult than it would otherwise be, e.g., lack of skilled employees, lack of customers orders or the need to achieve a high level of quality in product output.
3. **Relationship between Constraint and Bottleneck**: a bottleneck is always a constraint but a constraint need not be a bottleneck. For example, let the major constraint be meeting the delivery schedule for customer's orders. The bottleneck in such a case may be certain machine in the factory.

4. Throughput is thus related directly to the ability to cope with the constraint and to manage the bottleneck. This focus on throughput forced management to examine both the constraints and the bottleneck in order to increase throughput.

5. **Operation of TOC:** The main aim of TOC is to increase throughput contribution. This can be done by techniques such as –
   a) Linear programming for allocating the optimum use of bottleneck resources,
   b) Use of shadow prices for decision-making, and
   c) Variance analysis using Activity Based Costing Techniques.

Thus, Theory of Constraints attempts to do the following –
Objective: Maximise Throughput Contribution (i.e., Sales Revenue Less Direct Materials)
Constraints: Subject to i) Production Capacity (supply Constraints) and
ii) Sales Demand (Demand Constraints)

30. What are the options for demand stimulation? How would you adjust capacity to match current demand?

Ans:

Demand stimulating options:

Pricing – Varying (lowering) pricing to increase demand in periods when demand is less than peak e.g., off-season rates for hotels.

Promotion – Advertising, direct marketing, bulk purchase discounts, bonus, free offers are used to shift demand.

Back ordering – By postponing delivery on current orders, demand is shifted to period when capacity is not fully utilized.

New demand creation – A new, but complementary demand is created for a product or service – when restaurant customers have to wait, they are frequently diverted into a complementary service – the bar.

Options when can be used to increase or decrease capacity to match current demand are
   a) Hire or lay off workers.
   b) Overtime
   c) Part-time or casual workers.
   d) Inventory – build up in periods of slack demand and then used to fill demand during periods of high demand.
   e) Subcontracting work to an alternative source, additional capacity is temporarily obtained.

Objective and Bit Questions.

31. _____ Deals with the functions and procedures involved in the day – to – day processes of manufacturing goods and products.

32. _____ Deals with the direction and scope of organization over a long period on how they deliver to inter clients.

33. _____ is the total pattern of decisions which shape the long-term capabilities of any type of operations and their contribution to overall strategy.

34. _____ Involves reconciliation of market requirements with operations resources.

35. According to Mc Donald's operations strategy _____ and _____ are considered as order winners.

36. According to Mc Donald's operations strategy _____, _____ and _____ are considered as order qualifiers.

37. Operations, of whatever kind, are influenced by two major factors, _____ and _____

38. _____, _____ are the criteria for evaluating operations strategy.

39. Capacity is usually assumed to mean _____ rate at which a transformation system produces or processes inputs.

40. A more usable definition of capacity would be _____ and _____.

41. _____ is the process used to determine how much capacity is needed and when. In order to manufacture greater product.

42. Over long-term, capacity planning relates primarily to _____ involving the firms major production facilities.

43. Add capital equipment and modify the layout of the plant is _____ planning.

44. The easiest and most commonly used method to increase capacity in the _____ is working overtime.

45. Procedure for capacity planning includes: _____, _____, _____, _____.

46. CPOF is based on _____ and _____.

47. Capacity bills uses _____ and _____.

48. Capacity requirements as per capacity bills procedure = _____ x _____.

49. CRP is only applicable in firms using _____ or _____.

50. Resource profile = _____ + _____

51. Finite capacity scheduling (FCS) is an extension of _____

52. _____ is the process of developing, analyzing, and maintaining a preliminary, approximate schedule of the overall operations of the organizations.

53. Aggregate planning is an attempt to balance _____ and _____ in such a way that casts are minimized.

54. The MPS used in MRP has been described as the aggregate plan " _____".

55. Demand stimulation (i.e., demand needs to be increased in order to match capacity) includes _____, _____, _____ etc.

56. Options which can be used to increase or decrease capacity to match current demand include: _____ , _____ , _____, etc.

57. Two pure aggregate planning strategies are _____, _____.

58. Under _____ the firm maintains a level work – force and steady rate of output when demand is some what low.

59. _____ is simply a promise to deliver the product at a later date when it is more readily available.

60. _____ implies matching demand and capacity period by period.

61. Most firms embracing the just in time production concept utilize a _____ approach to aggregate planning.

62. AH is also known as _____.

63. $P_t = a\ W_{t-1} - b\ I_{t-1} + c\ F_{t+1} + c\ F_{t+1} + K$, is rate of production as per _____.

64. Bills of capacity are a procedure based on _____.

65. _____ is a set of principles and practices based on philosophy that firms should hold little or not inventory beyond that required for immediate production or distribution.

66. Reducing waste, maximizing cost efficiency and securing competitive advantage are the objectives of _____.

67. _____ is a westernized version of JIT.

68. _____ is a process of measuring and reducing inventory and steamlinging production.

69. _____, a philosophy of production that emphasizes minimizing the amount of all resources (including time) used in various enterprise activities.

70. _____ involves identifying and eliminating non-value adding activities in design, production, supply chain management and customer relationship.

71. The idea behind lean / JIT is a concept called _____

72. To balance inventory carrying cost and ordering cost the concept of _____ was developed.

73. Setup time can be divided into _____ and _____.

74. Under _____ system entire batch of production is rejected when defective units exceeds predetermined sample size.

75. Optimized production technology originally known as _____

76. TOC is systematic and strives to identify _____ to system success and to effect the changes necessary to remove them.

77. Components of the theory of constants includes _____, _____, _____ and _____.

78. According to Goldratt _____, _____ ,_____ are the key performance measures.

79. Problems discovered through current reality tree and cause effect diagram are known as __.

80. An evaporating cloud is a _____ tool.

81. _____ in TOC includes drum – buffer – rope scheduling, buffer management and VAT analysis.

82. The drum in TOC is the _____ and therefore sets the pace for the entire system.

83. A buffer includes time or materials that supporting _____ and / or due date performance.

84. The 'Rope' in TOC is a _____ for releasing raw materials to the floor.

85. _____ Analysis of TOC determines the general flow of parts and products from raw material to finished products.

86. _____ starts with one or a few raw materials and the product expands into a number of different products as it flows through its routings.

87. _____ of TOC consists of numerous similar finished products assembled from common assemblies and sub-assemblies.

88. Systems that are specifically geared toward serving general predictable management functions are some time called _____

89. _____, or the process of analyzing empirical data allows for the extra polation of information.

90. _____ Tools allow the users to find the information needed to perform any specific function.

91. An _____ is a private computer network that uses internet protocols and network connectivity to securely share part of any organization's information or operations with its employees.

92. Sometimes the term refers only to the most visible service, the internal _____.

93. The same concepts and technologies of the such as client and servers running on the internet protocol suite are used to build an _____

94. HTTP and other internet protocols are commonly used as well, such as _____

95. An _____ can be understood as a private version of an Internet, or as a version of the internet confined to an organization.

96. Internets also called as _____

97. One of the main business information tools available to staff globally via intranet is a ____

98. The earliest form of MRP-II was known as _____

99. _____ is a computer based, time phased system for planning and controlling the production and inventory function of a firm from the purchase of materials to the shipment finished product.

100. The MRP system is composed of three primary modules. All of which function as a form of input these are _____ , _____ , _____.

101. The MPS is divided into units of time called _____.

102. _____ is a hierarchical testing of the type and number of parts needed to produce one unit of finished goods.

103. _____ , contains a count of the on hand balance of every part held in inventory.

104. An MRP – II system has a simulation capability that enables its users to conduct _____ or evaluate a variety of possible scenarios.

105. _____ refers to a computer information system that integrates all the business activities and processes throughout an entire organization.

106. _____ is a process of continuously comparing and measuring an organistion's business process against business leaders any where in the world, to gain information that will help the organization take action to improve its performance.

107. _____, a measure, best – in – class achievement.

108. Product benchmarking is an age old practice of product oriented _____.

109. _____, the activity of measuring discrete performance and functionally against organizations through performance in excellent analogous business processes.

110. _____, An application of process benchmarking performed, within an organization by comparing the performance of similar business units or business process.

111. _____, the application of process benchmarking of the level of business strategy.

112. Analyzing PEST scan for recognizing best standard of excellence for bench marking is _____

113. _____ and _____ are the two types of bench trending.

Answers to Objective and Bit Questions:

31. Operations
32. Strategy
33. Operations Strategy
34. Operations Strategy
35. Consistent and High- performance quality
36. Speed, Cost, innovation
37. Resources for operations and market requirements.
38. Consistency and contribution.
39. Maximum rate
40. The volume of output per elapsed time, production capability of a facility.
41. Capacity
42. Strategic issues.
43. Long-term capacity planning
44. Short term.
45. CPOF, Capacity bills, resources profiles, and CBP.
46. MPS, Production standard
47. Bills of material, routing sheets.
48. Units required by MPS x Hours required per unit.
49. MRP or MRP – II
50. Capacity bills + Lead time.
51. CRP
52. Aggregate planning
53. Capacity, demand.
54. Disaggregated.
55. Pricing promotion, back ordering etc.,
56. Time / Lay off, over time, sub contracting etc.,
57. Level strategy, chase strategy.
58. Level strategy
59. Backlog or back order
60. Chase strategy
61. Chase strategy
62. Flexi year
63. MCM (management coefficient model)
64. MPS
65. JIT
66. JIT
67. Lean Manufacturing
68. Lean Manufacturing
69. Lean Manufacturing
70. Lean Manufacturing
71. Ideal production

72. EOQ
73. External time and internal time
74. Quality Improvement system (QIS)
75. Theory of constraints
76. Constraints
77. Performance measures, five focusing steps, logical thinking process, and logistics.
78. Throughput, Inventory and operating expenses.
79. Undesirable effects.
80. Conflict – resolution tool.
81. Logistics
82. Constraint
83. Throughput
84. Schedule
85. VAT analysis
86. V- logical structure
87. T- logical structure
88. Management Information Systems (MIS)
89. Data Mining
90. Query tools
91. Intranet
92. Website
93. Internet, Intranet
94. FTP
95. Intranet
96. Enterprise portals
97. Competitors database
98. MRP
99. Material Requirement Planning
100. MPS, BOM, Inventory status files.
101. Buckets.
102. BOM
103. Inventory status files
104. Sensitivity Analysis
105. ERP
106. Benchmarking
107. Bench Mark
108. Reverse Engineering
109. Process bench marking
110. Internal bench marking
111. Strategic bench marking
112. Bench Trending
113. Strategic bench trending, process or operations bench trending

3
COST PLANNING AND ANALYSIS FOR COMPETITIVE ADVANTAGE

1. Define Value Analysis.

Ans:

Value Analysis: Value Analysis defines a 'basic function' as anything that makes the products work or sell. A function that is defined as 'basic' cannot change. Secondary functions, also called supporting functions, described the manner in which basic functions were implemented. Secondary functions could be modified or eliminated to reduce product cost. The term value has four different meanings: cost value; use value; esteem value and exchange value. The first step in the value analysis process is to define the problem and its scope. Once this is done, the functions of the product and its items are derived. These functions are 'basic' and 'secondary' functions. A cost function matrix or value analysis matrix is prepared. Improvement opportunities are then brainstormed, analyzed and selected.

2. Define Value Engineering (VE). What are the issues that need to be dealt with during a VE review?

Ans:

A. **Meaning:**

1. **Value Engineering:** involves searching for opportunities to modify the design of each component or part of a product to reduce cost, but without reducing the functionality or quality of the product.

2. **Value Analysis**: entails studying the activities that are involved in producing the product to detect non-value-adding activities that may be eliminated or minimized to save costs, but without reducing the functionality or quality of the product.

B. **Scope:** Value Engineering and Value Analysis help identify costs into a) Value-Added Cost and b) Non Value-Added Cost. The objective is to retain (if possible, reduce) Value-Added Cost, while totally avoiding or eliminating Non-Value Added Costs.

1. **Value-Added Cost**: A Value – Added Cost is a cost that, if eliminated, would reduce the value or utility (usefulness) customers obtain from using the product or service.

2. **Non Value-Added Cost**: A Non Value-Added Cost is a cost that, if eliminated, would not reduce the value or utility customers obtain from using the product or service.

    Some issues analysed during VE review are –

    1. **Elimination of unnecessary functions from the production process:**

    a) This involves a detailed review of the entire manufacturing process to see if there are any steps that add no value to the product, e.g., interim quality review before further processing and final quality check.

    b) By eliminating unnecessary or duplicate functions, the Firm can reduce its associated direct or overhead costs from the total product cost.

    c) The effect of elimination of any intermediate production function, should be carefully analysed. The engineering team must be careful to develop work-around steps that eliminate the need for the original functions.

    2. **Elimination of unnecessary Product qualities:**

    a) Product Quality should be studied with reference to the nature of its use, longevity of product's useful life.

    b) If some unnecessary quality e.g. excessive degree of sturdiness in consumable item (as opposed to a durable item) can be eliminated, it should be done in order to save significant material and other product costs.

c) However, visible reduction in durability or reliability cannot be stretched too far. Hence any designs that have had their structural integrity reduced must be thoroughly tested to ensure that they meet all design standards.

3. Design Minimisation:
a) This involves the creation of a design that uses fewer parts or has fewer features.
b) This approach is based on the assumption that a minimal design is easier to manufacture and assemble. Also, with fewer parts to purchase, purchase related overhead is minimized.
c) However, sometimes it would be less expensive to settle for a few extra standard parts that are more easily and cheaply obtained, rather than customized pre-fabricated parts, which complicate the assembly process.

4. Better Product Design to suit manufacturing Process:
a) This is also known as Design For Manufacture and Assembly (DFMA) and involves the creation of a product design that can be created in only a specific manner.
b) When used for the assembly of an entire product, this approach ensures that a product is not incorrectly manufactured or assembled, which would call for a costly disassembly or product recalls from customers who have received defective goods.

5. Substitution of Parts:
a) This is also called Component Parts Analysis. This approach encourages the search for less expensive components or materials that can replace more expensive parts currently used in a product design.
b) Substitution of new parts is encouraged since new materials are being developed every year.
c) However parts substitution must be accompanied by a review of related changes elsewhere in the design and the consequent impact on total costs.
d) This also involves allied analysis on tracking the intentions of suppliers to continue production of parts in the future. If parts are not available, they must be eliminated from the product design.

6. Combination of Steps:
a) A careful review of all processes associated with a product may reveal that some steps can be eliminated, other steps can be consolidated, or that several steps an be accomplished by one person, rather than by many people in different departments. This is also known as process Costing.
b) By combining steps, transfer and queue time can be eliminated from the production process, which in turn reduces the chances of damage during transfers.

7. Search for better way of doing things:
a) This seeks to answer a basic question – Is there a better way?
b) It strikes at the core of the cost reduction issue. It is a more general attempt to start from scratch and build a new product or process that is not based in any way on pre-existing ideas.
c) Improvements resulting from this technique have a favourable impact on cost reduction but can be the most difficult for the Firm to adopt, especially if it has used other design or systems for production.

3. Define Target costing. Explain in brief the main features of Target costing System.
Ans:

Target Costing is defined as "a structured approach in 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."

The main features or practices followed in Target Costing are

Step1	Identify the market requirements as regards design, utility and need for a new product or improvements of existing product.
Step2	Set Target Selling Price based on customer expectations and sales forecasts.
Step3	Set Target Production Volumes based on relationships between price and volume.
Step4	Establish Target Profit Margin for each product, based on the company's long term profit objectives, projected volumes, and course of action. etc.
Step5	Set Target Cost (or Allowable cost) per unit, for each product. Target cost = Target selling price less Target profit margin
Step6	Determine Current Cost of producing the new product, based on available resources and conditions.
Step7	Set cost reduction Target in order to reduce the Current Cost to the Target Cost.
Step8	Analyze the Cost Reduction Target into various components and identify cost reduction opportunities using Value Engineering (VE) and Value Analysis (VA) and Activity Based Costing (ABC)
Step9	Achieve cost reduction and Target profit by Effective Implementation of Cost Reduction decisions
Step10	Focus on further possibilities of cost reduction ie Continuous Improvement program.

4. Discuss the steps in Target Costing procedure
Ans:

Target Costing is viewed as integral part of the design and introduction of new products. It is part of an overall Profit Management Process, rather than simply a tool for cost Reduction and Cost Management.

Step 1: Customer product Design Specification:
(a) The customer requirements as to the functionality and quality of the product is of prime importance
(b) The design specification of the new product is based on customer's tastes, expectations and requirements.
(c) Competitor's products and the need to have extra features over competitor's products are also considered. However the need to provide improved products, without significant increase in prices, should be recognized as charging a higher price may not be possible in competitive conditions.

Step 2 & Step 3: Market – Target Selling Price and Production Volume:
(a) The Target Selling Price is determined using various sales forecasting techniques.
(b) The price is also influenced by the offers of competitors, product utility, prices, volumes and margins.
(c) In view of competition and elasticity of demand, the Firm has to forecast the price volume relationship with reasonable certainty. Hence the Target Selling Price is market driven and should encompass a realistic reflection of the competitive environment.
(d) Establishment of Target Production Volumes is closely related to Target Selling price, given the relationship between price and volume.
(e) Target Volumes are also significant in computation of unit costs particularly Capacity Related Costs and Fixed Costs. Product Costs are dependent upon the production levels over the life cycle of the product.

Step 4: Profitability – Target Profit Margin:
(a) Since profitability is Critical for survival, a Target Profit Margin is established for all new products.

(b) The Target Profit Margin is derived from the company's long term business plan, objectives and strategies.

(c) Each product or product line is required to earn atleast the Target Profit Margin.

Step 5: Setting Target Costs:
a) The difference between the Target Selling Price and Target Profit Margin indicates the "Allowable Cost" for the product.

b) Ideally, the Allowable Cost becomes the "Target Cost for the product". However, the Target Cost may exceed the Allowable Cost, in light of the realities associated with existing capacities and capabilities.

Step 6: Computing Current Costs:
a) The "Current Costs" for producing the new product should be estimated.

b) The estimation of Current Cost is based on existing technologies and components, taking into account the functionalities and quality requirements of the new product.

c) Direct Costs are determined by reference to design specifications, materials prices, labour processing time and wage rates. Indirect Costs may be estimated using Activity Based Costing Principles.

Step 7: Setting Cost Reduction Targets:
a) The difference between Current Cost and Target Cost indicates the required cost reduction.

b) This amount may be divided into two constituents namely – a) Target Cost – Reduction Objective and b) Strategic Cost – Reduction Challenge.

c) The former is viewed as being achievable (yet still a very challenging target) while the latter acknowledges current inherent limitations.

d) After analyzing the Cost Reduction Objective, a Product-Level Target Cost is set which is the difference between the current cost and the target cost –reduction objective.

Step 8: Identifying Cost Reduction Opportunities:
a) After the Product-Level Target Cost is set, a series of analytical activities, commence to translate the cost challenge into reality.

b) These activities continue from the design stage until the point when the new product goes into production.

c) The total target is broken down into its various components, each component is studied and opportunities for cost reductions are identified.

d) These activities are referred to as a) Value Engineering (VE) and b) Value Analysis (VA).

5. What are the Advantages of Target Costing?

Ans:
a) **Innovation:** It reinforces top-to-bottom commitment to process and product innovation, and is aimed at identifying issues to be resolved.

b) **Competitive Advantage:** It enables a Firm to achieve competitive advantage over other Firms in the industry. The firm which achieves cost reduction targets realistically stands to gain in the long run.

c) **Market Driven Management:** It helps to create a Company's competitive future with market-driven management for designing and manufacturing products that meet the price required for market success.

d) **Real Cost Reduction:** It uses management control systems to support and reinforce manufacturing strategies, and to identify market opportunities that can be converted into real savings to achieve the best value rather than simply the lowest cost.

6. Write Short Note on Target Costing.

Ans:

Target Costing: This technique has been developed in Japan. It aims at profit planning. It is a device to continuously control costs and manage profit over a product's life cycle. In short, it is a part of a comprehensive strategic profit management system. For a decision to enter a market prices of the competitors' products are given due consideration. Target Costing initiates cost management at the earliest stages of product development and applies it throughout the product life cycle by actively involving the entire value chain. In the product concept stage selling price and required profit are set after consideration of the medium term profit plans, which links the operational strategy to the long term strategic plans.

Target Cost = Planned Selling Price – Required Profit.

From this, the necessary target cost can be arrived at. Target cost, then, becomes the residual or allowable sum. If it is thought that the product cannot generate the required profit, it will not be produced as such and aspects of the product would be redesigned until the target is met. Value engineering and value analysis may be used to identify innovative and cost effective product features in the planning and concept stages.

Throughout the product's life target costing continues to be used to control costs. After the initial start up stage target costs will be set through short-period budget. Thus all costs including both variable and fixed overheads are expected to reduce on a regular (monthly) basis. Target profit is a commitment agreed by all the people in a firm, who have any part to play in achieving it.

7. What do you mean by Kaizen Costing?

Ans:

Introduction: The initial VE review may not be complete and perfect in all cost aspects. There may be further chances of waste reduction, cost and time reduction and product improvement. Such continuous cost reduction technique is called as Kaizen Costing.

The review of product costs under the target costing methodology is not reserved just for the period up to the completion of design work on a new product. There are always opportunities to control costs after the design phase is completed, though these opportunities are fewer than during the design phase.

Meaning: Kaizen Costing refers to the ongoing continuous improvement program that focuses on the reduction of waste in the production process, thereby further lowering costs below the initial targets specified during the design phase. It is a Japanese term for a number of cost reduction steps that can be used subsequent to issuing a new product design to the factory floor.

Process of Kaizen Costing: Activities in Kaizen Costing include elimination of waste in production, assembly, and distribution processes, as well as the elimination of unnecessary work steps in any of these areas. Thus Kaizen Costing is intended to repeat many of the value engineering steps, continuously and constantly refining the process, thereby eliminating out extra costs at each stage.

Kaizen Costing Vs Value Engineering: Cost reductions resulting from Kaizen Costing are much smaller than those achieved with value engineering. But these are still significant since competitive pressures are likely to force down the price of a product over time, and any possible cost savings allow a Company to still attain its targeted profit margins.

Multiple Versions of Products – Continuous Kaizen Costing: Multiple improved versions of products can be introduced to meet the challenge of gradually reducing costs and prices. The market price of products continues to drop over time, which forces a Company to use both target and kaizen costing to reduce costs and retain its profit margin.

However, prices eventually drop to the point where margins are reduced, which forces the Company to develop a new product with lower initial costs and for which kaizen costing can again be used to further

reduce costs. This pattern may be repeated many times as a Company forces its costs down through successive generations of products.

The exact timing of a switch to a new product is easy to determine well in advance since the returns from kaizen costing follow a trend line of gradually shrinking savings. Since prices also follow a predictable downward track, plotting these two trend lines into the future reveals when a new product version must be ready for production.

8. State the experience of Kaizen Costing in Toyota.

Ans:

Toyota's Experience of Kaizen Costing: Toyota aggressively pursued Kaizen Costing to reduce costs in the manufacturing phase. In July and January, Plant Managers submit six months plan for attaining their kaizen goal. Methods for achieving these goals include cutting material costs per unit and improvement in standard operating procedures. These are pursued based on employee's suggestions. For improvements involving industrial engineering and value engineering, employees often receive support from technical staff. To draw up a Kaizen plan after Kaizen goals have been set by top management, employees look for ways to contribute to Kaizen in their daily work. About two million suggestion were received from Toyota employees in t\one recent year alone roughly thirty-five per employee. Ninety-seven percent of them were adopted. This is really a prime example of concept of employee empowerment in which workers are encouraged to take their own initiatives to improve operations, reduce costs, and improve product quality and customer service.

9. Differentiate Kaizen Costing and Standard Costing

Ans:

Standard Costing is used in conjunction with management by exception (management's attention is directed towards situations where actual results differ from expected results). The expected results are based on standards, which have been derived from the capability of current organizational processes. Standard costing, therefore, reflects current level of performance and fails to provide any motivation to improve. A table given below set out principal differences between Kaizen Costing and Standard Costing:

Basis of Difference	Standard Costing	Kaizen Costing
Concepts	It is used for cost control	It is used for cost reduction.
	It is assumed that current manufacturing conditions remain unchanged.	It assumes continuous improvement.
	The cost focus is on standard costs based on static conditions	The cost focus is on actual costs assuming dynamic conditions
	The aim is to meet cost performance standards	The aim is to achieve cost reduction targets.
Techniques	Standards are set every six or twelve months	Cost reduction targets are set and applied monthly
	Costs are controlled using variance analysis based on standard and actual costs.	Costs are reduced by implementing continuous improvement (kaizen) to attain the target profit or to reduce the gap between target and estimated profit.
	Management should investigate and respond when standards are not met.	Management should investigate and respond when target kaizen amount are not attained.
Employees	They are often viewed as the cause of problems	They are viewed as the source of, and are empowered to find, the solutions.

10. Write a short note on quality function deployment.

Ans: Quality Function Deployment (QFD) Process:

Quality Function Deployment begins with product planning; continues with product design and process design; and finishes with process control, quality control, testing, equipment maintenance, and training. As a result, this process requires multiple functional disciplines to adequately address this range of activities. QFD is synergistic with multi-function product development teams. It can provide a structured process for these teams to begin communicating, making decisions and planning the product. It is a useful methodology, along with product development teams, to support a concurrent engineering or integrated product development approach.

Quality Function Deployment, by its very structure and planning approach, requires that more time be spent up-front in the development process making sure that the team determines, understands and agrees with what needs to be done before plunging into design activities. As a result, less time will be spent downstream because of differences of opinion over design issues or redesign because the product was not on target. It leads to consensus decisions, greater commitment to the development effort, better coordination, and reduced time over the course of the development effort.

Quality Function Deployment is an extremely useful methodology to facilitate communication, planning, and decision-making within a product development team. It is not a paperwork exercise or additional documentation that must be completed in order to proceed to the next development milestone. It not only brings the new product closer to the intended target, but reduces development cycle time and cost in the process.

11. Write a short note on Learning Curve.

Ans:

Learning is the process by which an individual acquires skill, knowledge and ability. When a new product or process is started, the performance of worker is not at its best and learning phenomenon takes place. As the experience is gained, the performance of worker improves, time taken per unit reduces and thus his productivity goes up. This improvement in productivity of workers is due to learning effect. Cost predictions especially those relating to direct labour cost must allow for the effect of learning process. This technique is a mathematical technique. It is very much used to accurately and graphically predict cost. 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; Experience curve, improvement curve and progress curve are other terms which are synonymously used. Learning curve is essentially a measure of the experience gained in production of an article by an organisation. As more units are produced, people involved in production become more efficient than before. Each subsequent unit takes fewer man hours to produce. The amount of improvement will differ with types of articles and processes. This improvement or experience gain is reflected in a decrease in man hours or cost. The application of learning curve can be extended to commercial and industrial activities as well as defense production.

$$\text{Learning Curve Ratio} = \frac{\text{Average labour cost of first 2 units}}{\text{Average labour cost of first N units}}$$

Learning curve Equation:

Mathematicians have been able to express relationship in equations. The basic equation

$$Y_x = KX^S$$

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 lot.

S is the improvement exponent or the learning coefficient or the index of learning, which is calculated as follows:

$$S = \frac{\text{Logaritham of learning ratio.}}{\text{Logarithm of 2}}$$

12. What are the merits and limitations of concept of Learning Curve?

Ans: <u>Learning Curve Application:</u>

Knowledge of learning curve can be useful both in planning and control. Standard cost for new operations should be revised frequently to reflect the anticipated learning pattern.

<u>Merits of Learning Curve Theory:</u>

Its main uses are summarized below:

a) <u>Helps to analyse CVP relationship during familiarization phase:</u>

Learning curve helps to analyse cost-volume-profit relationship during familiarization phase of product or process and thus it is very useful for cost estimates. Learning curve is of immense value as a tool for forecasting.

b) <u>Helps in budgeting and profit planning:</u>

Incorporation of the learning curve introduces new complexity and sophisticated in the process of budgeting and profit planning. Budget executive should select those costs which reflect learning effect and then he should be able to incorporate this effect in process of developing budgets or in the exercises relating to project planning.

c) <u>Helps in pricing:</u>

The use of cost data adjusted for learning effect helps in development of advantageous pricing policy. Suppose, firm A is preparing a bid to produce 220 MW turboset. Hitherto, company had produced a set of 100 MW only. There is a strong possibility of production over-run. Firm A is competing with Firm B. Firm A is not aware of the learning effect, while Firm B is aware of the learning effect. In this situation, Firm B will definitely go away with the contract.

d) <u>Design makers:</u>

It helps design engineers in making decisions based upon expected (predictable from past experience) rates of improvement.

e) <u>Helps in negotiations:</u>

It is very helpful to Government in negotiations about the contracts. Government receives full advantage of the decreasing unit cost in establishing the contract price.

f) <u>Helps in setting standards:</u>

The learning curve is extremely useful in setting standards in learning phase.

<u>Limitations of Learning Curve Theory:</u>

1. All activities of a firm are not subject to learning effect. Following types of activities are subject to learning effect:

   a) Those, that have not been performed in this present operational mode.

   b) Those which are being performed by new workmen, new employees or others not familiar with the particular activity. In contrast, activities being performed by

experienced workmen, who are thoroughly familiar with those activities will not be subject to learning effect.

c)   Those involving utilization of material not used by firm so far.

2.   It is correct that learning effect does take place and average time taken is likely to reduce. But in practice it is highly unlikely that there will be a regular consistent rate of decrease, as exemplified earlier. Therefore any cost predictions based on conversational learning curves should be viewed with caution.

3.   Considerable difficulty arises in obtaining valid data, that will form basis for computation of learning effect.

4.   Even slight change in circumstances quickly renders the learning curve obsolete. While the regularity of conventional learning curves can be questioned, it would be wrong to ignore learning effect altogether in predicting future costs for decision purposes.

13.   What is the meaning of Product Life Cycle?

Ans:

a)   Product Life Cycle is a pattern of expenditure, sale level, revenue and profit over the period from new idea generation to the deletion of product from product range.

b)   Product Life Cycle spans the time from initial R & D on a product to when customer servicing and support is no longer offered for the product. For products like motor vehicles, this time-span may range from 5 to 7 years. For some basic pharmaceuticals, the time-span be 7 to 10 years.

14.   What are the phases in Product Life Cycle?

Ans:

The 4 identifiable phases in the product Life Cycle are – a) Introduction b) Growth c) Maturity and d) Decline. A comparative analysis of these phases is given below –

Particulars	Introduction	Growth	Maturity	Decline
Phase	I	II	III	IV
Sales Volumes	Initial stages, hence low.	Rise in sales levels at increasing rates.	Rise in sales levels at decreasing rates	Sales level off and then start decreasing
Prices of products	High levels to cover initial costs and promotional exps.	Retention of high level prices except in certain cases.	Prices fall closer to cost, due to effect of competition.	Gap between price and cost is further reduced.
Ratio of promotion expenses to sales	Highest, due to effort needed to inform potential customers, launch products, distribute to customers etc.	Total expenses remain the same, while ratio of S&D OH to sales is reduced due to increase in sales.	Ratio reaches a normal % of sales. Such normal % becomes the industry standard.	Reduced sales promotional efforts as the product is no longer in demand.
Competition	Negligible and insignificant	Entry of a large number of competitors.	Fierce Competition	Starts disappearing due to withdrawal of products.
Profits	Nil, due to heavy initial costs	Increase at a rapid pace	Normal rate of profits since costs and prices are normalized.	Decline profits due to price competition, new products etc.

- In the growth stage, the Firm will maintain the prices at the high levels, in order to realize maximum profits.

- Price reduction will not be undertaken unless a) the low prices will lead to market penetration, b) the Firm has sufficient production capacity to absorb the increased sales volume, and c) Competitors enters the market.
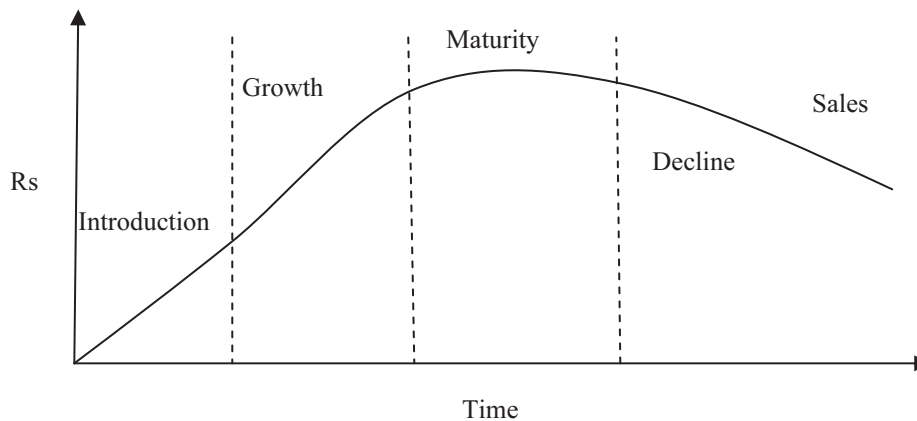
15. What do you understand by Life Cycle Costing?

Ans:
a) **Life Cycle Costing**, aims at cost ascertainment of a product, project etc. over its projected life.
b) It is a system that tracts and accumulates the actual costs and revenues attributable to cost object (i.e., product) from its inception to its abandonment.
c) Sometimes the terms, "cradle-to-grave costing" and "womb-to-tomb costing" convey the meaning of fully capturing all costs associated with the product from its initial to final stages.

16. Bring out the importance of Product Life Cycle costing. What are the benefits of product Life Cycle Costing?

Ans:
Product Life Cycle Costing is considered important due to the following reasons –
a) **Time based analysis**: Life cycle costing involves tracing of costs and revenues of each product over several calendar periods throughout their life cycle. Costs and revenues can analysed by time periods. The total magnitude of costs for each individual product can be reported and compared with product revenues generated in various time periods.
b) **Overall Cost Analysis**: Production Costs are accounted and recognized by the routine accounting system. However non-production costs like R&D, design, marketing, distribution, customer service etc. are less visible on a product – by – product basis. Product Life Cycle Costing focuses on recognizing both production and non-production costs.
c) **Pre-production costs analysis**: The development period of R&D and design is long and costly. A high percentage of total product costs maybe incurred before commercial production begin. Hence, the Company needs accurate information on such costs for deciding whether to continue with the R&D or not.
d) **Effective Pricing Decisions**: Pricing Decisions, in order to be effective, should include market considerations on one hand and cost considerations on the other. Product Life Cycle Costing and Target Costing help analyze both these considerations and arrive at optimal price decisions.

e) **Better Decision Making**: Based on a more accurate and realistic assessment of revenues and costs, at least within a particular life cycle stage, better decisions can be taken.

f) **Long Run Holistic view**: Product Life Cycle Costing can promote long-term rewarding in contrast to short-term profitability rewarding. It provides an overall framework for considering total incremental costs over the entire life span of a product, which in turn facilitates analysis of parts of the whole where cost effectiveness might be improved.

g) **Life Cycle Budgeting**: Life Cycle Budgeting, i.e., Life Cycle Costing with Target Costing principles, facilitates scope for cost reduction at the design stage itself. Since costs are avoided before they are committed or locked in the Company is benefited.

h) **Review**: Life Cycle Costing provides scope for analysis of long term picture of product line profitability, feedback on the effectiveness of life cycle planning and cost data to clarify the economic impact of alternatives chosen in the design, engineering phase etc.

17. What is product Life Cycle Costing? State its characteristics and benefits.

Ans:

Product Life Cycle Costing (PLCC) is an approach used to provide a long term picture of product line, profitability, feedback on the effectiveness of the life cycle planning and cost data to clarify the economic impact on the alternative, chosen in the design, engineering phase etc.,

Characteristics: PLCC –

a) Involves tracing of costs and revenues of each product over several calendar periods throughout their entire life cycle.

b) Traces research, design and development costs and total magnitude of these costs for each individual product and compared with product revenue.

c) Assists report generation for costs and revenues.

Benefits: PLCC –

a) Results in earlier actions to generate revenue or to lower costs than otherwise might be considered.

b) Ensures better decision from a more accurate and realistic assessment of revenues and costs atleast within a particular life cycle stage.

c) Promotes long-term rewarding.

d) Provides an overall framework for considering total incremental costs over the life span of the product.

18. Define Activity Based Costing. And Define a Cost Object and Cost Driver.

Ans:

Activity based Costing (ABC) is a technique which involves identification of cost with each cost driving activity and making it as the basis for apportionment / assignment of costs over different cost objects / jobs / products / customers / services.

Cost Object: It is an item for which cost measurement is required, e.g., a product, a job or a customer.

Cost Driver: It is the factor that causes a change in the cost of an activity. Cost Drivers are classified into –

a) **Resources 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.

b) **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.

	Linked through			Linked through	
Overhead Costs	→	**Activities**	→		**Cost Objects**
	Resource Cost Drivers			**Activity Cost Drivers**	

Examples of Cost Drivers:

Function	Cost Drivers
Research and Development	Number of Research Projects
	Personnel Hours on a project
Customer Service	N umber of Service Calls
	Number of Products serviced
	Hours spent on servicing products
Design of products, services and processes	Number of Products in design
	Number of parts per product
	Number of Engineering Hours
Marketing	Number of Advertisements / Insertions
	Number of Sales Personnel
	Sales Revenue
Distribution	Number of items distributed
	Number of Customers
	Weight of items distributed

Note: Multiple Cost Drivers may be identified for each activity. However, for fixing ABC rate, the most relevant / dominant Cost Driver will be considered.

19. **Enumerate the steps in Activity Based Costing.**
Ans:

The steps involved in computation of ABC are –

Step 1: Identify the various significant Activities within the Firm. Classify the Activities into :
Primary Activities and Secondary Activities.

Step 2: Relate the Overheads to the Activities using Resource Cost Drivers.

a) Overheads will be related to support and primary activities, using resource cost drivers (the quantity of resources used by an activity);

b) All costs will be identified under the activities, thus creating activity cost pools/activity cost buckets.

Step 3: Apportion the costs of Support Activities over the Primary Activities on suitable basis.

a) This is similar to re-appointment of service department expenses to production departments;

b) Cost of support activities are spread over to primary activities to collect cost only under the latter. For this purpose, the measure of how support activities are used , will form the allocation base. For example, canteen expenses will be apportioned based on the number of employees in the primary activities.

Step 4: Determine the Activity Cost Drivers for each Activity / Cost Pool.

a) Activity cost drivers are used to relate the OH collected in the cost pools to cost objects (products);

b) Activity cost drivers constitute the reason governing cost, i.e. casual factory for cost in each activity. This is based on the factor that drives the consumption of the activity, i.e., the answer to the question: What causes the activity to incur costs?

Step 5: Calculate Activity Cost Driver Rate = Total Cost of Activity (Cost Pool) ÷ Activity Cost Driver

Activity Cost Driver Rates are computed for each activity, just like overhead absorption rates.

This rate can be used – (i) to ascertain cost of products, [as in Traditional Absorption Costing], (ii) to ascertain cost of other cost objects such as customers/customer segments & distribution channels.

Step 6: Assign costs to the Cost objects using the formula

Resources Consumed x Activity Cost Driver Rate

20. **What are Cost Drivers? List three factors that are important in selecting cost drivers in Activity Based Costing System.**
Ans:
Meaning: Cost Drivers are characteristic of an event or activity that results in the incurrence of costs. In ABC system, the activity cost drivers are used for assigning the cost of activities to cost objects.

Considerations: Selection of Cost Drivers is dependent upon –
1. **Degree of Correlation**:

a) ABC System seeks to assign the costs of each activity to product lines on the basis of how each product line consumes the cost driver. So, the accuracy of resulting cost assignment depends on degree of correlation between consumption of activity and the consumption of cost drivers.

b) **Example**: If Inspection Cost is selected as an Activity cost Pool, the Cost Driver may be – i) the number of inspections, or ii) hours of inspection time. If every inspection requires the same amount of time for all products, then the number of inspections on a product line will be highly correlated with consumption of inspection activity by that product line. However, if inspection time significantly varies, hours of inspection time would be highly correlated with actual consumption of the inspection activity. Depending on the circumstances of the case, the appropriate Cost Driver should be chosen.

2. **Cost of Measurement:** Designing any information system entails cost benefit trade – offs. The more activity cost pools are in an ABC system, the greater will be the accuracy of the cost assignment but higher will be the costs of implementing and maintaining the system.

3. **Behavioural Effects:** Information systems have the potential not only to facilitate decisions but also to influence the bahaviour of decision makers. In identifying cost drivers, ABC analyst should consider the possible behavioural effects.

21. What are the steps involved in the installation of an Activity based Costing System?

Ans:

The introduction of an ABC system involves the following procedure –

a) **Specification of Objectives**: The objectives for pursuing an ABC system generally involve the following –

(i) To improve product costing where it is believed that existing methods under cost some products and over cost others, or

(ii) To identify non-value adding activities in the production process which might be a suitable focus for attention or elimination.

b) **Identification of Costs for ABC**: Direct costs, like materials and Direct Labour, are easily assigned directly to products. Product – specific Indirect Costs (e.g., specific advertising, dealer's commission), may be directly assigned to the product. Hence, the remaining indirect costs form the focus of ABC. Such costs are indirectly assigned to the cost object (i.e, product) via Cost Pools and Activity Drivers.

c) **Process Specification**: This involves identification of different stages of the production process, the commitment of resources to each process, processing times and bottlenecks. This provides a list of transactions which may, or may not, be defined as 'activities' at a subsequent stage.

d) **Activity Definition**: The list of transactions as identified in the previous stage is analysed to ensure aggregation or grouping of common activities and elimination of immaterial activities. Activities are categorized into Primary Activities and support activities. The resultant cost pools will likely have a number of different events, or drivers, associated with their incurrence.

e) **Activity Driver Selection**: Activity Cost Drivers used to relate the overheads collected in cost pools to cost objects (products) should be determined. Generally a single Driver is selected for every activity even through multiple and inter-related activity drivers may exist.

f) **Costing:** A single representative activity driver can be used to assign costs from the activity pools to the cost objects. Such linking of Total Costs to Cost Objects is based on the activity Cost Driver Rate.

g) **Staff Training:** The co-operation of the workforce is essential for successful implementation of ABC. Staff training should be oriented to create an awareness of the purpose of ABC.

h) **Review and Follow-up**: The actual operation of the ABC system should be closely monitored. Periodic Review and Follow-up action is necessary for successful implementation of the system.

22. Distinguish between Activity Based Costing (ABC) and Activity Based Management (ABM)

Ans:

ABC	ABM
1. ABC refers to the technique of determining the cost of activities and the cost of output produced by those activities	It refers to the management philosophy that focuses on the planning, execution and measurement of activities as a key to competitive advantage.
2. The aim of ABC is to generate improved cost data for use in managing a Company's activities	ABM is a much broader concept and aims to use information given by ABC, for effective business processes and profitability.
3. ABC is the operational segment of ABM	It is a conceptual aspect. i.e., management attitude.

23. Write short notes on Value Added and Non-Value Added activities

Ans:

Value Added Activities (VA)	Non-Value Added Activities (NVA)
1. These are activities necessary for the performance of the process	These are additional and extraneous activities, not fully necessary for the performance of the process.
2. These represent work that is valued by the external or internal customer	These represent work that is not valued by the external or internal customer.
3. They improve the quality or function of a product. Hence, the customers are usually willing to pay for the service. VA activities result in "costs" and not in losses.	NVA activities do not improve the quality or function of a product or service, but they can adversely affect costs and prices. NVA activities create waste, result in delay of some sort, add cost to the products or services for which the customer is not willing to pay.
4. **Example**: Making product more versatile for certain other uses	**Examples**: Expediting due to work delays, cost for re-work of defectives, etc.

24. What are the benefits of Activity Based Management?

Ans: **Activity Based Management**:

ABM currently being used for a variety of business applications. Such as:

a)   Cost reduction:

ABCM helps the organization to identify costs against activities and to find opportunities to streamline or reduce the costs or eliminate the entire activity, especially if there is no value added. It is particularly useful in identifying and quantifying process waste and providing vehicle for continuous process improvement through continuous cost reduction.

b)   Activity Based Budgeting:

Activity Based Budgeting analyse the resource input or cost for each activity. It provides a framework for estimating the amount of resources required in accordance with the budgeted level of activity. Actual results can be compared with budgeted results to highlight both in financial and non-financial terms those activities with major discrepancies from budget for potential reduction in supply of resources. It is a planning and control system which seeks to support the objectives of continuous improvement.

c)   Business process re-engineering:

Business process re-engineering involves examining business processes and making substantial changes to how organization currently operates. ABCM is a powerful tool for measuring business performance,

determining the cost of business output and is used as a means of identifying opportunities to improve process efficiency and effectiveness.

d) Benchmarking:

Determination of Benchmarking goal statement.

e) Performance measurement:

Many organizations are now focusing on activity performance as a means of facing competitors and managing costs. To monitor efficiency and effectiveness of activities performance measures are required. Activity performance measures consists of measures relating to costs, time, quality and innovation.

25. What is Value Chain Analysis?

Ans: **Value Chain Analysis**: Value Chain depicts how customer value accumulates along a chain of activities that lead to an end product or service. It is described as the internal processes or activities a company performs to design, produce, market, deliver and support its product.

Value Chain Analysis requires a strategic framework or focus for organizing internal and external information and for summarizing findings and recommendations. It requires a team effort. Management accountants of today has to collaborate with engineering, production, marketing, distribution and service professionals to focus on the strength, weakness, opportunities and threats identified in the value chain analysis results. This helps the firms to better understand which segments, distribution channels, price points, product differentiation, selling propositions will yield them the greatest competitive advantage. The analysis involves the following steps:

a) Internal cost analysis – to determine the sources of profitability and relative cost positions of internal value-creating processes.

b) Internal differentiation analysis – to understand the sources of differentiation within internal value creating processes.

c) Vertical linkage analysis – to understand the relationship and associated costs among external suppliers and customers in order to maximize the value delivered to customers and to minimize cost.

26. Define value chain and Industry Value Chain.

Ans:

Value Chain:

a) **Porter's Definition:** Value Chain is the series of internal processes or activities a Company performs, "to design, produce, market deliver and support its product". "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 economies of the activities themselves."

b) **Definition of John Shank and V.Govindarajan**: "The value Chain for any Firm is the value – creating activities all the way from basic raw material sources from component supplies through to the ultimate end-use product delivered into the final consumers' hands".

Industry Value Chain:

a) Industry Value Chain refers to the series of activities, which add value to the product supplied to the industry.

b) It starts with the value – creating processes of suppliers, who provide the basic raw materials and components.

c) It continues with the value creating processes of different classes of buyers or end-use consumers, and culminates in the disposal and recycling of materials.

27. How is the business activities classified for value chain analysis purpose?
Ans:
Porter classified business activities into – q) Primary or Line Activities, and 2) Support Activities.
1. **Primary Activities**: are directly involved in transforming inputs into outputs and delivery and after-sales support to output. They are handled by line functions in an organization. They include –
    a) Material handling and warehousing;
    b) Transforming inputs into final product;
    c) Order processing and distribution;
    d) Communication, pricing and channel management; and
    e) Installation, Repair and parts replacement.

2. **Support Activities**: are activities that support primary activities. They are handled by the organization's staff functions and include –
    a) Procurement – purchasing of Raw materials, Supplies and other Consumable Items as well as Assets.
    b) Technology Development – Know-how, Procedures and Technological inputs needed in every Value Chain activity.
    c) Human Resource management – Selection, promotion and placement, appraisal, rewards; management development; and labour/employee relations.
    d) Administration – general management, planning, finance accounting, legal, government affairs and quality management.

28. Write short note on Supply Chain Management?
Ans:
Supply Chain Management encompasses the planning and management of all activities involved in sourcing, procurement, conversion, and logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies. More recently, the loosely coupled, self organizing network of businesses that cooperates to provide product and service offerings has been called the **extended enterprise**

29. What are the basic components of Supply Chain Management?
Ans:
a) **Plan** – This is the strategic portion of SCM. You need a strategy for managing all the resources that go toward meeting customer demand for your product or service. A big piece of planning is developing a set of metrics to monitor the supply chain so that it is efficient, costs less and delivers high quality and value to customers.
b) **Source** – Choose the suppliers that will deliver the goods and services you need to create your product. Develop a set of pricing, delivery and payment processes with suppliers and create metrics for monitoring and improving the relationships. And put together processes for managing the inventory of goods and services you receive from suppliers, including receiving shipments, verifying them, transferring them to your manufacturing facilities and authorizing supplier payments.

c) **Make** – This is the manufacturing step. Schedule the activities necessary for production, testing, packaging and preparation for delivery. As the most metric-intensive portion of the supply chain, measure quality levels, production output and worker productivity.

d) **Deliver** – This is the part that many insiders refer to as logistics. Coordinate the receipt of orders from customers, develop a network of warehouses, pick carriers to get products to customers and set up an invoicing system to receive payments.

e) **Return** – The problem part of the supply chain. Create a network for receiving defective and excess products back from customers and supporting customers who have problems with delivered products.

30. What are the criteria for measuring successful implementation of Supply Chain Management?
Ans:
Supply chain metrics are the calculations by which an implementing organization can measure how successful they are in achieving their desired positioning within the competitive market space.

a) Perfect Order Fulfillment
b) Order Fulfillment Cycle Time
c) Upside Supply Chain Flexibility
d) Upside Supply Chain Adaptability
e) Downside Supply Chain Adaptability
f) Supply Chain Management Cost
g) Cost of Goods Sold
h) Cash-to-Cash Cycle Time
i) Return on Supply Chain Fixed Assets
j) Return on Working Capital

31. Distinguish Marginal Costing and Absorption Costing & Advantages and Disadvantages of Marginal Costing.
Ans: Marginal Costing and Absorption Costing & Advantages and Disadvantages of Marginal Costing:
Marginal cost is defined as the amount at any given volume of output by which aggregate costs are changed if the volume of output is increased or decreased by one unit. Marginal Cost is a constant ratio which may be expressed in terms of an amount per unit of output. On the other hand, fixed cost which is not normally traceable to particular units denotes a fixed amount of expenditure incurred during an accounting period. Fixed cost is, therefore, also called time cost, period cost, standby cost, capacity cost, or constant cost. Variable cost or marginal cost is also termed as direct cost, activity cost, volume cost or out-of-pocket cost.

Marginal costing is the ascertainment of marginal costs and of the effect on profit of changes in volume or type of output by differentiating between fixed costs and variable costs. Several other terms in use like direct costing, contributory costing, variable costing, comparative costing, differential costing and incremental costing are used more or less synonymously with marginal costing.

The other type of costing which includes fixed costs in the calculation of product costs is known as total costing, absorption costing, or conventional costing.

The term direct cost should not be confused with direct costing. In absorption costing, direct cost refers to the cost which is attributable to a cost centre of cost unit (e.g., direct labour, direct material and direct expenses including traceable fixed expenses, i.e., the fixed expense which are directly chargeable). In direct costing (or marginal costing), factory variable overhead is taken as a direct cost while in the absorption cost method, it is indirect cost.

Contribution or gross margin is the difference between sales and the marginal cost of sales. Marginal costing assumes that the contribution provides a pool out of which fixed cost is met; any surplus constitutes the profit or the net margin. Contribution margin is also termed marginal income, profit contribution, variable gross margin, marginal balance or contribution to fixed costs.

32. What is Contribution? And how contribution approach helps in business decisions?
Ans:
In common parlance, contribution is the reward for the efforts of the entrepreneur or owner of a business concern. From this, one can get in his mind that contribution means profit. But it is not so. Technically or in Costing terminology, contribution means not only profit but also fixed cost. That is why, it is defined as the amount recovered towards fixed cost and profit.

Contribution can be computed by subtracting variable cost from sales or by adding fixed costs and profit.
Symbolically, $C = S-V \rightarrow (1)$

Where C = Contribution
S = Selling Price
V = Variable cost
Also $C = F+P \rightarrow (2)$
Where, F = Fixed cost and P = Profit

From (1) and (2) above, we may deduce the following equation called Fundamental equation of Marginal costing i.e.,
$$S-V = F+P \rightarrow (3)$$

Contribution is helpful in determination of profitability of the products and / or priorities for profitability of the products. When there are two or more products, the product having more contribution is more profitable.

For example: The following are the three products with selling price and cost details:

Particulars	A	B	C
Selling price (Rs.)	10	15	20
Variable cost (Rs.)	5	7	10
Contribution (Rs.)	5	8	10

In the above example, one can say that the product 'C' is more profitable because, it has more contribution. This proposition of product having more contribution is more profitable is valid, as long as, there are no limitations on any factor of production. In this context, factors of production means, the

factors that are responsible for producing the products such as material, labour, machine hours, demand for sales etc.,

In case of limitation on any factor of production, the profitability of the product can not simply be determined by finding out the contribution of the unit, but it can be found out by ascertaining the contribution per unit of that factor of production which is limited in the given situation.

Continuing the example given above, it may be explained as follows:

The three products take same raw material. A takes 1 kg, B requires 2 kgs, C requires 5 kgs and the raw material is not abundant.

Then profitability of the above products is determined as follows:

$$\text{Profitability} = \left(\frac{Contribution}{Key\,Factor} \right)$$

A	B	C
$\left(\dfrac{5}{1} \right)$	$\left(\dfrac{8}{2} \right)$	$\left(\dfrac{10}{5} \right)$
Rs. 5	Rs. 4	Rs. 2

Now, product A is more profitable because it has more contribution per kg of material.

The key factor can also be called as scarce factor or Governing factor or Limiting factor or Constraining factor etc., Whatever may be the name, it indicates the limitation on the particular factor.

From the above, it is essentially understandable that contribution is helpful in determination of profitability of the products, priorities for profitability of the products and in particular, profitability when there is a limitation on any factor.

33. What is Profit Volume Ratio (P/V Ratio) Or Contribution Ratio? And state its uses.
Ans: First of all, a ratio is a statistical or mathematical tool with the help of which a relationship can be established between the variables of the same kind. Further, it may be expressed in different forms such as fractional form, quotient, percentage, decimal form, and proportional form.
 For example:

Gross profit ratio: It may be expressed as follows:

→ Gross profit is ¼th of sales

→ Sales is 4 times that of gross profit

→ Gross profit ratio is 25%

→ Gross profit is 0.25 of sales and lastly

→ Gross profit and sales are in the ratio of 1:4

So, P/V ratio or contribution ratio is association of two variables. From this, one may assume that it is the ratio of profit and sales. But it is not so. It is the ratio of Contribution to sales.

Symbolically,   P/V ratio $= \left(\dfrac{\text{Contribution}}{\text{Sales}} \right) \times 100$ → (1)

$$\Rightarrow \text{P/V ratio} = \left(\dfrac{C}{S} \times 100 \right)$$

$$\Rightarrow \text{Contribution} = \text{Sales x P/V ratio} \rightarrow (2)$$

$$\Rightarrow \text{Sales} = \left(\dfrac{Contribution}{P\,/\,V\,ratio} \right) \rightarrow (3)$$

When cost or accounting data is given for two periods, then:

$$\text{P/V ratio} = \left(\dfrac{Change\ in Contribution}{Change\ in\ sales} \times 100 \right) \text{ or}$$

$$\text{P/V ratio} = \left(\dfrac{Change\ in\ profit}{Change\ in\ sales} \times 100 \right)$$

Since sales consists of variable costs and contribution, given the variable cost ratio , P/V ratio can be found out. Similarly, given the P/V ratio, variable cost ratio can be found out.

For example, P/V ratio is 40%, then variable cost ratio is 60%, given variable cost ratio is 70%, then P/V ratio is 30%. Such a relationship is called complementary relationship. Thus P/V ratio and variable cost ratios are said to be complements of each other.

P/V ratio is also useful like contribution for determination of profitability of the products as well as the priorities for profitability of the products. In particular, it is useful in determination of profitability of the products in the following two situations:

i)   When sales potential in value is limited.
ii)   When there is a greater demand for the products.

34. Discuss Break Even Analysis or Cost – Volume - Profit (CVP) Analysis:
Ans: When someone asks a layman about his business he may reply that it is alright. But a technical man may reply that it is break even. So, Break even means the volume of production or sales where there is no profit or loss. In other words, Break-even point is the volume of production or sales where total costs are equal to revenue. It helps in finding out the relationship of costs and revenues to output. In understanding

the Break-even , Cost, Volume and Profit are always used. The break even analysis is used to answer many questions of the management in day to day business. It is clearly understood by way of charts to know the changes in profit due to changes in costs and output. Therefore it can also be called Cost-Volume-Profit Analysis [CVP Analysis]. It is said by Gitman in his book, "Financial Management", that the Cost-Volume-Profit Analysis, Break even Analysis and Profit Graphs are interchangeable words. The formal break even
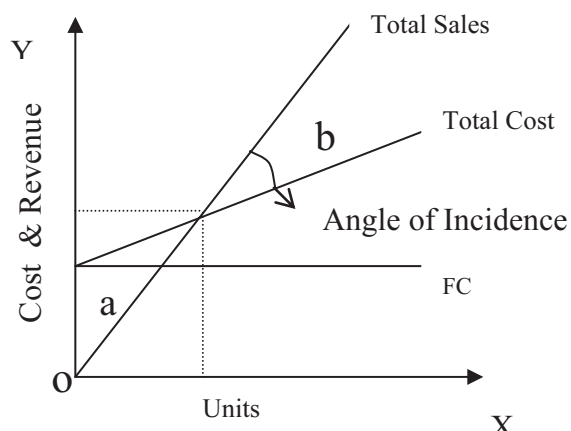
chart is as follows:
   a = Losses, b = Profits

ANGLE OF INCIDENCE:
Angle of Incidence is an angle formed at the intersection point of total sales line and total cost line in a formal break even chart. If the angle is larger, the rate of growth of profit is higher and if the angle is lower, the rate of growth of profit is lower.

The change in profit can be studied through Break even charts in different situations in the following manner:

i) **Increase in No. of Units**
--- = Change in total sales or total cost
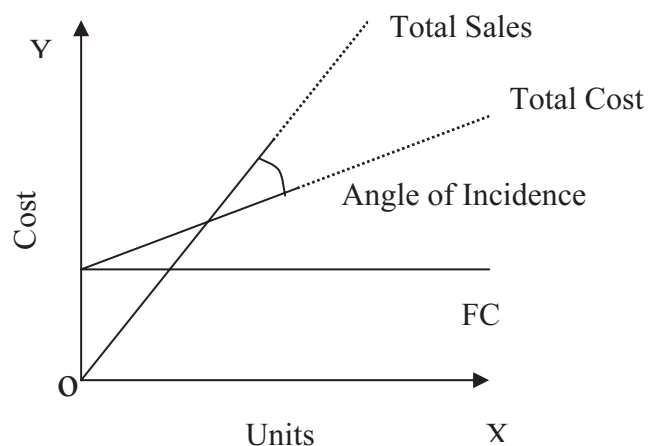
There is no change in BEP even if there is increase or decrease in number of units.

ii) Increase in Sales due to increase in selling price.

NTS = New Total Sales line

If there is change in selling price, BEP also changes. If selling price is increased then BEP decreases. If selling price is decreased then BEP increases. Thus there is inverse relationship between selling price and BEP.

iii) Decrease in variable cost:
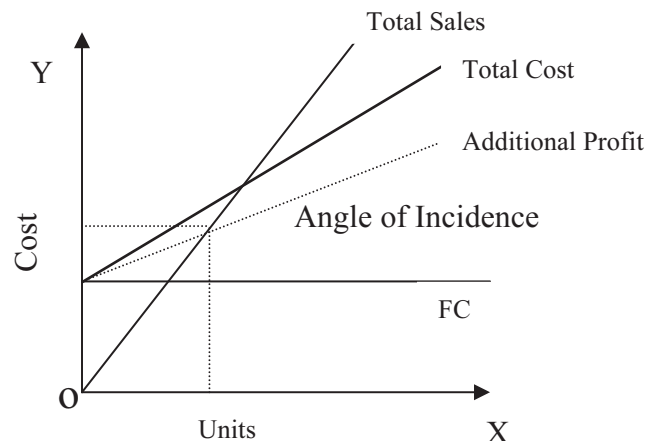
If there is change in variable cost then BEP also changes. If variable cost is decreased then BEP also decreases. If variable cost is increased then BEP also increases. Thus there is direct relationship between variable cost and BEP.

iv) Change in fixed cost:
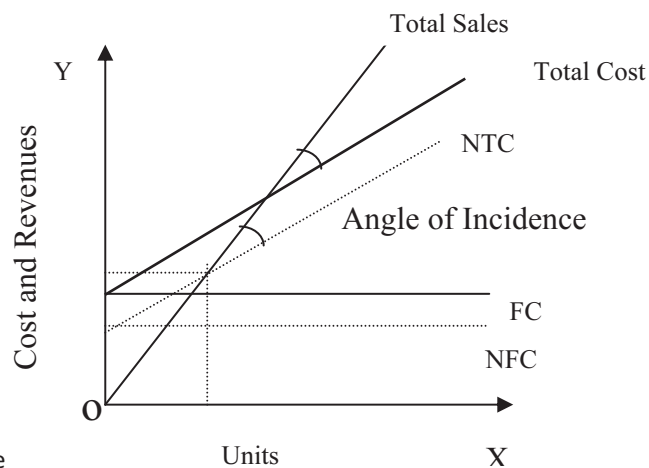
NTC = New Total Cost Line

NFC = New Fixed Cost Line

If fixed cost is increased then BEP also increases. If fixed cost is decreased then BEP also decreases. Thus there is a direct relationship between fixed cost and BEP.

Non linear Break even Chart:
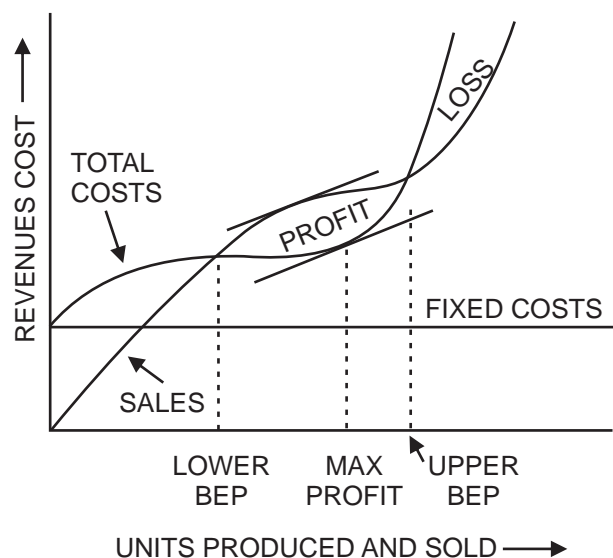
In some cases on account of non-linear behaviour of cost and sales there may be two or more break even points. In such a case the optimum profit is earned where the difference between the sales and the total costs is the largest. It is obvious that the business should produce only upto this level. This is being illustrated in the above chart.

COMPUTATION OF BREAK EVEN POINT:

$$\text{Break Even Point in value} = \frac{F \times S}{S - V} \quad \rightarrow (1)$$

$$= \frac{F \times S}{C} \quad \rightarrow (2)$$

$$= \frac{F \times S}{F + P} \quad \rightarrow (3)$$

$$= \frac{F}{P.V. \, Ratio} \quad \rightarrow (4)$$

$$= \frac{F}{C/S} \quad \text{or}$$

$$= \frac{F}{\dfrac{S-V}{S}} \text{ or}$$

$$= \frac{F}{1 - \dfrac{V}{S}} \rightarrow (5)$$

$$\text{Break Even Point} = \frac{\text{Fixed Cost}}{\text{Contribution per Unit}}$$

Proof for basic break-even:

Let, V be the variable cost per unit

Let U be the volume of output i.e., No. of units

Let P be the Profit

Let F be the Fixed Cost

Let S be the Selling Price

By substituting the notations in general sales equation:

Sales = F + V+ P

SU = F + VU + P

at Break Even, SU = F +VU (Since P = 0)

➔ SU – VU = F

➔ U(S – V) = F

➔ U = $\dfrac{F}{S-V}$

OR

$$\text{No. of Units} = \frac{\text{Fixed Cost}}{\text{Contribution per unit}}$$

$$SU \, (Sales) = \frac{F \times S}{S - V}$$

35. What are the Uses, Applications of Break even Analysis (Or) Profit Charts (Or) Cost Volume Profit Analysis?

Ans: Uses, Applications of Break even Analysis (Or) Profit Charts (Or) Cost Volume Profit Analysis: The important uses to which cost-volume profit analysis and break-even and profit charts may be put to:

a) Forecasting costs and profits as a result of change in Volume Determination of costs, revenue and Variable cost per unit at various levels of output.

b) Fixation of sales Volume level to earn or cover given revenue, return on capital employed orates of dividend.

c) Determination of effect of change in Volume due to plant expansion or acceptance of order, with or without increase in costs or in other words, determination of the quantum of profit to be obtained with increased or decreased Volume of sales.

d) Determination of comparative profitability of each product line, project or profit plan.

e) Suggestion for shift in sales mix.

f) Determination of optimum sales volume.

g) Evaluating the effect of reduction or increase in price, or price differentiation in different markets.

h) Highlighting the impact of increase or decrease in fixed and variable costs on profit.

i) Studying the effect of costs having a high proportion of fixed costs and low variable costs and vice-versa.

j) Inter-firm comparison of profitability.

k) Determination of sale price which would give a desired profit bar break-even.

l) Determination of the cash requirements as a desired volume of output, with the help of cash break-even charts.

m) Break-even analysis emphasizes the importance of capacity utilization for achieving economy.

n) During severe recession, the comparative effects of a shutdown or continued operation at a loss is indicated.

o) The effect on total cost of a change in the fixed overhead is more clearly demonstrated through break-even charts.

36. What are the Limitations of Break even Analysis?

Ans:

a) That Costs are either fixed or variable and all costs are clearly segregated into their fixed and variable elements. This cannot possibly be done accurately and the difficulties and compilations involved in such segregation make the break-even point inaccurate.

b) That the behavior of both costs and revenue is not entirely related to changes in volume.

c) That costs and revenue patterns are linear over levels of output being considered. In practice, this is not always so and the linear relationship is true only within a short run relevant range.

d) That fixed costs remain constant and variable costs vary in proportion to the Volume. Fixed costs are constant only within a limited range and are liable to change at varying levels of activity and also over a long period, particularly when additional plants and equipments are introduced.

e) That sales mix is constant or only one product is manufactured. A combined analysis taking all the products of the mix does not reflect the correct position regarding individual products.

f) That production and sales figures are identical or the change in opening and closing stocks of the finished product is not significant.

g) That the units of production on the various product line are identical. Otherwise, it is difficult to find a homogeneous factory to represent volume.

h) That the activities and productivity of the concern remain unchanged during the period of study.

i) That as output is continuously varied within a limited range, the contribution margin remains relatively constant. This is possible mainly where the output is more or less homogeneous as in the case of process industries.

Objective and Bit Questions:

37. _____ is a structured approach to defining customer needs or requirements and translating them into specific plans to produce products to meet those needs.
38. QFD requires that the _____ needs are identified.
39. Product planning, Assembly / Part deployment, process planning. Process / Quality control are phases of _____.
40. _____ is an extremely useful methodology to facilitate communication, planning and decision making with in a product development team.
41. _____ = $\dfrac{performance + capability}{cost}$ (or) $\dfrac{function}{cost}$
42. Value analysis classifies functions into _____ and _____
43. Value has four different meanings, such as _____, _____, _____, _____.
44. _____ function of value analysis can not be changed.
45. Value analysis evolved into _____.
46. _____ is a philosophy in which product development.
47. Target costing is also called as _____.
48. _____ = Target price – Target profit.
49. _____ is a structured approach for determining the cost at which a product with a specific functionality and quality must be produced to generate the desired level of profitability.
50. Target cost enables are _____ , _____
51. Target cost for producer + Target cost for consumer can be stated as _____.
52. Life cycle costing (LCC) also called _____
53. _____ is accountable for any decision relating to the cost of a project or programme.
54. _____ techniques allow evaluation of competing proposals on the basis of through life costs.
55. _____ = acquisition Cost + Operational / Maintenance Cost + Disposal Cost.
56. _____ is a central to LCC analysis.
57. People prefer to receive goods and services now rather than later. This is known as _
58. _____ is a method of preparing income statements that separates variable costs from fixed cost in order to emphasize the importance of cost behavior patterns for purpose of planning and control.
59. _____ is a study of the interrelationships of costs and volume and its impact on profit.
60. _____ states that the more times a task has been performed, the less time will be required on each subsequent iteration.
61. _____ is broader in scope than the learning curve effect encompassing for more than just labour time.
62. The emergence of strategic cost management (SCM) results from blending of _____, _____, _____.
63. _____ encompasses the planning and management of all activities involved in sourcing, procurement, conversion, and logistics management activities.
64. Self organizing network of businesses that co-operates to provide product and service offerings has been called the _____.

65. Five Basic components of supply chain management include _____, _____, _____, _____, _____.

66. _____ is a clever way of describing everyone who contributes to a product.

Answers to Objective and Bit Questions:

37. Quality Function Deployment (QFD)
38. Basic Customer needs
39. Quality Function Deployment
40. Quality Function Deployment
41. Value
42. Basic Function, Supporting function
43. Cost Value, use value, Esteem Value, Exchange value
44. Basic function
45. Value Analysis evolved into FAST.
46. Target cost Management.
47. Price – led costing
48. Target Cost
49. Target costing
50. Quality Function Deployment, Functional Analysis.
51. Target life cycle cost
52. Whole life costing
53. Investment decision maker.
54. LCC
55. LCC
56. CBS
57. Time preference
58. Contribution approach
59. Break even analysis
60. Learning curve effect
61. Experience curve effect
62. Value chain Analysis, strategic positioning Analysis, Cost driver analysis.
63. Supply chain management
64. Extended enterprise
65. Plan, source, make deliver, return
66. Extended supply chain.

PROBLEMS AND SOLUTIONS: LEARNING CURVE

Problem No.1.

The usual learning curve model is $Y = ax^b$ where

Y is the average time per unit for x units.

a is the time for first unit

x is the cumulative number of units

b is the learning coefficient and is

$$\text{equal to } \frac{\log 0.8}{\log 2} = -0.322 \text{ fo a learning rate of } 80\%$$

Given that a = 10 hours and learning rare 80%, you are required to Calculate:

(i)   The average time for 20 units.

(ii)   The total time for 30 units.

(iii)   The time for units 31 to 40.

Given that   log 2 = 0.301, Antilog of 0.5811 = 3.812

log 3 = 0.4771,Antilog of 0.5244 = 3.345.

log 4 = 0.6021,Antilog of 0.4841 = 3.049.

Solution:

i) $Y = AX^b$

Y = 10(20)$^{-0.322}$

Taking log on both sides

Logy = log 10 + log 20$^{(-0.322)}$

Logy = log 10 – (0.322) log 20

= 1 – (0.322) log 20

= 1- (0.322) x (1.3010)

= 1-0.41892 = 0.5811

Log y = 0.5811

Y = Anti log (0.5811) = 3.812 hrs (average time)

ii)   Log y = log 10 + log 30$^{(-0.322)}$

Log y = 1-(0.322) x (1.4771)

= 1 - (0.4756) = 0.5244

Y = anti log (0.5244) = 3.345 hrs (average time)

Total time = 3.345 x 30 = 100.35 hrs

iii) Log y = log 10 + log40$^{(-0.322)}$

= 1-(0.322) x (1.6021)

Log y = 0.4841

Y = anti log (0.4841) = 3.049hrs

Total time = 40 x 3.049 = 121.96hrs

Time from 31 to 40 units = 121.96 – (100.35) = 21.61hrs

Problem No.2.

The learning curve as a management accounting has now become or going to become an accepted tool in industry, for its applications are almost unlimited. When it is used correctly, it can lead to increase business and higher profits; when used without proper knowledge, it can lead to lost business and bankruptcy. State precisely:

    (i)   Your understanding of the learning curve:
    (ii)   The theory of learning curve;
    (iii) The areas where learning curves may assist in management accounting; and
    (iv) Illustrate the use of learning curves for calculating the expected average units cost of making.
 (a) 4 machines   (b) 8 machines

Using the data below:

Data:

Direct Labour need to make first machine	= 1000 hrs.
Learning curve	= 90%
Direct Labour cost	= Rs.15/- per hour.
Direct materials cost	= Rs.1,50,000
Fixed cost for either size orders	= Rs.60,000.

Solution

Statement showing computation of cost of making 4 machines&8 machines:

No of machines	Average time	Labour cost	Material	Fixed cost	Total
	Hours	Rs.	Rs.	Rs.	Rs.
1	1000	15000	150000	60000	225000
2	900	13500	150000	30000	193500
4	810	12150	150000	15000	177150
8	729	10935	150000	7500	168435

Average cost of making 4 machines Rs.177150
 Average cost of making 8 machines Rs.168435

Problem No.3.

Z.P.L.C experience difficulty in its budgeting process because it finds it necessary to qualify the learning effect as new products are introduced.

Substantial product changes occur and result in the need for retraining.

An order for 30 units of a new product has been received by Z.P.L.C So far, 14 have been completed; the first unit required 40 direct labour hours and a total of 240 direct labour has been recorded for the 14 units. The production manager expects an 80% learning effect for this type of work.

The company use standard absorption costing. The direct costs attributed to the centre in which the unit is manufactured and its direct materials costs are as follows:

		Rs.
	Direct material	30.00 per unit.
	Direct Labour	6.00 per hour.
	Variable overhead	0.50 per direct labour hour.
	Fixed overhead	6,000 per four-week operating period.

There are ten direct employees working a five-day week, eight hours per day. Personal and other downtime allowances account for 25% of total available time.

The company usually quotes a four-week delivery period for orders.

You are required to:

(i) Determine whether the assumption of an 80% learning effect is a reasonable one in this case, by using the standard formula $y = ax^b$

Where Y = the cumulative average direct labour time per unit (productivity)

       a = the average labour time per unit for the first batch.

       x = the cumulative number of batches produced.

       b = the index of learning.

(ii) Calculate the number of direct labour hours likely to be required for an expected second order of 20 units.

(iii) Use the cost data given to produce an estimated product cost for the initial order, examine the problems which may be created for budgeting by the presence of the learning effect.

Solution:

(i)   **Total time taken to produce 14 units**

$$Y = ab^x$$

$$Y = 40 (14)^{-0.322}$$

$$= 17.14$$

Total time = 17.14 x 14   = 239.96

                               = 240 hours

It is true that learning ratio 80% is effective.

(ii)   **30 units**

$$Y = 40 (30)^{-0.322} = 13.380 \text{ hours (Average time)}$$

       50 units

$$Y = 40 (50)^{-0.322} = 11.35 \text{ hours (Average time)}$$

Total time for 30 units = 13.38 x 30 = 401.4 hours

Total time for 50 units = 11.35 x 50 = 567.5 hours

Time taken for 20 units from 31 to 50 units (567.5 – 401.4) = 166.1 hours

(iii)

Man hours = 10 x 8 x 5 x 4	=	1600
(-) down time	=	400
		1200

Fixed Cost per hour = 6000/1200 = Rs. 5

Computation of total cost for the initial order

		Rs.
Material (30 x 30)	=	900.0
Labour (401.4 x 6)	=	2408.4
Variable Overheads (0.5 x 401.4)	=	200.7
Fixed Overheads (5 x 401.4)	=	2007.0
	=	5516.1

Problem No.4.

A firm received an order to make and supply eight units of standard product which involves intricate labour operations. The first unit was made in 10 hours. It is understood that this type of operations is subject to 80% learning rate. The workers are getting a wages rate of Rs. 12 per hour.

(i)   What is the total time and labour cost required to execute the above order?

(ii) If a repeat order of 24 units is also received from the same customer, what is the labour cost necessary for the second order?

Solution:

80% Learning Curve results are given below:

Production (Units)	Cumulative Average Time (hours)	Total Time (hours)
1	10	10
2	8	16
4	6.4	25.6
8	5.12	40.96
16	4.096	65.54
32	3.2768	104.86

Labour time required for first eight units = 40.96 hours

Labour cost required for 8 units = 40.96 hours x Rs. 12/hr = Rs. 491.52

Labour time for 32 units = 104.86 hours

Labour time for first eight units = 40.96 hours

Labour time required for 2^{nd} order for 24 units = 36.90 hours

Labour cost for 24 units = 63.90 hours x Rs. 12/hr = Rs. 766.80

ACTIVITY BASED COSTING

Problem No.5.

The budgeted overheads and cost driver volumes of XYZ are as follows.

Cost Pool	Budgeted Overheads (Rs)	Cost Driver	Budgeted Volume
Material procurement	5,80,000	No. of orders	1,100
Material handling	2,50,000	No. of movements	680
Set-up	4,15,000	No. of set ups	520
Maintenance	9,70,000	Maintenance hours	8,400
Quality control	1,76,000	No. of inspection	900
Machinery	7,20,000	No. of machine hours	24,000

The company has produced a batch of 2,600 components of AX-15, its material cost was Rs. 1,30,000 and labor cost Rs. 2,45,000. The usage activities of the said batch are as follows.

Material orders – 26, maintenance hours – 690, material movements – 18, inspection – 28, set ups – 25, machine hours – 1,800

Calculate – cost driver rates that are used for tracing appropriate amount of overheads to the said batch and ascertain the cost of batch of components using activity Based Costing.

Solution:
Computation of Cost Driver Rates

	Particulars		Amount (Rs.)
1.	Material procurement	580000/1100	527
2.	Material handing	250000/680	368
3.	Set-up	415000/520	798
4.	Maintenance	970000/8400	115
5.	Quality control		196
6.	Machinery	720000/24000	30

Computation of Batch Cost of 2600 units of AX-15

		Rs.
Material cost		1,30,000
Labour Cost		2,45,000
Prime Cost		3,75,000
Add: Overheads		
Material orders 26 x 527	13,702	
Material handling 18 x 368	6,624	
Set-up 25 x 798	19,950	
Maintenance 690 x 115	79,350	
Quality Control 28 x 196	5,488	
Machinery 1800 x 30	54,000	1,79,114
Total Cost		**5,54,114**

Problem No.6.

A company produces four products, viz. P, Q, R and S. The data relating to production activity are as under

Product	Quantity of production	Material cost/unit Rs.	Direct labour hours/unit	Machine hours/unit	Direct Labour cost/unit Rs.
P	1,000	10	1	0.50	6
Q	10,000	10	1	0.50	6
R	1,200	32	4	2.00	24
S	14,000	34	3	3.00	18

Production overheads are as under: Rs.

(i)	Overheads applicable to machine oriented activity:	1,49,700
(ii)	Overheads relating to ordering materials	7,680
(iii)	Set up costs	17,400
(iv)	Administration overheads for spare parts	34,380
(v)	Material handling costs	30,294

The following further information have been compiled:

Product	No. of set up	No. of materials orders	No. of times materials handled	No. of spare parts
P	3	3	6	6
Q	18	12	30	15
R	5	3	9	3
S	24	12	36	12

Required:

i) Select a suitable cost driver for each item of overhead expense and calculate the cost per unit of cost driver.

ii) Using the concept of activity based costing, compute the factory cost per unit of each product.

Solution:

Computation of Cost Driver Rates

1) Overheads relating to Machinery oriented activity

Cost Driver → Machine Hour Rate

$$(1000 \times 0.5) + (1000 \times 0.5) + (1200 \times 2) + (14000 \times 3)$$

1,49,700/49,900 = Rs. 3 per hour

2) Overheads relating to ordering materials

Cost driver → No. of Material orders

7680/30 = Rs. 256 per order

3) Set up costs

Cost driver → No. of set ups

17400/50 = Rs.348 per set up

4) Administrative Overheads for spare parts

Cost driver → No. of spare parts

34380/36 = Rs. 955 per spare part.

5) Material Handling costs

Cost driver → No. of times materials handled

30294/81 = Rs. 374 per material handling

Computation of factory cost for each product

	P		Q		R		S	
Materials		10.00		10.00		32.00		34.00
Labour		6.00		6.00		24.00		18.00
Overheads								
Machine oriented activity	1.500		1.50		6.00		9.00	
Ordering of Materials	0.768		0.31		0.64		0.22	
Set up costs	1.044		0.63		1.45		0.60	
Administrative Spare Parts	5.730		1.43		2.39		0.82	
Material handling	2.244	11.29	1.12	4.99	2.81	13.29	0.96	11.60
Factory Cost (Rs)		**27.29**		**20.99**		**69.29**		**63.60**

Problem No.7.

Precision Auto comp Ltd. Manufactures and sells two automobile components A and B. Both are identical with slight variation in design. Although the market for both the products is the same, the market share of the company for product A is very high and that of product B very low. The company's accountant has prepared the following profitability statement for the two products Cost of production: (same for both the products)

Direct Material	Rs.	125
Dirbect Labour	Rs.	24
Direct Expenses (sub-contract charges)	Rs.	36
Overheads (400% of direct labour)	Rs.	96
Total Cost	Rs.	281

		Product A	Product B	Total
Quantity sold	No.	1,24,000	23,150	1,47,150
Unit sale price	Rs.	300	290	
Total sales realisation	Rs.			4,39,13,500
Cost of sales as above	Rs.			4,13,49,150
Margin	Rs.			25,64,350

The company's marketing manager, after attending a workshop on activity-based costing challenges the accountant's figures. The nearest competitor's prices for the two products are Rs. 330 and Rs. 275 per unit respectively and, if the company can match the competitor's prices, it can sell 75,000 nos. each of the two products. The Production Manager confirms that he can produce this product mix with the existing facilities. The management engages you as consultant, and the following facts have been identified by you:

(a) product A undergoes 5 operations and product B undergoes two operations by sub-contractors, although the total subcontract charges are the same for both the products, and

(b) 75% of the overheads is accounted for by three major heads relating to sub-contracting operations, *viz.,* ordering, inspection and movement of components, to and from the sub-contractor's works.

Prepare a revised profitability statement to find out if the marketing manager's proposal is viable.

Solution:

Total overheads = 1,47,150 x 96   =   Rs.1,41,26,400

Operations overhead = 1,41,26,400 x 75/100   =   Rs.1,05,94,800

Balance 25% assumed to be fixed i.e. Rs. 35,31,600

Allocation of Variable Overheads under ABC

A   =   1,05,94,800 x 5/7 =   Rs.75,67,714

B   =   1,05,94,800 x 2/7 =   Rs.30,27,086

Statement showing computation profit under Activity Based Costing as per Manager's suggestion:

		A		B		Total
No. of units		Units	75000	Units	75000	
Materials	Rs.	125	93,75,000	125	93,75,000	1,87,50,000
Labour	Rs.	24	18,00,000	24	18,00,000	36,00,000
Direct expenses	Rs.	36	27,00,000	36	27,00,000	54,00,000
Prime Cost	Rs.	185	1,38,75,000	185	1,38,75,000	2,77,50,000
Variable Overheads	Rs.	101	75,67,714	41	30,27,086	1,05,94,800
Fixed Overheads	Rs.	24	17,65,800	24	17,65,800	35,31,600
Total Cost	Rs.	310	2,32,08,514	250	1,86,67,886	4,18,76,400
Profit	Rs.	30	15,41,486	25	19,57,114	34,98,600
Sales	Rs.	330	2,47,50,000	275	2,06,25,000	4,53,75,000

As the profit is more at the Marketing Manager's proposal by Rs. 9,34,250 and hence this proposal may be accepted.

Problem No.8.

Relevant data relating to a company are:

		Products			
		P	Q	R	Total
Production and sales (units)		60,000	40,000	16,000	
Raw material usage in units		10	10	22	
Raw material costs	Rs.	50	40	22	24,76,000
Direct labour hours		2.5	4	2	3,42,000
Machine hours		2.5	2	4	2,94,000
Direct labour costs	Rs.	16	24	12	
No. of production runs		6	14	40	60
No. of deliveries		18	6	40	64
No. of receipts		60	140	880	1,080
No. of production orders		30	20	50	100

Overheads: **Rs.**

Setup   60,000

Machines   15,20,000

Receiving   8,70,000

Packing   5,00,000

Engineering   7,46,000

The company operates a JIT inventory policy and receives each component once per production run.

Required:

i) Compute the product cost based on direct labour-hour recovery rate of overheads.

ii) Compute the product cost using activity based costing.

Solution:

(i)

Traditional Method of absorption of overhead i.e. on the basis of Direct Labour Hours

$$Total\ overheads = \frac{36,96,000}{Hours\ (60000 \times 2.5) + (400000 \times 4) + (160000 \times 3)}$$

$$= \frac{36,96,000}{3,42,000} = Rs.\ 10.81\ per\ labour\ hour$$

Calculation of Factory cost of the products

	P	Q	R
	Rs.	Rs.	Rs.
Raw Material	50=000	40=00	22=00
Direct Labour	16=000	24=00	12=00
Overheads (2.5 x 10.81)	27=025	43=24	21=62
Factory cost	**93=000**	**107=24**	**55=62**

(ii) **Under Activity Based Costing System**

Computation of Cost Drivers Rates.

1) Set up cost : Cost driver → No. of Production run

60000/60 = Rs. 1000/per run

2) Machines : Cost driver → Machine hour rate

15,20,000/2,94,000 = Rs. 5.17 per Machine hour rate

3) Receiving cost: Cost driver → No. of Receipts

8,70,000/1080 = Rs. 805.56

4) Packing : Cost driver → No. of deliveries

5,00,000/64 = Rs. 7812.5 per delivery

5) Engineering: Cost driver → No. of Production order

7,46,000/100 = Rs. 7,460 per order

Calculation of Factory Cost per unit of Production

	P		Q		R	
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Materials		50.00		40.00		22.00
Direct Labour		16.00		24.00		12.00
Overheads						
Setup cost	0.10		0.35		2.50	
Machines	12.93		10.34		20.68	
Receiving cost	0.81		2.82		44.31	
Packing	2.34		1.17		19.53	
Engineering	3.73	19.91	3.73	18.41	23.31	110.33
Factory Cost		**85.91**		**82.41**		**144.33**

Problem No.9.

Trimake Limited makes three main products, using broadly the same production methods and equipment for each. A conventional product costing system is used at present, although an Activity Based Costing (ABC) system is being considered. Details of the three products, for typical period are:

	Labour Hours per unit	Machine Hours per unit	Material Per unit	Volumes Units
Product X	½	1 ½	Rs. 20	750
Product Y	1 ½	1	12	1,250
Product Z	1	3	25	7,000

Direct labour costs Rs. 6 per hour and production overheads are absorbed on a machine hour basis. The rate for the period is Rs. 28 per machine hour.

You are required:

(a) to calculate the cost per unit for each product using conventional methods.

Further analysis shows that the total of production overheads can be divided as follows

	%
Costs relating to set-ups	35
Costs relating to machinery	20
Costs relating to materials handling	15
Costs relating to inspection	30
Total production overhead	100%

The following activity volumes are associated with the product line for the period as a whole.

Total activities for the period

	Number of Set-ups	Number of movements of materials	Number of Inspections
Product X	75	12	150
Product Y	115	21	180
Product Z	480	87	670
	670	120	1,000

You are required:

b) To calculate the cost per unit for each product using ABC principles; c) to comment on the reasons for any differences in the costs in your answers to (a) and (b)

Solution:

(a)   Computation of cost per unit using Conventional Methods:

Total overheads Rs.

X	= 750 x 1.5 x 28	=	31,500
Y	= 1250 x 1 x 28	=	35,000
Z	= 7000 x 3 x 28	=	5,88,000
			6,54,500

Computation of Cost

	X	Y	Z
	Rs.	Rs.	Rs.
Materials	20	12	25
Labour	3	9	6
Overheads	42	28	84
Factory Cost	**65**	**49**	**115**

(b) **Under ABC Costing**

		Setup Cost	Machine Cost	Machine Handling Cost	Inspection Expenses	Total
Costs	Rs.	2,29,075	1,30,900	98,175	1,96,350	6,54,500
Cost Driver		No. of setups	Machine hours	No. of Moment of Materials	No. of Inspections	
Cost driver rates	Rs.	341.90	5.6	818.125	196.35	
		(229075/670)	(130900/23375)	(98,175/120)	(196350/1000)	

Cost per unit under ABC costing

	X		Y		Z	
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Materials		20.00		12.00		25.00
Labour		3.00		9.00		6.00
Overheads						
Setup Cost	34.19		31.45		23.44	
Machine cost	8.40		5.60		16.80	
Machine Handling Cost	13.09		13.74		10.17	
Inspection Cost	39.27	94.95	28.27	79.06	18.79	69.20
Total Cost		**117.95**		**100.06**		**100.20**

MARGINAL COSTING

Problem No.10.

Accelerate Co. Ltd., manufactures and sells four types of products under the brand names of A, B, C AND D. The sales mix in value comprises 33 1/3%, 41 2/3%, 16 2/3% and 8 1/3% of products A,B,C and D respectively. The total budgeted sales (100% are Rs.60,000 p.m.). Operating Costs are:

Variable Costs:

Product A 60% of selling Price

Product B 68% of selling Price

Product C 80% of selling Price

Product D 40% of selling Price

Fixed Costs: Rs.14,700 p.m.

(a) Calculate the break-even-point for the products on overall basis and

(b) Also calculate break-even-point, if the sales mix is changed as follows the total sales per month remaining the same.

(Mix: - A - 25% : B - 40% : C - 30%:   D - 5%)

Solution:

(a) Statement showing computation of break even point on overall basis:

		A	B	C	D	TOTAL
a) Sales	Rs.	20000	25000	10000	5000	60000
b) Variable cost	Rs.	12000	17000	8000	2000	39000
c) Contribution	Rs.	8000	8000	2000	3000	21000
d) Fixed cost	Rs.					14700
e) Profit	Rs.					6300
f) P/V ratio	%	40%	32%	20%	60%	35%
g) Break even sales	Rs.			14700/35% =		42000

(b) Statement showing computation of break even point if the sales mix is changed:

		A	B	C	D	TOTAL
Sales	Rs.	15000	24000	18000	3000	60000
Variable cost	Rs.	9000	16320	14400	1200	40920
Contribution	Rs.	6000	7680	3600	1800	19080
Fixed cost	Rs.					14700
P/V ratio	%	40%	32%	20%	60%	(19080/60000) x 100 = 31.8%
Break even sales	Rs.					14700/31.8% = 46266

Problem No.11.

A Co. currently operating at 80% capacity has the following; profitability particulars:

	Rs.	Rs
Sales		12,80,000
Costs:		
Direct Materials	4,00,000	
Direct labour	1,60,000	
Variable Overheads	80,000	
Fixed Overheads	5,20,000	11,60,000
Profit		1,20,000

An export order has been received that would utilise half the capacity of the factory. The order has either to be taken in full and executed at 10% below the normal domestic prices, or rejected totally. The alternatives available to the management are given below:

a) Reject order and Continue with the domestic sales only, as at present;

b) Accept; order, split capacity equally between overseas and domestic sales and turn away excess domestic demand;

c) Increase capacity so as to accept the export order and maintain the present domestic sales by:
   i)   buying an equipment that will increase capacity by 10% and fixed cost by Rs.40,000 and
   ii)   Work overtime a time and a half to meet balance of required capacity.

Prepare comparative statements of profitability and suggest the best

Solution:

Statement showing computation of comparative profit of different alternatives:

	80% capacity	100% capacity	130% capacity
	(Rs.)	(Rs.)	(Rs.)
Sales	1280000	800000 + 720000	1280000 + 720000
Variable cost:			
Material	400000	500000	650000
Direct labour	160000	200000	260000
Variable OHs	80000	100000	130000
Overtime premium			20000
	640000	800000	1060000
Contribution	640000	720000	940000
Fixed cost	(520000)	(520000)	(560000)
Profit	120000	200000	380000

From the above computations we find that the profit is more at alternative III i.e., accepting the foreign order fully & maintaining the present domestic sales.

Problem No.12.

A practicing Cost and Management Accountant now spends Rs.0.90 per K.m on taxi fares for his client's work. He is considering to other alternatives the purchase of a new small car or an old bigger car.

Item	New Small Car	Old Bigger Car
	(Rs.)	(Rs.)
Purchase price	35,000	20,000
Sale price after 5 years	19,000	12,000
Repairs and servicing per annum	1,000	1,200
Taxes and insurance p.a.	1,700	700
Petrol consumption per liter(k.m.)	10	7
Petrol price per liter	3.5	3.5

He estimates that he does 10,000 K.m annually. Which of the three alternatives will be cheaper? If his practice expands he has to do 19,000 Km p.a will be cost of the two cars break even and why? Ignore interest and Income-tax.

Solution:

Statement showing computation of break-even point for three alternatives:

	Taxi	New smaller car	Old bigger car
	(Rs.)	(Rs.)	(Rs.)
Fixed Cost:			
Depreciation		16000/5 = 3200	8000/5 = 1600
Repairs		1000	1200
Taxes		1700	700
		5900	3500
Variable cost per KM	0.9	0.35	0.5
TOTAL COST PER 10000 KMS	9000	3500 + 5900 = 9400	5000 + 3500 = 8500
Cost per 19000 KMS	17100	12550	13000

(a) At 10000 KMS old bigger car is cheaper than the other two alternatives.

(b) At 19000 KMS it is better and cheaper to purchase the new smaller car.

Indifference point = (difference in fixed cost / difference in variable cost per unit)

= (2400/0.15) = 16000kms

Problem No.13.

Study Horse Ltd., a cycle manufacturing company, has drawn up a programme for the manufacture of a new product for the purpose of fuller utilisation of its capacity. The scheme envisages the manufacture of baby tricycle fitted with a bell. The company estimates the sales of tricycles at 10,000 during the first year and expects that from the second year onwards the sales estimates will stabilise at 20,000 tricycles. Since the company has no provision for the manufacture of the small bells is initially proposed to be met by way of purchase from the market, at Rs. 8 each.

However, if the company desires to manufacture the bell in its factory by installation of new equipment, it has two alternative proposals as under:

	Installation of Super - X Machine	Installation of Janta Machine
Initial cost of machine	Rs. 3,00,000	Rs. 2,00,000
Life	10 years	10 years
Fixed overheads other than depreciation on machines (per annum)	Rs. 54,000	Rs. 28,000
Variable expenses per bell	Rs. 4.00	Rs. 5.00

Depreciation on machine should be charged on straight line basis.

Required:

i)   For each of the two levels of output namely, 10,000 and 20,000 bells state with suitable workings whether the company should purchase the bells from market or install new equipment for manufacture of bells. If your decision is in favour of the installation of new equipment, which of the two new machines should be installed?

ii)   What would be your decision in case the forecast of requirement from the second year onwards is estimated at 40,000 bells instead of 20,000 bells.

iii)   At what volume of bells will the installation of the two machines break-even.

Solution:

(i) and ii)

Statement showing comparative costs at the 3 levels of output at the 3 alternatives

	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
Particulars		10,000			20,000			40,000	
	Market	SPX	Janta	Market	SPX	Janta	Market	SPX	Janta
Fixed Cost:									
Depreciation	-	30,000	20,000	-	30,000	20,000	-	30,000	20,000
FOH other than dep.	-	54,000	28,000	-	54,000	28,000	-	54,000	28,000
	-	84,000	48,000	-	84,000	48,000	-	84,000	48,000
Variable Cost	80,000	40,000	50,000	1,60,000	80,000	1,00,000	3,20,000	1,60,000	2,00,000
Total Cost	80,000	1,24,000	98,000	1,60,000	1,64,000	1,48,000	3,20,000	2,44,000	2,48,000

From the above computations it is evident that,

At level of out put 10,000 – buying from market

20,000 – Installation of Janta

40,000 – Installation of Super – X are beneficial.

iii) Volume of bells at which the two machines will break even = $\dfrac{Difference\ in\ FC}{Difference\ in\ VC\ per\ unit}$

$$\frac{84,000 - 48,000}{5 - 4} = 36,000$$

Problem No.14.

Something More Ltd. is considering adding to its product line. After a lot of deliberations between the sales and production personnel, it is decided that products P, Q and R would be the most desirable additions to be company's product range on account of the technical competency, marketing potential and production flexibility as regards these products. In fact P, Q and R can all be made on the same kind of plant as that already in use and therefore as regards production, all products can be readily interchanged. However, it is considered necessary to build further plant facilities to cater for additional production. In this connection the following data are relevant:

Products (Per Unit)		P	Q	R
Direct Materials	Rs.	100	120	90
Direct Labour	Rs.	50	70	90
Variable Overheads	Rs.	50	130	100
Selling Price	Rs.	350	420	370
Demand in units per cost period (on the basis of the above selling price)	Rs.	200	125	750
Machine Hours required per units of production	Rs.	15	5	3

It is felt that initially extra plant facilities can be built to operate at the following five different levels of activity, viz., 1,800; 2,300; 2,800; 3,300 and 3,800 machine hours per cost period. The fixed overhead costs for a cost period relevant to these five different levels of activity are estimated at Rs. 15,000; Rs.20,000; Rs. 26,000; Rs.33,000 and 39,000 respectively.

You are required to advise, with supporting figures, the product or products to be manufactured and in what quantities at each of the five contemplated levels of activity in order to maximize the profits at each level and also indicate the level of activity and would seem most desirable to be pursued for such maximization of profits.

Solution:

Statement showing contribution per machine hour and determination of priority for profitability

		P		Q		R
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Selling Price	-	350		420		370
Variable Cost:						
Direct Material	100		120		90	
Direct Labour	50		70		90	
Variable Overheads	50	200	130	320	100	280
Contribution Per unit		150		100		90
Contribution per machine hour		10		20		30
		III		II		I

Statement Showing optimum mix and profit of the 5 levels and determination of capacity to be pursued for maximization of profit:

Level of Activity	P			Q			R			Total Contrib. Rs.	Fixed Cost Rs.	Profit Rs.
	Hours	Units	Contrib. Rs.	H	U	C	H	U	C			
1800	-	-	-	-	-	-	1800	600	54000	54000	15000	39000
2300	-	-	-	50	10	1000	2250	750	67500	68500	20000	48500
2800	-	-	-	550	110	11000	2250	750	67500	78500	26000	52500
3300	425	28.33	4250	625	125	12500	2250	750	67500	84250	33000	51250
3800	925	61.67	9250	625	125	12500	2250	750	67500	89250	39000	50250

From the above computation it is evident that 2800 hour capacity level of activity is to be pursued to maximize profit.

Problem No.15.

Bathing care Ltd. manufactures and sells soaps under the brand name — Elite, Lovely, Fresh and Janata. The Janata soap is very popular as it is of good quality and at the same time reasonably priced. The company produces and sells per annum on an average 50,000 cakes of Elite, 1,00,000 cakes of Lovely, 75,000 cakes of fresh and 2,00,000 cakes of Janata at a unit selling price of Rs.3.50, Rs.3.00, Rs.2.50 and Rs.1.5 respectively.

At this level of production and sales the unit cost of a cake of each brand of soap is as follows:

				(Expressed in Paise)
	Elite	Lovely	Fresh	Janata
Direct Material	50	40	35	45
Direct Labour	20	20	15	10
Production Expenses:				
Variable	10	10	5	5
Fixed	20	25	20	20
Administrative Expenses:				
Fixed	30	40	25	30
Variable	15	5	10	5
Selling & Distribution Expenses:				
Fixed	80	60	45	10
Variable	45	20	25	5
Total Cost	**270**	**220**	**180**	**130**

The co. has lot of unutilised capacity and there is ample scope for improving production and sales volumes. Bathing Care Ltd. has built a name for its products in the market and with proper sales effort it should be possible to sell whatever is produced by the co., the production manager sees no problems. The sales manager put up a bold scheme for almost quadrupling the present profits of the company.

1. An exclusive advertising campaign has to be undertaken to produce and sell Janata Soaps and it is estimated at Rs.4,85,000.
2. At the same time the selling price of Janata Soap should be reduced to Rs. 1/- by adopting this sales strategy the sales manager is confident that he is able to double the present sales volume of Janata Soap and with each 1 lack increase of Janata Soap he would be able to push 30,000 cakes of Elite, 70,000 of lovely, 50,000 of fresh in the market. You are required to find out the profit at present and profit if the sales managers scheme is implemented.

Solution:

Statement showing computation of profit at the current Mix:

	Elite (Rs.)	Levels (Rs.)	Fresh (Rs.)	Janata (Rs.)	Total (Rs.)
I) SP	3.50	3.00	2.50	1.50	
II) VC:					
DM	0.50	0.40	0.35	0.45	
DL	0.20	0.20	0.15	0.10	
Prod. Exp.	0.10	0.10	0.50	0.50	
AOH	0.15	0.05	0.10	0.05	
SOH	0.45	0.20	0.25	0.05	
	1.40	0.95	0.90	0.70	
III) Contrib.	2.10	2.05	1.60	0.80	
IV) Total Cont.	1,05,000	2,05,000	1,20,000	1,60,000	5,90,000
V) F.C:					
Prod. Exp.	0.20	0.25	0.20	0.20	
Adv. Exp.	0.30	0.40	0.25	0.30	
S & D Exp.	0.80	0.60	0.45	0.10	
	1.30	1.25	0.90	0.60	
VI) Total F.C	65,000	1,25,000	67,500	1,20,000	3,77,500
VII) Profit	40,000	80,000	52,500	40,000	2,12,500

Statement showing computation of profit by adopting Sales Manager's scheme:

		Elite	Levels	Fresh	Janata	Total
No. of Units		1,10,000	2,40,000	1,75,000	4,00,000	
Contribution per unit	Rs.	2.10	2.05	1.60	(0.8 – 0.5) 0.30	
Total Contribution	Rs.	2,31,000	4,92,000	2,80,000	1,20,000	11,23,000
F C	Rs.					8,62,500
Profit	Rs.					2,60,500

Problem No.16.

Evenkeel Ltd. manufactures and sells as single product X whose price is Rs.40 per unit and the variable cost is Rs.16 per unit.

(a) If the fixed costs for this year are Rs.4,80,000 and the annual sales are at 60% margin of safety, calculate the rate of net return on sales, assuming an income tax level of 40%.

(b) For the next year, it is proposed to add another product line Y whose selling price would be Rs.50 per unit and the variable cost Rs.10 per unit. The total fixed costs are estimated at Rs.6,66,600. The sales mix of X:Y would be 7:3. At what level of sales next year, would Evenkeel Ltd. break even ? Give separately for both X and Y the break even sales in rupees and quantities.

Solution:

a) Statement showing computation of profit on X:

SP   = 40

VC   = 16

C   = 24

P/V Ratio = $\dfrac{c}{s} \times 100 = \dfrac{24}{40} \times 100 = 60\%$

BES = $\dfrac{FC}{PV\ Ratio} = \dfrac{4,80,000}{60\%} = Rs.8,00,000$

Let x be the total sales

0.6x = x – 8,00,000

=> x = 20,00,000

=> No. of units = $\dfrac{x}{40} = 50,000\ units$

			Rs.
I)	Sales (50,000 x 40)	=	20,00,000
II)	Variable Cost	=	8,00,000
III)	Contribution	=	12,00,000
IV)	Fixed Cost	=	4,80,000
V)	Profit	=	7,20,000
VI)	Tax (7,20,000 x 40%)	=	2,88,000
VII)	Net Profit	=	4,32,000

b) Let the break – even units of products X & Y be 7a & 3a respectively.

In order to break even the contribution must be equal to FC

    ⇨ (7a x 24) + (3a x 40) = 6,66,000

    ⇨ a = 2314.58

BES of X = 7a = 16,202.08 x SP = 648080

Y = 3a = 6943.75 x SP = 347200

Problem No.17.

(a) The profit for the year of Push On Ltd. work out to 12.5% of the capital employed and the relevant figures are as under:

	Rs
Sales	5,00,000
Direct Material	2,50,000
Direct labour	1,00,000
Variable overheads	40,000
Capital employed	4,00,000

The new sales manager who has joined the company recently estimates for the next year a profit of about 23% on the capital employed provided the volume of sales is increased by 10% and simultaneously there is an increase in Selling Price of 4% and an overall cost reduction in all the elements of cost by 2%.

Find out by computing in detail the cost and profit for next year, whether the proposal of sales manager can be adopted.

(b) Details about the single product marketed by a company are as under

Per Unit	Rs
Selling Price	100
Direct Material	60
Direct Labour	10
Variable Overheads	10

No. of units sold in the year 5.035. Pursuant to an agreement reached with the Employee's union, there would be next year a 10% increase in wages across the board for all those directly engaged in production.

Work out:

i)   How many more units have to be sold next year to maintain the same quantum of profit?

ii) Or else, by what percentage the Selling Price has to be raised to maintain the same P/V ratio.

Solution:

a)   Computation of Fixed Cost:

		Rs.
Sales		5,00,000
(-) Profit	4,00,000 x 12.5%	50,000
Total Cost		4,50,000
(-) VC: DM	2,50,000	
DL	1,00,000	
VOH	40,000	3,90,000
Fixed Cost		60,000

Statement showing computation of profit obtained on adopting the sales manager's proposal:

		Rs.
I) Sales	$4,00,000 \times \dfrac{100}{100} \times \dfrac{104}{100}$	5,72,000
II) Variable Cost	$3,90,000 \times \dfrac{110}{100} \times \dfrac{98}{100}$	4,20,420
III) Contribution		1,51,480
IV) Fixed Cost	60,000 x 98%	58,800
V) Profit		92,780

% of profit on capital employed = $\dfrac{92,780}{4,00,000} \times 100 = 23.195 > 23\%$.

∴ Proposal is adoptable.

b)   Current year details:

		Rs.
Sales	5035 x 100	5,03,500
Variable Cost	80 x 5035	4,02,800
Contribution		1,00,700
P/V Ratio	$\dfrac{c}{s} \times 100 = \dfrac{20}{100} \times 100 =$	20%

Details of next year:

		Rs.
SP		100
VC: DM	60	
DL – 10 x 110%	11	
VOH	10	81
C		19

i)   No. of units to maintain same profit = $\dfrac{Desired\ Contribution}{c\ per\ unit} = \dfrac{1,00,000}{19} = 5,3000$

ii) Let S be the new SP

P/V Ratio = $\dfrac{s-v}{s} \times 100$

$\Rightarrow$ 0.2 = $\dfrac{s-81}{s}$

$\Rightarrow$ S = Rs.101.25

$\therefore$ SP has to be increased by 1.25%.

Problem No.18.

The management accountant of X Ltd. has prepared the following estimates of working results for the year ending 31st Dec, 1986 for the purpose of preparing the budget for the year ending 31st Dec, 1987.

	Year ending 31-12-1986
Direct material	Rs. 16 per unit
Direct wages	Rs. 40 per unit
Variable	Rs. 12 per unit
Selling price	Rs.125 per unit
Fixed expenses	Rs.6,75,000 per annum
Sales	Rs.25,00,000 per annum

During the year 1987, it is expected that the material prices and variable over heads will go up by 10% and 5% respectively. As a result of reorganisation of production methods the overall direct labour efficiency will increase by 12% but the rate will go up by 5%. The fixed overheads are also expected to increase by Rs.1,25,000.

The technical director states that the same level of output as obtained in 1986 should be maintained in 1987 also and efforts should be made to maintain the same level of profit by suitably increasing the selling price.

The marketing director states that the market will not absorb any increase in the selling price. On the other hand he proposes that publicity involving advertisement expenses in these proportions 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:

i)   Present an income statement for the year 1986

ii) Find the revised price and the percentage of increase in the price for 1987 if the technical directors views are accepted.

iii) Evaluate the four alternative proposals put forth by the marketing director, determine the best output level to be budgeted and prepare the overall income statement for 1987 at the level of output.

Solution:

i) **Statement showing computation of profit for the year 1986:**

		Rs.
I) SP		125
II) Variable Cost		68
III) Contribution		57
IV) Total Contribution	25,00,000 x $\frac{57}{125}$	11,40,000
V) Fixed Expenses		6,75,000
VI) Profit		4,65,000

ii) **Technical director's proposal:**

VC:		Rs.
R M	16 x $\frac{110}{100}$	17.6
Wages	40 x $\frac{105}{100} \times \frac{100}{112}$	37.5
Variable OH	12 x $\frac{105}{100}$	12.6
Total VC		67.7

FC	6,75,000	
(+) Addnl.	1,25,000	8,00,000
Total Cost		21,54,000
Profit		4,65,000
Sales		26,19,000

$$SP = \frac{26,19,000}{20,000} = Rs.130.95$$

$$\% \uparrow in\ SP = \frac{5.95}{125} \times 100 = 4.76\%$$

iii) **Marketing Director's view:**

Additional Sales	Units	2,000	4,000	6,000	8,000
Cost per unit	Rs.	57.3	57..3	57.3	57.3
Add: C	Rs.	1,14,600	2,29,200	3,43,800	4,58,400
Add: FC	Rs.	80,000	1,94,000	3,20,000	4,60,000
P / (L)	Rs.	34,600	35,200	23,800	(16,000)

Statement showing computation of profit at optimum level forecasted by the marketing director:

I) No. of units			24,000
II) C per unit	Rs.		57.3
III) Total C	Rs.		13,75,200
IV) FC	Rs.	(8,00,000 + 1,98,000)	9,94,000
V) Profit	Rs.		3,81,200

Problem No.19.

S.U Ltd. produces three products namely A, B and C. The budgeted production, costs and selling prices for the next year are as under:

Direct materials (Rs./unit)	24	16	12
Direct wages:			
Dept. Rate/Hour:			
1. Rs 4 Hrs/ unit	3	5	25
2. Rs 2 Hrs/unit	3	8	6
Budgeted Production (units)	10,000	12,000	20,000
Max. possible sales (units)	12,000	16,000	24,000
Selling price (Rs./unit)	75	105	60

Variable overheads:

Dept.1 Recovered at 100% of direct wages.

Dept.2 Recovered at 50% of direct wages.

Fixed overheads Rs.5,00,000 per annum.

A direct labour hour in Dept1 is in short supply and the budgeted volume of output envisages full utilisation of the available direct labour hours. In Dept 2, the co. has committed to engage the workers to the extent of the direct labour hours required for the budgeted volume of production. Should a change in the product mix be desired, the co. can engage additional direct labour hours required in dept 2 at normal rates; but any portion of the direct labour hours of dept 2 rendered surplus by reasons of a change in the present product mix have to be paid by the co. as idle wages in view of the commitment already made.

Required:

i)   Present a statement showing the budgeted profitability.

ii)   Set optimal product mix and work out the optimum profit after taking into consideration the idle time wages, if any, payable in dept 2.

If the co. desires to subcontract the surplus direct labour hours, if any, in dept 2, what minimum charges should be quoted per direct labour hour.

Solution:

i)   Statement showing computation of budgeted profit and contribution per labour hour in dept. 1:

	A	B	C	Total
	Rs.	Rs.	Rs.	Rs.
SP	75	105	60	
VC:				
DM	24	16	12	
DW: Dept 1	12	16	12	
Dept 2	6	16	12	
VOH	15	23	16	
	57	70	50	
Contribution	18	35	10	
Contr. Per lab hour	6	5	4	
In Dept. I				
	I	II	III	
Budged units	10,000	12,000	20,000	8,00,000
Total contrib.	1,80,000	4,20,000	2,00,000	5,00,000
Profit				3,00,000

ii) Statement showing optimum mix and profit at that mix:

No. of Units		A	B	C	Total
No. of Units		12,000	16,000	9,600	
C P.U	Rs.	18	25	10	
Total	Rs.	2,16,000	4,00,000	96,000	7,12,000
FC	Rs.				5,00,000
Profit	Rs.				2,12,000
(-) Cost of idle wages in dept 2	Rs.	24,400 x 2			48,800
Profit after idle wages	Rs.				1,63,200

Working Notes:

No. of hours in dept 1 = (10,000 x 3) + (12,000 x 5) + (20,000 x 2.5) = 1,40,000

No. of hours in dept 2 = (10,000 x 3) + (12,000 x 8) + (20,000 x 6) = 2,46,000

	Dept I hrs	Dept II hrs
Available Hours	1,40,000	2,46,000
(-) utilized for A	36,000	36,000
	1,04,000	2,10,000
(-) for B	80,000	1,28,000
	24,000	82,000
No. of Units of C = $\dfrac{24,000}{2-5}$ = 9,600 units	24,000	9600 x 6 = 57,600
	-	24,400

iii) Hire charges = Labour Cost + Var. O.H
    = 2 + 2 x 50% = Rs. 3

Problem No.20.

V Ltd. produces two products P and Q. The draft budget for the next month is as under:

Budgeted production and sale (units)	40,000	80,000
Selling price Rs./unit	25	50
Total costs Rs./unit	20	40
Machine hours/unit	2	1
Max. sale potential (units)	60,000	1,00,000

The fixed expenses are estimated at Rs.9,60,000 per month. The co. absorbs fixed Ohs on the basis of machine hours which are fully utilised by the budgeted production and cannot be further increased.

When the budget was discussed, the managing director states that the product mix should be altered to yield optimum profit. The marketing director suggests that he could introduce a new product C each unit of which take 1.5 machine hours. However a processing vat involving a capital outlay of Rs.2,00,000 is to be installed for processing product C. The additional fixed overheads relating to the processing vat was estimated at Rs.60,000 per month. The variable costs are product C was estimated at Rs.21 per unit.

Required:

i) Calculate the profit as per draft budget for the next month.

ii) Revise the product mix based on data given P and Q to yield optimum profit.

iii) The company decides to discontinue either product P on Q whichever is giving lower profit and proposes to substitute product C instead. Fix the selling price of C in such a way to yield 15% return on additional capital employed besides maintaining the same overall profit as envisaged in (ii) above.

Solution:

Computation of profit as per draft budget:

		P	Q	Total
		Rs.	Rs.	Rs.
SP		25	50	
Total Cost		20	40	
Profit		5	10	
Budgeted Units		40,000	80,000	
Profit		2,00,000	8,00,000	10,00,000
FC P u		12	6	
VC P u		8	34	
C P u		17	16	
C Per machine hour		8.5	16	
Priority		II	I	

Statement showing optimum mix and relevant profit:

		P	Q	Total
No. of units		30,000	1,00,000	
C P. u.	Rs.	17	16	
Total C	Rs.	5,10,000	16,00,000	21,10,000
FC	Rs.			9,60,000
Profit	Rs.			11,50,000

Working Notes:

Available hours = (40,000 x 2) + (80,000 x 1) = Rs.1,60,000

(-) Utilised for Q   Rs.1,00,000

            Rs. 60,000

No. of units of P = $\dfrac{60,000}{2} = 30,000\ units$

Computation of SP of product C:

Out of products P & Q, P is less profitable and hence can be replaced by c.

Variable Cost   Rs.21

FC   Rs.60,000

Machine hours released = 60,000 hrs.

No. of units of C = $\dfrac{60,000}{1.5} = 40,000\ units$

In order to get the profit as above, the contribution to be recovered is as follows:

	Rs.
Total Contribution	21,00,000
(+) Fixed Cost (addnl.)	60,000
(+) Return on capital employed	30,000
	22,00,000
(-) Recovered from Q	16,00,000
	6,00,000

C per unit = $\dfrac{60,000}{40,000} = 15$ Rs.

(+) VC   21Rs.

Selling Price   **36Rs.**

Problem No.21.

Household Equipments Ltd. is producing kitchen equipment from five components three of which are made using general purpose machines and two by manual labour. The data for the manufacture of the equipment is as follows:

Components	A	B	C	D	E	Total
Machines hours reqd. per unit	10	14	12	-	-	36 hrs
Labour hours reqd. per unit	-	-	-	2	1	3hrs
Variable cost per unit (in Rs.)	32	54	58	12	4	160
Fixed cost per unit (apportioned) Rs.	48	102	116	24	36	316
Total component cost Rs.	80	156	174	36	30	476
Assembly cost/unit (all variable)						Rs.40
Selling price/unit						Rs.600

The marketing department of the company anticipates 50% increase in demand during the next period. General purpose machinery used to manufacture. A,B and C is already working to the maximum capacity of 4752 hours and there is no possibility of increasing this capacity during the next period. But labour is available for making components D and E and also for assembly according to demand. The management is considering the purchase of one of the components A,B or C from the market to meet the increase in demand. These components are available in the market at the following prices:

    Components A: Rs.80

    Components B: Rs.160

    Components C: Rs.125

Required:

 a) Profit made by the company from current operations.

 b) If the company buys any one of the components A,B or C, what is the extent of additional capacity that can be created?

 c) Assuming 50% increase in demand during the next period, which component should the company buy from the market?

 d) The increase in profit, if any, if the component suggested in c) is purchased from the market.

Solution:

 a) Statement showing profit at current operations:

		Rs.
SP		600
Variable Cost	(160 + 40)	200
Contribution		400
No. of units	$\dfrac{4752}{36}$	Units 132
Total Contribution		52,800
Fixed Cost		41,712
Profit		11,088

b)

	A	B	C
	Rs.	Rs.	Rs.
Buying cost	80	160	125
Variable Cost	32	54	58
Extra buying Cost	48	106	67
Excess buying cost per hour	4.8	7.571	5.583

It is better to buy component A from the market because excess buying cost per machine hour is less.

Computation of additional capacity created if components are bought from outside:

If A is bought:

No. of units that can be manufactured $\dfrac{4752}{26}$ 182.76 units

Increase in capacity $\dfrac{182.76-132}{132}\times100$ 38.46 %

If B is bought:

No. of units $\dfrac{4752}{22}$ 216

Increase in capacity $\dfrac{182.76-132}{132}\times100$ 63.64%

If C is bought:

No. of units $\dfrac{4752}{24}$ 198

Increase in capacity $\dfrac{198-132}{132}\times100$ 50%

c) A is cheaper to buy. But the increase in capacity will not be sufficient to meet the expected demand for next year. Therefore, we shall try to buy the next cheaper component. i.e., C and by buying it the increase in capacity will be exactly equal to the demand for our product during the next year. Hence, component 'C' should be bought from the market.

d) **Statement showing computation of profit by buying C from outside:**

I) No. of Units $\dfrac{4752}{24}$ Units 198

II) Selling Price Rs. 600

III) Variable Cost (200 – 58 + 125) Rs. 267

IV) Contribution Rs. 333

V) Total Contribution Rs. 65,934

VI) Fixed Cost Rs. 41,712

VII) Profit Rs. 24,222

Less: Existing Profit Rs. 11,088

Increase in profit Rs. 13,134

Problem No.22.

As a part of its rural upliftment programme, the Government has put under cultivation a farm of 96 hectors to grow tomatoes of four varieties: Royal Red, Golden Yellow, Juicy Crimson and Sunny Scarlet of the total 68 hectors are suitable for all four varieties, but the remaining 28 hectors are suitable for growing only Golden Yellow and Juicy Crimson. Labour is available for all kinds of farm work and there is no constraint. The market requirement is that all four varieties of tomato must be produced with a minimum of 1,000 boxes of any one variety.

The farmers engaged have decided that the area devoted to any crop should be in terms of complete hectors and not in fractions of a hector. The other limitation is that not more than 22,750 boxes of any one variety should be produced. The following data are relevant.

	Royal Red	Golden Yellow	Juicy Crimson	Sunny Scarlet
Annual Yield				
Boxes per hector	350	100	70	180
Costs	Rs.	Rs.	Rs.	Rs.
Direct:				
Material per hector	476	216	196	312
Labour:				
Growing per hector	896	608	371	528
Harvesting and				
packing per box	3.60	3.28	4.40	5.20
Transport per box	5.20	5.20	4.00	9.60
Market price per box	15.38	15.87	18.38	22.27

Fixed overheads per annum:

Growing	Rs.	11,200
Harvesting	Rs.	7,400
Transport	Rs.	7,200
General Administration	Rs.	10,200

Find out: i) within the given constraints, the area to be cultivated with each variety of tomatoes, if the largest total profit has to be achieved.

ii) The amount of such profit in rupees.

A nationalized bank has come forward to help in the improvement programme of the 28 hectors in which only Golden Yellow and Juicy Crimson will grew, with a loan of Rs. 5,000 at a very nominal interest of 6% per annum. When this improvement is carried out, there will be a saving of Rs. 1.25 per box in the harvesting cost of Golden Yellow and the 28 hectors will become suitable for growing Royal Red in addition to the existing Golden Yellow and Juicy Crimson varieties. Assuming that other constraints continue, find the maximum total profit that would be achieved when the improvement programme is carried out.

Solution:

Statement showing contribution per hectare and determination of priority for profitability

	Royal Red	Golden Yellow	Juicy Crimson	Sunny Scarlet
	Rs.	Rs.	Rs.	Rs.
i) Sales realised per hectare	**5383**	**1587**	**1288.6**	**4008.6**
ii) Variable cost:				
a. direct material	476	216	196	312
b. growing cost per hectare	896	608	371	528
c. harvesting and packing	1260	328	308	936
d. transport	1820	520	280	1728
	4452	**1672**	**1055**	**3504**
iii) Contribution per hectare	**931**	**-85**	**233.6**	**504.6**
iv) Priority	1	4	3	2

Statement showing optimum product mix under the given conditions and computation of profit at that mix

	Royal Red	Golden Yellow	Juicy Crimson	Sunny Scarlet	Total
Minimum boxes to be produced (Units)	1,000.00	1,000.00	1,000.00	1,000.00	
Area required for this minimum (hectors)	3.00	10.00	14.00	6.00	33.00
Remaining land Apportioned on the basis of given data according to priority (hectors)	59.00		4.00		63.00
i) No. of hectares	62.00	10.00	18.00	6.00	96.00
ii) Contribution per hectare (Rs.)	931.00	(85.00)	131.60	504.60	
iii) Total contribution (Rs.)	57,722.00	(850.00)	2,368.80	3,027.60	62,268.40
iv) Fixed cost (Rs.)					36,000.00
v) Profit (Rs.)					26,268.40

Statement showing optimum mix after the improvement programme and computation of profit

	Royal Red	Golden Yellow	Juicy Crimson	Sunny Scarlet	Total
Area required for this minimum (hectors)	3.00	10.00	14.00	6.00	33.00
Remaining land Apportioned on the basis of given data according to priority(hectors)	62.00			1.00	63.00
i) No. of hectares	65.00	10.00	14.00	7.00	96.00
ii) Contribution per hectare (Rs.)	931.00	(85.00)	131.60	504.60	
iii) Total contribution(Rs.)	60,515.00	400.00	2,368.80	3,532.20	66,289.60
iv) Fixed cost(Rs.)					36,300.00
v) Profit(Rs.)					29,989.60

Problem No.23.

Nice and Warm, Ltd. manufactures and markets hot plates. During the first five years of operations, the company has experienced a gradual increase in sales volume, and the current annual growth in sales of 5% is expected to continue in the foreseeable future. The plant is now producing at its full capacity of one lakh hot plates.

At the monthly Management Advisory committee meting, amongst other things, the plan of action for next year was discussed.

Managing Director proposed two alternatives. First, operations could be continued at full capacity and with the existing facilities, an output of one lakh hot plates at a selling price of Rs. 100 per plate per unit could be maintained. Secondly, production and sales could be increased by 5% to take advantage of the rate of expansion in demand for the product. But this could increase cost, as to achieve the output, the company will have to resort to weekend and over time workings. However, a policy of steady growth was preferable to maintaining status quo.

In view of the company's competitors having a substantial share of the market, the Works Director was of the view that it was not enough for the company to maintain merely the present share of the total

market. A large share of the total market should be obtained. For that, the company should increase production by 10% through a modest expansion of the plant capacity. In order to sell the output of 1,10,000 units the selling price could be reduced to Rs. 95 per unit.

Thinking on the same lines, the Marketing Director put forth a more radical proposal. The strategy should be to seize the competitive leadership in the market with regard to both price and volume. With this end in view, he suggested that the company should straightaway embark on an expensive modernisation programme, which will initially increase volume by 20%. The entire output of 1,20,000 hot plates could be easily sold at a price of Rs. 90 per unit.

At this juncture, the Managing Director expressed concern about the probable behavior of the company's competitors. They might also expand in order to produce more and sell at lower prices. Suppose this happened, he wanted also the financial effects of the proposals of the Works Director and Marketing Director, if in these proposals, the expected increase in sales were to be only half of that predicted.

As a Cost Accountant of the company, you are required to critically evaluate the six alternative along with your recommendations and circulate the same to the Directors. In this connection, you have gathered the following details:

i) If next year's production was maintained at the current year's level, variable cost would remain at Rs. 50 per unit. Fixed cost would remain unchanged at Rs. 30 lakhs.

ii) The week-end and overtime working would increase with the variable and fixed costs. Variable cost would rise to Rs. 55 per unit while fixed cost would increase to Rs. 30,25,000

iii) In the proposal of the Works Director, the ratio of variable costs to sales would continue to be 50%. Fixed costs would rise to Rs. 32,25,000.

iv) In the proposal of Marketing Director, as a result of increased production, efficiency and some savings from purchase of materials, it is estimated that the ratio of variable cost of sales would decrease to 48% and the fixed costs would increase by Rs. 5,16,000.

Your answer should contain:

a) A tabular statement of comparative figures pertaining to total turnover, total contribution, Percentage of Profit to Sales and Breakeven units as regard to each of the six proposals.
b) Comments on the relative risk involved.
c) Consideration of the short-term and long-term implications of the Managing Director's proposals.
d) Comment on the price elasticity of demand for the company's products and your suggestions on the pricing policy and cost structure
e) Comment on financial implications of the expansion scheme.

Solution:

a) **Statement showing contribution, profit at six alternatives**

	Managing director		Works director		Marketing director	
	I	II	I	II	I	II
i) No. of units	100,000.00	105,000.00	110,000.00	105,000.00	120,000.00	110,000.00
ii) Selling price per unit(Rs.)	100.00	100.00	95.00	95.00	90.00	90.00
iii) Sales turnover (Rs. Lakhs)	100.00	105.00	104.50	99.75	108.00	99.00

iv) Variable cost per unit(Rs.)	50.00	55.00	47.50	47.50	43.20	43.20
v) Contribution per unit (ii-iv) (Rs.)	50.00	45.00	47.50	47.50	46.80	46.80
vi) Total contribution (Rs. Lakhs)	50.00	47.25	52.25	49.88	56.16	51.48
vii) Fixed cost (Rs. Lakhs)	30.00	30.25	32.25	32.25	3,516.00	35.16
viii) Profit (Rs. Lakhs) (vi-vii)	20.00	17.00	20.00	17.63	21.00	16.32
ix) % of profit on sales (%)	20.00	16.19	19.14	17.67	19.44	16.48
x) Break even units (vii/v)(units)	60,000.00	67,222.00	67,895.00	67,895.00	75,128.00	75,128.00
xi) Margin of safety units	40,000.00	37,778.00	42,105.00	37,105.00	44,872.00	34,872.00
xii) P.V ratio (%)	0.50	0.45	0.50	0.50	0.52	0.52

b) Managing Directors first proposal seems to be more favorable from the risk point of view because it has low break even and high margin of safety coupled with higher percentage of profit to sales.

c) From the short run point of view, Managing director's second proposal, i.e steady growth of 5% a year would be better, even by resorting to weekend over time working. However, from the long term view point, the above proposal is not advisable because when they have steady growth, they can go for expansion of business rather than resorting to overtime working. If it I not possible to go for expansion, a steady status quo is the best solution.

d) It was given that , annual growth of sales of 5% is expected to continue in foreseenable future. It is not clear, why the second proposal of the works director and marketing director should suggest, reduction in price for 5% and 10% respectively.
It seems no serious study has been made on the price elasticity of demand of the product. If there is demand for the product and increased production, they may reduce the price by adapting discriminate price policy

e) If the company desires to expand the production, it is necessary to find out the sources of financing of expansion scheme by relative profitability of different funds.

Problem No.24.

Domestic political trouble in the country of an overseas supplier is causing concern in your company because it is not known when further supplies of raw material 'x' will be received. The current stock held of this particular raw material is 17,000 kilograms, which costs Rs. 1,36,000. Based on raw material `x', your company makes five different products and the expected demand for each of these, for the next three months, it given below together with other relevant information:

Product code	Kilogram of raw material 'x' per unit of finished product	Direct labour hours per unit of finished product	Selling price per unit	Expected demand over three month
	Kg.	Hours	Rs.	units
701	0.7	1.0	26	8,000
702	0.5	0.8	28	7,200
821	1.4	1.5	34	9,000
822	1.3	1.1	38	12,000
937	1.5	1.4	40	10,000

The direct wages rate per hour is Rs. 5 and production overhead is based on direct wages cost - The variable overhead absorption rate being 40% and the fixed overhead absorption rate being 60% variable selling costs, including sales commission, are 15% of selling price.

Budget fixed selling and administration costs are Rs. 300,000 per annum. Assume that the fixed production overhead incurred will equal the absorbed figure.

You are required to:
   a) Show what quantity of the raw material on hand ought to be allocated to which products in order to maximize profits for the forthcoming three months.
   b) Present a brief statement showing contribution and profit for the forthcoming three months, if your suggestion in (a) is adopted;
   c) Comment briefly on the analysis you used to aid the decision making process in (a) and give three other examples of business problems where this type of analysis can be useful.

Statement showing computation of contribution per koilogram of material and determination of priority for profitability

Solution:

Statement showing computation of contribution per koilogram of material and determination of priority for profitability

	701	702	821	822	937
	Rs.	Rs.	Rs.	Rs.	Rs.
i) Selling price	**26.00**	**28.00**	**34.00**	**38.00**	**40.00**
ii) Variable cost					
a. Direct material	5.60	4.00	11.20	10.40	12.00
b. labour	5.00	4.00	7.50	5.50	7.00
c. Production overheads	2.00	1.60	3.00	2.20	2.80
d. selling expenses	3.90	4.20	5.10	5.70	6.00
	16.50	**13.80**	**26.80**	**23.80**	**27.80**
iii) Contribution	**9.50**	**14.20**	**7.20**	**14.20**	**12.20**
iv) Contribution per kilogram of material	**13.57**	**28.40**	**5.14**	**10.90**	**8.13**
v) Priority	2	1	5	3	4

Statement showing optimum mix under given conditions and computation of profit at that mix

	701	702	821	822	937	Total
No. of units	8,000.00	7,200.00		6,000.00		
Contribution per Unit (Rs.)	9.50	14.20		14.20		
Total contribution(Rs.)	76,000.00	102,340.00		85,200.00		263,440.00
Fixed cost(Rs.)						136,080.00
Profit(Rs.)						127,360.00

Working Notes:

Computation of material apportion on the basis of priority

	(Rs.)
Available material	17,000.00
Less : used for 702 (7200 x 0.5)	3,600.00
	13,400.00
701 (8000 x 0.7)	5,600.00
	7,800.00

Therefore no. of units of 822 to be produced from remaining material (7800/1.3) = 6000 Units

Fixed Cost

	(Rs.)
Selling and adm. Overheads [(300000/12)x3]	75,000.00
Factory overheads [(8000x5x60%)+(7200x4x60%)+(6000x5.5x60%)]	61,080.00
	1,36,080.00

Problem No.25.

Z Ltd., makes a range of five products to which the following standards apply:

PER UNIT

	A	B	C	D	E
	Rs.	Rs.	Rs.	Rs.	Rs.
Sales price	50	60	70	80	90
Direct materials	9	10	17	12	21
Direct Wages	16	20	24	28	32
Variable production overheads	8	10	12	14	16
Variable selling and distribution overheads	5	6	7	8	
Fixed overheads	4	5	6	7	8
	42	51	66	69	86

The direct labour wage rate is Rs.4 per hour. Fixed overheads have been allocation the basis of direct labour hours. The company has commitments to produce a minimum of 400 units of each product per month direct hours cannot exceed 13,000 per month due to restriction of space. The Board is now considering an offer of a new three-year contract to produce an additional 400 units of product B per month at a selling price of Rs.58 per unit. The contract would involve an outlay of Rs.1,00,000 on the lease

of additional factory premises and purchase of new plant and equipment. There would be residual value at the end of the contract. Variable production costs would be in accordance with existing standards, variable selling and distribution costs would be one-half of the existing rate and cash outflows on fixed costs would be Rs.20,000 per annum. There would be no change to existing production arrangements. An outside supplier has offered to supply 400 units of product B per month at a price of Rs.48 per unit. If purchased externally cash flows on additional fixed costs will be Rs. 25,000 per annum.

Required:
(a) Give recommendations, supported by calculations, to show how direct labour hours in the existing factory should be utilised in order to maximize profits.
(b) Show the budgeted trading results on the basis of your recommendations in (a)
(c) Give calculations to show whether or not the proposed contract for product B should be accepted and, if so, whether it should be purchased externally or manufactures in the new premises. The company's cost of capital is 10% (the present value of an annuity of Rs.1 for three years at 10% is Rs.2.49). Ignore taxation and inflation

<u>Solution:</u>

A. Statement showing contribution per labour hour and determination of priority for profitability

	A	B	C	D	E
	Rs.	Rs.	Rs.	Rs.	Rs.
i) Selling price	**50.00**	**60.00**	**70.00**	**80.00**	**90.00**
ii) Variable cost					
a. Direct material	9.00	10.00	17.00	12.00	21.00
b. labour	16.00	20.00	24.00	28.00	32.00
c.Variable overheads	8.00	10.00	12.00	14.00	16.00
d. Variable selling & dis. Overheads	5.00	6.00	7.00	8.00	9.00
	38.00	46.00	60.00	62.00	78.00
iii) Contribution	12.00	14.00	10.00	18.00	12.00
iv) Contribution per labour hour	3.00	2.80	1.66	2.57	1.50
v) Priority	I	II	IV	III	V

B. Statement showing optimum mix under given conditions and computation of profit at that mix.

	A	B	C	D	E	Total
Minimum no. of units	4,800.00	4,800.00	4,800.00	4,800.00	4,800.00	
Units in remain hours (w/n)	3,000.00					
No. of units	7,800.00	4,800.00	4,800.00	4,800.00	4,800.00	
Contribution per Unit(Rs.)	12.00	14.00	10.00	18.00	12.00	
Total contribution(Rs.)	93,600.00	67,200.00	48,000.00	86,400.00	57,600.00	352,800.00
Fixed cost (156000 hoursx1) (Rs.)						156,000.00
Profit(Rs.)						196,800.00

Working notes:

Available hours	156,000.00 hrs.
Hours utilised for minimum {(4+5+6+7+8)x4800}	144,000.00 hrs.
Remaining hours	12,000.00 hrs.
Therefore units of a to be produced (12000/4)	3000 units

C.

Option I	(Rs.)
Selling price offered	58.00
Less ; Variable cost (46-(6/2))	43.00
Contribution	15.00
No. of units	4,800.00
Total contribution	72,000.00
Less ;: Fixed cost	20,000.00
Profit	52,000.00

Present value of profit for three years contract

	(Rs.)
i.e Inflow (52000x2.49)	129,480.00
Less : outflow	100,000.00
Net present value	29,480.00

Option II	(Rs.)	
Contract value (4800x48)	230,400.00	
Add : Fixed cost	25,000.00	
	255,400.00	
Present value for three years	(255400x2.49)	(Rs.) (635,946.00)
Present value of inflows	(4800x58x2.49)	(Rs.)693,216.00
Net present value		(Rs.)57,270.00

It is better to accept the order for product-b and to supply them by sub-contracting the order

Problem No.26.

The Management Accountant of X ltd., has prepared the following estimates of working results for the year ending 31st December,1986 for the purpose of preparing the budgets for the year ending 31st December,1987.

Year ending 31/12/1986

Direct material	Rs./unit	16.00
Direct wages	"	40.00
Variable overheads	"	12.00
Selling price	"	125.00
Fixed expenses	Rs.	6,75,000 p.a.
Sales	Rs.	25,00,000p.a.

During the year 1987, it is expected that the material prices and variable overheads will go up by 10% and 5% respectively. As a result of re-organisation of production methods 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 technical director states that the same level of output as obtained in 1986 should be maintained in 1987 also and efforts should be made to maintain the same level of profit by suitably increasing the selling price. The marketing director states that the market will not absorb any increase in the selling price. On the other hand he proposes that publicity involving advertisement expenses in the proportions 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:

(i)   Present an income statement for the year 1986.

(ii) Find the revised price and the percentage of increase in the price for 1987 if the Technical Directors' views are accepted.

(iii) Evaluate the four alternative proposals put forth by the Marketing Director, determine the best output level to be budgeted and prepare an overall income statement for 1987 at that level of output.

Solution:

I. Statement of profit at budget

	(Rs.)	
i) Selling price	**125.00**	
ii) Variable cost		
a. direct material	16.00	
b. direct wages	40.00	
c. variable overheads	12.00	
	68.00	
iii) Contribution (i-ii)	**57.00**	
iv) No. of units (25,00,000/125)	**20,000.00**	Units
v) Total contribution	**1,140,000.00**	
vi) Less: Fixed cost	**675,000.00**	
vii) Profit (v-vi)	**465,000.00**	

II. Computation of selling price, if the technical director views are implemented

Variable cost		(Rs.)
Direct material	(16x110%)	17.60
Direct wages	[(40x105%)x(100/112)]	37.50
Variable overheads	(12x105%)	12.60
		67.70

In order to get the same profit contribution to be recovered is as follows:

	(Rs.)
Existing fixed overheads	675,000.00
Add :Expected increase	125,000.00
	800,000.00
Add : desired profit	465,000.00
	1,265,000.00

Therefore contribution per unit (1265000/20000)	63.25
Required selling price = variable cost + contribution =67.7+63.25	130.95
% increase in profit =[{(130.95-125)/125}x100]	4.76%

III. Computation of additional profit at four alternatives proposed by marketing director

Units		2000	4000	6000	8000
a. contribution per unit (125-67.7)	Rs.	57.30	57.30	57.30	57.30
b. Total contribution	Rs.	114,600.00	229,200.00	343,800.00	458,400.00
c. additional fixed cost	Rs.	80,000.00	194,000.00	320,000.00	460,000.00
d. Profit/(loss)	Rs.	34,600.00	35,200.00	23,800.00	(1,600.00)

Statement showing overall income for the year 1987

a. No. of units		24,000.00
b. Contribution per unit	Rs.	57.30
c. Total contribution	Rs.	1,375,200.00
d. Fixed cost (800000+194000)	Rs.	994,000.00
e. Profit	Rs.	381,200.00

Problem No.27.

Allplay Ltd., are specialists in the manufacture of dolls for children. They manufacture and market four types of dolls patented the names, Dolly, Molly, Jolly, Polly and a doll dress sewing kit. They require your assistance as a Cost Accountant for determining the appropriate sales and product-mix of their products for the coming year. From the production standards established market forecasts and pricing policies, you get the following data:

Doll's name	Estimated demand for next year	Standard material cost per unit	Standard labour cost per unit.	Estimated net price per unit.
	Unit	Rs.	Rs.	Rs.
Dolly	50,000	1.40	0.80	5.20
Molly	42,000	0.70	0.50	2.40
Jolly	35,000	2.70	1.40	8.50
Polly	40,000	1.00	1.00	4.00
Sewing kit	3,25,000	0.60	0.40	3.00

(i)   To promote sales of the sewing kit, there is a 15% discount offered in the established price of a kit, purchased at the same time along with a doll and it is expected that all the customers will avail this benefit.

(ii)   The labour rate of Rs.2.00 per hour is expected to continue without change in the next year.   The plant has an effective capacity of 1,30,000 labour hours on a single shift basis. Present equipment can produce all of the products. Overtime worked is paid at double the normal rate.

(iii)   Next year's fixed cost is estimated at Rs.30,000 in the factory, Rs.20,000 in administration and Rs. 50,250 in selling and distribution.

(iv)   Variable costs will be equivalent to 50% of standard Direct Labour cost.

(v)   The company has a very small inventory of its products that can be ignored.

(a) You are required to draw a conservative estimate for the next year of the total contribution that would be made by each product line and the net income that would earned by the company.

(b) The company is at present having some industrial relations problem and if this continues in the next year, it would not then be possible to arrange for overtime work.   Anticipating that eventuality, you are required to suggest a product-mix that would absolutely minimize the drop in the income already envisaged. **With that product-mix, work out product-wise contribution and the new net income that would be earned as a result.**

		Dolly	Molly	Jolly	Polly	Sewing kit Discount	Sewing kit No Discount	Total
Selling price	Rs.	**5.20**	**2.40**	**8.50**	**4.00**	**2.55**	**3.00**	
Variable cost	Rs.							
a. direct material	Rs.	1.40	0.70	2.70	1.00	0.60	0.60	
b. direct wages	Rs.	0.80	0.50	1.40	1.00	0.40	0.40	
c. variable overheads	Rs.	0.40	0.25	0.70	0.50	0.20	0.20	
	Rs.	**2.60**	**1.45**	**4.80**	**2.50**	**1.20**	**1.20**	
Contribution	Rs.	**2.60**	**0.95**	**3.70**	**1.50**	**1.35**	**1.80**	
Hours per unit	hrs.	0.40	0.25	0.70	0.50	0.20	0.20	
Contribution per hour	Rs.	**6.50**	**3.80**	**5.29**	**3.00**	**6.75**	**9.00**	
No. of units	Rs.	50,000.00	42,000.00	35,000.00	40,000.00	167,000.00	158,000.00	
Total contribution	Rs.	**130,000.00**	**39,900.00**	**129,500.00**	**60,000.00**	**225,450.00**	**284,400.00**	**869,250.00**
Fixed cost	Rs.							100,250.00
Profit before considering o.t	Rs.							**769,000.00**
Less : o.t premium (w/n)	Rs.							20,000.00
Profit at conservative estimate	Rs.							**749,000.00**

Solution:

Statement showing computation of contribution per hour, determination of priority and profit at conservative estimate

Computation of over time premium

		hrs.
Available hours		130,000.00
Less : Utilised for		
Dolly	(50000x.4)	20,000.00
Molly	(42000x0.25)	10,500.00
Jolly	(35000x.7)	24,500.00
Polly	(40000x.5)	20,000.00
Sewing kit (discount)	(167000x.2)	33,400.00
Sewing kit)no discount)	(158000x0.2)	31,600.00
		10,000.00

Therefore overtime premium (10000x2) = Rs.20000

Computation of profit when no over time is available

		Dolly	Molly	Jolly	Polly	Sewing kit Discount	Sewing kit No Discount	Total
a. No. of units		50,000.00	42,000.00	35,000.00	20,000.00	147,000.00	178,000.00	
b. Contribution per unit	Rs.	2.60	0.95	3.70	1.50	1.35	1.80	
c. Total contribution	Rs.	130,000.00	39,900.00	129,500.00	30,000.00	198,450.00	320,400.00	848,250
d. Fixed cost	Rs.							100,250
e. Profit	Rs.							748,000

Problem No.28.

The operating results of B.N. Ltd., for the year 1981 were as under:

Sales mix: Product	Sales Mix %	P/V Ratio%
A	40	20
B	10	6
C	30	12
D	20	10

Total sales value of all the products was Rs.80 lacs. Total fixed overheads amounted to Rs. 10 lacs. Raw material contents of each product represented 50% of the respective variable cost. The forecast for the year 1982 is as under:

(i)   The raw material costs will go up by 10%

(ii) The company has been able to obtain export quota of raw material of the value of Rs. 35 lacs.

(iii) The maximum sale potential of any of the above four products is 40% of the 1981 sale value.

(iv) The Company expects to secure an increase of 5% in the selling prices of all the products uniformly.

Required:

a) Prepare a statement showing the profitability of 1981.

b) Set a Product mix to maximise profit in 1982.

c) Prepare a statement showing the profitability of 1982.

Solution:

Statement showing profit for 1981, computation of contribution per rupee of material and determination of priority for profitability

		A	B	C	D	Total
Sales	Rs.	3,200,000.00	800,000.00	2,400,000.00	1,600,000.00	8,000,000.00
Contribution	Rs.	640,000.00	48,000.00	288,000.00	160,000.00	1,136,000.00
Fixed cost	Rs.					1,000,000.00
Profit	Rs.					136,000.00

Variable cost	Rs.	2,560,000.00	752,000.00	2,112,000.00	1,440,000.00
Raw material cost	Rs.	1,280,000.00	376,000.00	1,056,000.00	720,000.00
Contribution per rupee	Rs.	0.50	0.13	0.27	0.22
Priority	Rs.	I	IV	II	III

Statement showing optimum mix under given conditions and computation of profit at that mix

	A	B	C	Total
	Rs.	Rs.	Rs.	Rs.
i) Sales	3,360,000.00	3,360,000.00	1,152,242.00	7,872,242.00
	(80x40%x105%)	(80x40%x10)	(w/n)	
ii) Variable cost				
a. Raw material	1,408,000.00	1,548,800.00	543,200.00	
	[32x(12.8/32)x110%]			
b. Other variable cost	1,280,000.00	1,408,000.00	493,818.00	
	2,688,000.00	2,956,800.00	1,037,018.00	6,681,818.00
iii) Contribution	672,000.00	404,000.00	115,224.00	1,190,424.00
iv) Fixed cost				1,000,000.00
v) Profit				190,424.00

Working notes

	Rs.
Available material	3,500,000.00
Less : utilised for	
A {(33.6)x(12.8x1.1)/(3.2 x1.05)]	1,408,000.00
C {(33.6)x(10.56x1.1)\(24x1.05)}	1,548,800.00
	543,200.00

Sales of D to be produced

Let X be sales

$[(X \times 7.2 \times 1.1)/16 \times 1.05] = 543200$

X = Rs. 1,152,242

Problem No.29.

A small-scale manufacturing unit has employed skilled persons for doing pressing and welding operations on various products. The welders produce two different products, W_1 and w_2. The press operators also produce two products, p_1 and p_2. Due to specific skill requirements, the press operators can't do welding job and vice-versa. The labour hours and cost data in respect of the above 4 products are as under.

	W_1	W_2	P_1	P_2
Hours per unit	4	4	5	2
Price per unit (Rs.)	50	50	80	65
Direct Material per unit (Rs.)	18	22	35	45
Direct Labour Rate per hour	Rs.4	4	4	4
Variable Overheads per unit	Rs. 2	2	3	3

The unit incurs Rs.50,000 per annum on fixed costs for producing the above products. The available labour hours for welding are 20,000 and for pressing 16,000.

The unit has also observed that the market can absorb minimum 2,000 units of W_1 2,500 units of W_2 1,800 units of P_1 and 2,200 units of P_2. The demand keeps on fluctuating. The manager of the shop has, therefore suggested that the workers should be trained to do either of welding or pressing job so that any excess demand can be fulfilled. It is estimated that this decision will increase the burden of fixed costs by Rs.5,000 p.a.

Required:

(a) Present the figures of optimum product mix assuming that the minimum marketable quantity is produced before the workers are trained and after they are trained.

(b) Prepare profitability statement for optimum product mix under both the above conditions and recommend whether it is advisable to train employees.

Solution: Statement showing computation per hour and determination of priority

	W1	W2	P1	P2
	Rs.	Rs.	Rs.	Rs.
i) Selling price	50.00	50.00	80.00	65.00
ii) Variable cost				
a. direct material	18.00	22.00	35.00	45.00
b. direct wages	16.00	16.00	20.00	8.00
c. variable overheads	2.00	2.00	3.00	3.00
	36.00	40.00	58.00	56.00
iii) Contribution	14.00	10.00	22.00	9.00
iv) Contribution per hour	3.50	2.50	4.40	4.50
v) Priority	III	IV	II	I

Statement showing calculation of profit before workers are trained

	W_1	W_2	P_1	P_2	Total
Minimum units	2,000.00	2,500.00	1,800.00	2,200.00	
Units in remaining time	500.00			1,300.00	
i) Total units	2,500.00	2,500.00	1,800.00	3,500.00	
ii) Contribution per unit	14.00	10.00	22.00	9.00	
iii) Total contribution	35,000.00	25,000.00	39,600.00	31,500.00	131,100.00
iv) Fixed cost					50,000.00
v) Profit					81,100.00

Working Notes:

	W_1 hours	P_2 hours
Available hours	20,000.00	16,000.00
Less : used for minimum	18,000.00	13,400.00
	2,000.00	2,600.00
units (2000/4)	500.00 (2600/2)	1,300.00

Statement showing calculation of profit after conversion

		W_1	W_2	P_1	P_2	
Minimum units		2,000.00	2,500.00	1,800.00	2,200.00	
Units in remaining time					2,300.00	
i) Total units		2,000.00	2,500.00	1,800.00	4,500.00	
ii) Contribution per unit	Rs.	14.00	10.00	22.00	9.00	
iii) Total contribution	Rs.	28,000.00	25,000.00	39,600.00	42,500.00	133,100.00
iv) Fixed cost	Rs.					55,000.00
v) Profit	Rs.					78,100.00

From the above, it is not advisable to convert the machines into versatile machines.

Problem No.30.

PH Ltd., has a productive capacity of 2,00,000 units of product BXE per annum. The company estimated its normal capacity utilisation at 90% for 1986-87.   The variable costs are Rs.22 per unit and the fixed factory overheads were budgeted at Rs.7,20,000 per annum. The variable selling overheads amounted to Rs.6 per unit and the fixed selling expenses were budgeted at Rs.5,04,000. The operating data for 1986-87 are as under:

Production	1,60,000 units
Sales @ Rs.40 per unit	1,50,000 units
Opening stock of finished goods	10,000 units

The cost analysis revealed an excess spending of variable factory overheads to the extent of Rs.80,000. There are no variances in respect of other items of cost.

Required:

(i)   Determine the budgeted break-even point for 1986-87

(ii)   What increase in price would have been necessary to achieve the budgeted profit?

(iii)   Present statements of profitability for 1986-87 using:
   (a) Marginal costing basis.
   (b) Absorption costing basis.

Solution:

Fixed cost =   Fixed overheads + selling expenses = 720000+504000 = 1224000

	Rs.
I Selling price	40.00
II Variable cost	28.00
III Contribution	12.00

 Break even at budget= (1224000/12) = 102000 units

i)   Contribution at budget = [(200000x90%)x12]   2160000

	Rs.
Contribution per unit (2160000/150000)	14.40
Add : Variable cost	28.00
	42.40
Standard variable production cost	22.00
Add: Standard fixed cost (720000/200000x90%)	4.00
	26.00

Profit under Absorption Costing

		Units	Rs.	Rs.
Standard Variable cost	(160000x22)			3,520,000.00
Add : Variance				80,000.00
				3,600,000.00
Add : Fixed production cost absorbed	(160000x4)		680,000.00	
Add : Under recovery	(720000-680000)		40,000.00	720,000.00
		160,000.00		4,320,000.00

Add : Opening stock		10,000.00		260,000.00
				4,580,000.00
Less : Closing stock		20,000.00	(43.2x2/1.6)	540,000.00
				4,040,000.00
Add : selling & dis. Cost				
Variable	(150000x6)		900,000.00	
Fixed			504,000.00	1,404,000.00
Total cost				5,444,000.00
profit (b/f)				556,000.00
Sales	(150000x40)			6,000,000.00
Profit under Marginal Costing				
i) Sales				6,000,000.00
ii) Variable cost				
Production			3,600,000.00	
Add : opening	(10000x22)		220,000.00	
			3,820,000.00	
Less : closing	20000x36/10)		450,000.00	3,370,000.00
Selling & distribution				900,000.00
				4,270,000.00
iii) Contribution				1,730,000.00
iv) Fixed cost				1,224,000.00
v) Profit				506,000.00

Problem No.31.

An umbrella manufacturer marks an average net profit of Rs.2.50 per piece on a selling price of Rs.14.30 by producing and selling 6,000 pieces or 60% of the capacity. His cost of sales is

	Rs
Direct material	3.50
Direct wages	1.25
Works overheads (50% fixed)	6.25
Sales overheads (25% variable)	0.80

During the current year, he intend to produce the same number but anticipates that fixed charges will go up by 10% which direct labour rate and material will increase by 8% and 6% respectively but he has no option of increasing the selling price. Under this situation, he obtains an offer for furthur 20% of the capacity. What minimum price you recommend for acceptance to ensure the manufacturer an overall profit of Rs.16,730.

Solution:

Statement showing computation of profit at present after increasing of:

	Particulars	Amount (Rs.)	Amount (Rs.)
I.	Selling Price		14.30
II.	Variable Cost:		
	Direct Material 3.5 x 106%	3.710	
	Direct Labour 1.25 x 108%	1.350	
	Works Overhead	3.125	
	Sales Overhead	0.200	8.385
III.	Contribution (I-II)		5.915
IV.	Total Contribution (6000 x 5.915)		35,490
V.	Fixed cost [(6000 (3.125 + 0.60) x 110/100]		24,585
VI.	Profit		10,905

Computation of Selling Price of the order:

Variable Cost (2000 x 8.385)	16,770
(+) Profit Required (16730 – 10905)	5,825
Sales required on the order	22,595

Selling Price   = 22,595/2000 = 11.2975 (or) 11.30

Problem No.32.

Y Company has just been incorporated and planed to produce a product that will sell for Rs. 10 per unit. Preliminary market surveys show that demand will be around 10,000 units per year. The company has the choice of buying one of the two machines 'A' would have fixed costs of Rs.30,000 per year and would yield a profit of Rs.Rs.30,000 per year on the sale of 10,000 units.   Variable costs behave linearly for both machines. Machine B would have F.c of Rs. 18,000 p.a. and would yield a profit of Rs.22,000 p.a. on the sale of 10,000 units.

Required to:

    a) Break-even sales for each machine

    b) Sales level where both machines are equally profitable

    c) Range of sales where one machine is more profitable than the other.

Solution:

a)   Statement Showing Computation of Break even of each machine, Calculation of indifference point & range of sales where each machine is profitable.

	Particulars		A	B
I.	Selling Price	Rs.	10	10
II.	No. of units		10,000	10,000
III.	Sales	Rs.	1,00,000	1,00,000
IV.	Fixed Cost	Rs.	30,000	18,000
V.	Profit	Rs.	30,000	22,000

VI.	Contribution	Rs.	60,000	40,000
VII.	Contribution Per unit	Rs.	6	4
VIII.	Variable Cost Per Unit	Rs.	4	6
	Break Even Sales	Rs.	50,000	45,000
	Break Even units		5000	4500

b)   Sales Level where both machines are equally profitable =

$$= \frac{Difference\ in\ Fixed\ Cost}{Difference\ in\ Variable\ Cost\ Per\ Unit} = \frac{12000}{2} = 6000\ units$$

c)   For the units $\geq$ 6000 units machine A is more profitable because Variable Cost Per   unit   is less for sales level below 6000 units Machine B is more Profitable because its   Variable Cost Per Unit is more.

Problem No.33.

A farmer owns an orchard which has an area of 300 acres on which he grows apples, apricots, Cherrie and plums. Of the total area, 200 acres of land are suitable for growing apricots and cherries and in the remaining acres of land any of the four fruits can be grown.

The marketing policy requires that in each season all the four types of fruits must be produced and the quantity of any one of the four fruits should not be less than 12,000 boxes.

It is essential that the area devoted to any one should be in terms of complete acres and not in fractions of an acre. There are no physical or marketing limitations and there is an adequate supply of all types of labour

The details regarding the selling price, production and cost are given below

	Apples	Apricots	Cherries	Plums
Selling price per box Rs	10	10	20	30
Acreage at each present devoted to each line	120	70	80	30
Seasons yield in boxes per acre	500	150	100	200
Weight per box kg	30	30	40	20
Costs (Rs.):				
Direct: Material per acre	180	70	60	100
Labour:				
Growing per acre	200	150	100	130
Harvesting & Picking per box	1	1	2	3
Transport per box	2	2	1	3

Fixed overhead incurred each season:

	Rs	Basis of apportionment to produce
Cultivation and growing	27,840	Direct labour cost incurred
Harvesting	20,900	Direct labour cost incurred
Administration	42,250	No. of boxes produced
Transport	5,110	Weight produced
Land revenue	9,000	No. of acres cultivated

Using above information, you are required to:

a) Calculate profit and loss per box of each type of fruit that the farmer will obtain from operating the orchard on the present basis.

b) Advise the farmer on the area to be allocated to each item in order to earn the maximum total profit.

Solution:

(a)   Statement showing computation of profit per box of each crop if the Orchard is maintained on the present basis.

	Particulars		Apples	Apricots	Cherries	Plums	Total
I.	Selling Price	Rs.	10	10	20	30	
II.	No. of boxes		60000	10500	8000	6000	84500
III.	Total Weight in kgs (No. of boxes x Wt per box)		1800000	315000	320000	120000	2555000
IV.	Sales	Rs.	600000	105000	160000	180000	1045000
V.	Variable Cost	Rs.					
	Direct Material	Rs.	21600	4900	4800	3000	34300
	Growing	Rs.	24000	10500	8000	3900	46400
	Harvesting	Rs.	60000	10500	16000	18000	104500
	Transport	Rs.	120000	21000	8000	18000	167000
		Rs.	225600	46900	36800	42900	352200
VI.	Contribution (Sales – Variable Cost)	Rs.	374400	58100	123200	137100	692800
VII.	Fixed Cost						
	Cultivation & Growing	Rs.	14400	6300	4800	2340	27840
	Harvesting	Rs.	12000	2100	3200	3600	20900
	Administration	Rs.	30000	5250	4000	3000	42250
	Transport	Rs.	3600	630	640	240	5110
	Land Revenue	Rs.	3600	2100	2400	900	9000
		Rs.	63600	16380	15040	10080	105100
VIII.	Profit	Rs.	310800	41720	108160	127020	587700
IX.	Profit Per box	Rs.	5.18	3.97	13.52	21.17	6.95
X.	Contribution per acre	Rs.	3120	830	1540	4570	
	Priority		II	IV	III	I	

b)   Statement showing optimum mix under the given conditions:

Particulars	Apples	Apricots	Cherries	Plums	Total
Minimum boxes to produce	12000	12000	12000	12000	
Area required for this minimum (acres)	24	80	120	60	284
Remaining Area (acres)	--	--	--	16	16
No. of acres	**24**	**80**	**120**	**76**	**300**

Problem No.34.

Taurus Ltd. produces three products A, B and C from the same manufacturing facilities. The cost and other details of the three products are as follows:

	A	B	C
Selling price per unit (Rs.)	200	160	100
Variable cost per unit (Rs.)	120	120	40
Fixed expenses/month (Rs.)	2,76,000		
Maximum production per month (units)	5,000	8,000	6,000
Total hours available for the month	200		
Maximum demand per month (units)	2,000	4,000	2,400

The processing hour cannot be increased beyond 200 hrs per month.

You are required to:

(a) Compute the most profitable product-mix.

(b) Compute the overall break-even sales of the co., for the month based in the mix calculated in (a) above.

<u>Solution:</u>

Statement showing computation of 'Contribution' per hour and determination of priority for profitability:

	Particulars		A	B	C
I.	Selling Price	Rs.	200	160	100
II.	Variable Cost	Rs.	120	120	40
III.	Contribution	Rs.	80	40	60
IV.	No. of units per hour [Assuming only one product is made during the entire month]		25 (5000/200)	40 (8000/200)	30 (6000/200)
V.	Contribution per hour	Rs.	2000 (25 x 80)	1600 (40 x 40)	1800 (60 x 30)
VI.	Priority		I	III	II

Statement Showing optimum mix under the given conditions and computation of Profit and Break-Even at that Mix.

	Particulars	A	B	C	Total
		Rs.	Rs.	Rs.	Rs.
I.	No. of units	2000	1600	2400	
II.	Sales	400000	256000	240000	896000
III.	Contribution	160000 (2000 x 80)	64000 (1600 x 40)	144000 (2400 x 60)	368000
IV.	Fixed Cost				276000
V.	Profit				92000

$$Break\ Even\ Sales = \frac{Fixed\ Cost\ x\ Sales}{Contribution} = \frac{276000 \times 896000}{368000} = Rs.\,672000$$

Working Notes:

Available Hours	=	200
(-) used for A (2000/25)	=	80
		120
(-) used for C (1800/30)	=	60
		40Hrs

Units of B = 40 x 40 = 1600Units

Problem No.35.

S.G Ltd produces four products in its factory. The volume of production and sales achieved is considerably lower than normal and so there has been substantial under recovery of overheads. The sales and cost particulars are as under:

					(Rs. In lakhs)
			Products		
	A	B	C	D	Total
Sales	160	200	80	40	480
Costs:					
Direct Material	24	32	16	3	75
Direct Wages	40	48	32	8	128
Factory Overheads	48	64	40	8	160
Selling & Admn. (15% Sales)	24	30	12	6	72
Total	136	174	100	25	435
Profit / Loss	24	26	(20)	15	45
Under recovery of overheads					24
Profit before tax					21

40% of factory overheads are variable at normal volume and the selling and administration overheads are variable to the extent of 5% of sales. 20% of sales of product C are done in connection with Product A in as much as the discontinuance of Product C will bring down the sale of Product A by 10%. Alternatively, the sale of product C can be reduced to 20% of the present level to maintain the sales of product A.

The view of the loss reported for Product C the management has for consideration three proposals, viz;

a) Discontinue product C. In that event the co. can save a sum of Rs.8 lakhs p.a. in fixed expenses.

b) Maintain the sales of product C to the extent of 20% of the present sales as sales as service to product A. In that event the reduction of fixed expenses will be Rs.3 lakhs p.a.

c)Discontinue product C totally and increase the sales of product D for which demand is available to the extent of another Rs.40 lakhs. This can be done without any change in fixed expenses.

Draft a report to the management bringing out the financial implications of the aforesaid three proposals as compared with the annual operating results generating a profit before tax of Rs.21 lakhs. Suggest a source of action to be followed by the S.G Ltd.

Solution:

Computation of Variable Factory Overheads

Rs. In lakhs

	A	B	C	D	Total
	Rs.	Rs.	Rs.	Rs.	Rs.
Fixed Overheads recovered	48	64	40	8	160
(+) under recovery (6:8:5:1)	7.2	9.6	6	1.2	24
Overheads at normal value	55.2	73.6	46	9.2	184
40% Overheads Variable	22.08	29.44	18.4	3.68	73.6
Fixed Overhead	**33.12**	**44.16**	**27.6**	**5.52**	**110.4**

Presentation of data in 'Contribution' format

Rs. In lakhs

		A	B	C	D	Total
		Rs.	Rs.	Rs.	Rs.	Rs.
I.	Sales	160	200	80	40	480
II.	Variable Cost					
	Direct Material	24	32	16	3	75
	Direct Wages	40	48	32	8	128
	Variable Overheads	22.08	29.44	18.4	3.68	73.6
	Variable Selling & Distribution Overheads.	8	10	4	2	24
		44.08	119.44	70.4	16.68	300.6
III.	**Contribution**	**65.92**	**80.56**	**9.6**	**23.22**	**179.4**
IV	Fixed Cost					
	Fixed Factory Overheads	33.12	44.16	27.6	5.52	110.4
	Fixed Selling & Distribution Overheads	16	20	8	4	48
		49.12	64.16	35.6	9.52	158.4
V.	Profit/Loss	16.8	16.4	(26)	13.8	20.56

a)   Computation of Profit at course of Action a

Rs. In lakhs

		A	B	D	Total
I.	Contribution (65.92 – 10%)	59.328	80.56	23.32	163.208
II.	Fixed Cost				150.400
III.	Profit				12.808

b)

Rs. In lakhs

		A	B	C	D	Total
I.	Contribution	65.92	80.56	1.92	23.32	171.72
II.	Fixed Cost					155.40
III.	Profit					16.32

c)

Rs. In lakhs

		A	B	D	Total
I.	Contribution	59.328	80.56	46.64	186.528
II.	Fixed Cost				158.400
III.	Profit				28.128

From the above computation, it was found that profit is more in the course of action C i.e., discounting in Product C completely & increasing the sales of Product D at 100%, it is the best course of action to be suggested.

Problem No.36.

T.T.D Ltd., manufacturing a single product has normal working capacity of 8,000 units per annum. The sales manager has projected a sale of 10,000 units for the year 1993-94 at a price of Rs.250 per unit.

The operating budget for 1993-94 as under:

	Rs. in lakhs	Rs. in lakhs
Sales: 8,000 units @ Rs.250 each		20.00
Cost of production		
Raw material	12.00	
Direct wages	3.00	
Works overhead (50% Fixed)	1.40	
Admn. overhead (all fixed)	0.60	
Selling & Distribution OH (80% fixed)	1.00	18.00
		2.00

In order to increase production to meet the sales demand, two proposals have been put forward as under:
1) Subcontracting the production of 2,000 units at Rs.225 per unit.
2) Installing additional machine which will entail the following expenses :
    a) Cost of machine Rs.2,00,000; Life 20 years
    b) Recruitment of 10 workers including direct workers to operate the machine at a wage rate of Rs.500 each per month. Add 25% towards fringe benefits. (None of the existing workers will be utilised for this purpose).
    c) Interest on capital required for the purchase of machine 15% p.a.

The following additional fixed expenses will be required in respect of both alternatives.

Administration expenses - Rs.10,000 per year.

Selling & Distribution expenses - Rs.20,000 per year.

You are required to prepare
 (1) A statement showing respective profitability of the two methods of increasing the production.
 (2) Comment upon the choice of one of the two proposals.

Solution:
Statement Showing Computation of Profit at Proposed alternatives as well as present position:

		Present Position (8000)	Sub Contract (10000)	Own Expansion (10000)
		Rs. In lakhs	Rs. In lakhs	Rs. In lakhs
I	Sales	20	25	25
II.	Variable Cost			
	Raw Materials	12	12	15
	Direct Wages	3	3	3
	Works Overhead	0.7	0.7	0.875
	Selling & Distribution Overhead	0.2	0.2	0.25
	Sub Contract Cost	--	4.5	--
	Add Workers	--	--	0.75
		15.9	20.4	19.875
III.	Contribution	4.1	4.6	5.125
IV.	Fixed Cost	2.1	2.4	2.8
V.	Profit	2.0	2.2	2.325

The best proposal is to produce by their own to meet the additional demand by installing a new machine because it has highest profit.

Problem No.37.

SV Ltd engaged in the manufacture of four products has prepared the following budget for 1989.

Production Units	20,000	5,000	25,000	15,000
Selling price Rs/unit	21.75	36.75	44.25	64.00
Direct Materials Rs/unit	6.00	13.50	10.50	24.00
Direct Wages Rs/Unit	7.50	10.00	18.00	24.00
Variable Overheads Rs./unit	5.00	6.00	6.50	2.25
Fixed Overheads Rs.p.a.	75,000	25,000	2,25,000	1,80,000

When the budget was discussed, it was proposed that the production should be increased by 10,000 units for which capacity existed in 1989.

It was also decided that for the next year i.e.1990, the production capacity should be further increased by 25,000 units over and above the increase of 10,000 units envisaged as above for 1989. The additional production capacity of 25,000 units should be used for the manufacture of product 'B' for which new production facilities were to be created at an annual fixed overhead cost of Rs.35,000. The direct material costs of all the four products were expected to increase by 10% in 1990 while the other costs and selling prices would remain the same.

Required: -

(a) Find the profit of 1989 on the assumption that the existing capacity of 10,000 units is utilised to maximize the profit.
(b) Prepare a statement of profit for 1990.
(c) Assuming that the increase in the output of product 'B' may not fully materialise in the year 1990, find the number of units of product B to be sold in 1990 to earn the same overall profit as in 1989.

Solution:

a)   Statement showing computation of profit for the year 1989

			A	B	C	D	Total
I.	Selling Price	Rs.	21.75	36.75	44.25	64.0	
II.	Variable Cost	Rs.	15.75	28.50	34.50	54.5	
III.	Contribution	Rs.	6.0	8.25	9.75	9.5	
IV.	No. of units		20000	5000	35000	15000	
V.	Total Contribution	Rs.	120000	41250	341250	142500	645000
VI.	Fixed Cost	Rs.	75000	25000	225000	180000	505000
VII.	Profit	Rs.					140000

b)   Profit for the year 1990

			A	B	C	D	Total
I.	No. of Units		20000	30000	35000	15000	
II.	Contribution Per Unit	Rs.	5.4	6.9	8.7	7.1	
III.	Total Contribution	Rs.	108000	207000	304500	106500	726000
IV.	Fixed Cost	Rs.					540000
V.	Profit	Rs.					186000

c)   In order to get the profit of 1989, the 'Contribution' to be recovered as follows:

	Rs.
Profit for the year 1989	140000
Existing Fixed Cost	505000
Additional Fixed Cost	35000
	680000
(-) 'Contribution' Recovered from A,C,D	519000
To be recovered from 'B'	161000

No. of units of B required = 161000 / 6.9 = 23,333units

Additional units minimum required = 23,333 – 5000 = 18,333units

Problem No.38.

(a)   A firm produces 5 different products from a single raw material. Raw material is available in abundance at Rs.6 per kg. The labour rate is Rs.8 per hour for all products. The plant capacity is 21,000 labour hours for the budget period. Production facilities can produce the products. The factory overhead rate is Rs.8 per hour, comprising Rs.5.60 per hour fixed overhead and Rs.2.40 per hour as variable overhead. The selling commission is 10% of the product price. Given the following information, you are to suggest a suitable sales mix which will maximise the company's profits. Determine the profits that will be earned at the selected sales mix.

Product	Market Demands (Units)	Selling Price	Labour Hours Per Unit	Raw Material Required Per Unit (in gms)
A	4,000	32.00	1.00	700
B	3,600	30.00	0.80	500
C	4,500	48.00	1.50	1,500
D	6,000	36.00	1.10	1,300
E	5,000	44.00	1.40	1,500

(b) Assume, in above situation, 3,500 hours of over time working is possible. It will result in additional fixed overheads of Rs.20,000; a doubling of labour rates and a 50% increase in variable overheads. Do your recommend to overtime working?

Solution:

(a) **Statement showing contribution per labour hour and ranking :**

		A	B	C	D	E
		Rs.	Rs.	Rs.	Rs.	Rs.
I.	Selling Price	32	30	48	36	44
II.	Variable Cost					
	Raw Materials	4.2	3	9	7.8	9
	Labour	8	6.4	12	8.8	11.2
	Variable Overhead	2.4	1.92	3.6	2.64	3.36
	Selling Commission	3.2	3.00	4.8	3.6	4.4
	Total	17.8	14.32	29.4	22.84	27.96
III.	Contribution	14.2	15.68	18.6	13.16	16.04
IV.	Contribution per hour	14.2	19.6	12.4	11.96	11.45
		II	I	III	IV	V

Working Notes:

	hrs.
Available hours	21,000
(-) Utilized for B 3600 x 0.8	2,880
	18,120
(-) for A	4,000
	14,120
(-) for C	6,750
	7,370
(-) for D	6,600
	770

No. of units of E = 770 / 1.4 = 550 units

Statement showing optimum mix and its profits under the given conditions

			A	B	C	D	E	Total
I.	No. of Units		4000	3600	4500	6000	550	
II.	Contribution Per Unit	Rs.	14.2	15.68	18.6	13.16	16.04	
III.	Total Contribution	Rs.	56,800	56,448	83,700	78,960	8,822	2,84,730
IV.	Fixed Cost	Rs.	22,400	16,128	37,800	36,960	4,312	1,17,600
V.	Profit	Rs.	34,400	40,320	45,900	42,000	4,510	1,67,130

(b) **If overtime is used for Product E,**

		Rs.
Contribution obtained = 11.45 x 3500		40,075
Less: Additional Fixed Cost	20,000	
Overtime Labour Cost 3500 x 8	28,000	
Addl. Variable Cost 3500 x 1.2	4,200	52,200
	Loss	12,125

Hence overtime working is not recommended.

Problem No.39.

Akshara combines manufactures 3 components X, Y and Z which are made up from 3 parts A, B and C in the following proportions:

X	1A and 1B
Y	2A, 2B and 1C
Z	3A, 1B and 2C

These parts are made on the premises. Further information as follows:

	A	B	C
Selling price	Rs 6	Rs 14	Rs 24
Direct materials	2	2	5
Time cost	2	9	12

Time cost which covers the cost of direct labour and overheads is valued at Rs.6 per hour. All parts can be sold individually at the above selling prices, but the market demand, which it is hoped, will be satisfied from the expansion will be for the components. The furthur expansion would provide an additional 58,000 hours and the additional market demand for the components would be 5,000 units each. Additional fixed expenses related to the expansion are expected to be Rs.15,000.

Prepare a statement showing how the additional capacity available should be used to generate maximum additional profit.

Solution:

Statement showing computation of 'Contribution' per hour & determination of priority for profitability:

		X	Y	Z
		Rs.	Rs.	Rs.
I.	Selling Price	20	64	80
		(6 + 14)	(12+28+24)	(18+14+48)
II.	Variable Cost			
	Direct Material	4	13	18
	Time Cost	11	34	39
		15	47	57
III.	Contribution	5	17	23
IV.	Contribution Per Hour	2.73	3.00	3.54
		$\dfrac{5}{11/6}$	$\dfrac{17}{34/6}$	$\dfrac{23}{39/6}$
V.	**Priority**	III	II	I

Statement showing optimum mix and its profit under the given conditions

			X	Y	Z	Total
I.	No. of Units			4500	5000	
II.	Contribution Per Unit	Rs.		17	23	
III.	Total Contribution	Rs.		76500	115000	191500
IV.	Fixed Cost	Rs.				15000
V.	Profit	Rs.				176500

Available hours		=	58000
(-) hours used for Z	(5000 x 39/6)	=	32500
			25500

No. of units produced by Y = 25500   = 4500 units
                                34/6

Problem No.40.

AB Ltd. manufactures three products. The standard selling prices and costs have been estimated for 1985 as follows:

	Per Unit		
	X	Y	Z
Selling Price	Rs 28	Rs 60	Rs 125
Direct materials	8	15	20
Direct wages	10	20	50
Variable overheads	5	10	25

Direct wages are paid at the rate of Rs.2 per hour in each case. Fixed overheads are budgeted at Rs.25,000 for the coming year.

In short run, the company cannot increase its direct labour strength and as a result, only 35,000 direct labour hours will be available in the coming year. The company has commitments to produce 500 units of each product.

It has been suggested that after meeting the minimum requirements for X, Y and Z, the balance of available direct labour hours should be used to produce the product Z.

You are required to:

    (a) to prepare an income statement showing the expected results if the proposal is adopted

    (b) comment on the statement you have produced in (a) and prepare an income statement for any alternative policy which you consider would be more profitable.

    (c) Basing your calculations on your suggestion in (b), show the company's BEP in terms of units and sales value.

    (d) Show the sales value which is required to produce an after tax return of 10% on capital employed of Rs.1,00,000 assuming tax rate of 50%.

Solution:

(a)

Statement showing computation of Contribution per hour & determination of priority for profitability:

		X	Y	Z
		Rs.	Rs.	Rs.
I.	Selling Price	28	60	125
II.	Variable Cost	23	45	95
III.	Contribution	5	15	30
IV.	Contribution Per hour	1	1.5	1.25
	Priority	**III**	**I**	**II**

Computation of Profit at the proposal

			X	Y	Z	Total (Rs.)
	Minimum Units to be produced		500	500	500	
	Units in Remaining time		--	--	600	
I.	No. of Units		500	500	1100	
II.	Contribution Per Unit	Rs.	5	15	30	
III.	Total Contribution	Rs.	2500	7500	33000	43000
IV.	Fixed Cost	Rs.				25000
V.	Profit	Rs.				18000

Working Notes:

Available Hours	=	35000
(-) Hours for Minimum units	=	20000
		15000
Units of Z	=	15000 / 25 = 600 units.

(b)

Computation of profit at Optimum Mix

			X	Y	Z	Total (Rs.)
	Minimum Units to be produced		500	500	500	
	Units in Remaining time		--	1500	--	
I.	No. of Units		500	2000	500	
II.	Contribution Per Unit	Rs.	5	15	30	
III.	Total Contribution	Rs.	2500	30000	15000	47500
IV.	Fixed Cost	Rs.				25000
V.	**Profit**	Rs.				**22500**

Units of Y = 15000 / 10 = 1500 units

In order to break even 'C' must be equal to Fixed Cost

'Contribution' recovered from minimum units of each product.

X	= 500 x 5	=	2500
Y	= 500 x 15	=	7500
Z	= 500 x 30	=	15000
	Fixed Cost	=	25000

(c)   Break Even Units & Value

	Units	Value
		Rs.
X	500	14000
Y	500	30000
Z	500	62500
	1500	106500

(d)   Required Return before tax   =   1,00,000 x 10% / 0.5   = Rs.20,000

Sales of Y required to get this profit= 20,000 / 15 x 60 = Rs.80,000

Total sales required   = 1,06,500 + 80,000   = Rs.1,86,500

Problem No.41.

A company produces four products A,B,C, and D which marketed in cartons. Of the total of 20 machines installed, 8 are suitable for manufacturing all the four products and the remaining 12 machines are not suitable for the manufacture of products A and D.

Each machine is in production for 300 days per year and each is used on a given product in terms of full days and not in fractions of days. The company however has not problem in obtaining adequate supplies of labour and raw materials.

The marketing policy is that all four products should be sold and the minimum annual production should be 3000 cartons for each product. Fixed costs budgeted amount to Rs.50 lacs. production cost and price data are as under:-

	A	B	C	D
Production/day/machine (cartons)	14	4	3	6
Selling price/carton	Rs.810	790	845	1290
Cost: Process I				
Direct Materials/day.				
Machine	Rs.140	52	45	84
Direct Labour/day/Machine	224	148	90	132
Process II				
Direct Material/Carton	Rs. 30	30	30	30
Direct Labour/Carton	Rs.240	216	300	360
Variable Overheads/Carton	Rs.390	390	300	720

With a view to meeting the increasing demand for products A and D, the company is contemplating to convert such number of machines as may necessary out of the 12 machines which at present are unsuitable to produce products A and D into all purpose machines. The cost of conversion of these machines is Rs.2,10,000 per machines. The expenditure is to be amortized over a period of three years. The company expects 12.5% return on this expenditure. Market research indicates that the company's sales products A and D can be increased to 37,500 cartons and 5,400 cartons respectively.

Required:

(a) Calculate the optimum profit of the company if the existing machines were worked on most profitable basis before conversion.

(b) Recommend the maximum number of machines to be converted into all purpose machines giving supporting calculations.

(c) Calculate for the first year the optimum profit of the company after conversion of the required number of machines into all-purpose machines.

<u>Solution:</u>

Statement showing computation of Contribution per machine days determination of priority for profitability.

		A	B	C	D
		Rs.	Rs.	Rs.	Rs.
I	Selling price per carton	810	790	845	1290
II	Variable Cost				
	Process 1				
	Direct Material	10	13	15	14
	Direct Labour	16	37	30	22
	Process 2				
	Direct Material	30	30	30	30
	Direct Labour	240	216	300	360
	Variable Overheads	390	390	300	720
		686	686	675	1146
III	Contribution per carton	124	104	170	144
IV	Contribution per machine day	1736	416	510	864
V	Priority	I	IV	III	IV

Statement showing optimum mix under the given conditions & Computation of profit at that mix.

		A	B	C	D	Total
	Minimum no. of cartons to be produced	3000	3000	3000	3000	
	Cartons in the remaining machine days	23590 (1685x14)		5550 (1850 x 3)		
I	No. of Cartons	26590	3000	8550	3000	
II	Contribution per Carton	124	104	170	144	
III	Total Contribution	32,97,160	3,12,000	14,53,500	4,32,000	54,94,660
IV	Fixed Cost					50,00,000
V	Profit					4,94,660

Available Machine days	(300 x 8)		(300 x 12)
	2400		3600
A = 3000/14	215	B = 3000/4	750
D = 3000/6	500	C = 3000/3	1000
Machine Days	1685		1850

(b)   Computation of No. of machines to be converted

	A	D
Maximum Production	37500	5400
No. of machine days required	2679	900
	(37500/14)	(5400/6)

Total machine days required to meet the demand = 2679 + 900	=	3579
(-) Machine days already available	=	2400
No. of machine days further required	=	1179

No. of machines required to be converted   = 1179/300 = 3.93 (say) 4

(c)   Computation of Optimum Mix after conversion & Profit.

			A	B	C	D	Total
I	No. of cartons		37500	3000	5014	5400	
II	Contribution per carton	Rs.	124	104	170	144	
III	Total Contribution	Rs.	4650000	312000	852380	777600	6591980
IV	Fixed Cost	Rs.					5280000
V	Profit	Rs.					1311980
	(-) Capital cost @ 12.5% on 840000	Rs.					105000
						Rs.	1206980

Total No. of Machine days (20 x 300)   = 6000.00

$$A \quad - \quad 37500/14 \quad = \quad 2678.57$$
$$B \quad - \quad 3000/4 \quad = \quad 750.00$$
$$C \quad - \quad 5400/6 \quad = \quad 900.00 \quad \underline{4328.57}$$

Machine days available to 'Contribution'   = 1671.43

No. of Cartons produced by Contribution   =   1671.43 x 3 = 5014

Problem No.42.

A firm has two machines, namely, machine 'P' and machine 'Q'. Machine 'P' can be used for the production of either product 'A' or product 'B' or both. Machine 'Q' can be used for the production of either product 'X' or product 'Y' or both. In order to maintain customer relations a minimum quantity of 1500 units each of 'A' and 'B' and 1200 units each of 'X' and 'Y' should be produced by the firm.

The production and cost data for 1984 are as under:

Machine hours available   P-4500 hours

                                             Q-5100 hours

	PRODUCTS			
	A	B	X	Y
Machine used	P	P	Q	Q
Machine hours required per unit of out put	1.0	1.25	1.25	0.8
Selling price per unit	Rs.200	Rs.250	Rs.300	Rs.256
Direct material per unit	80	100	100	80
Direct labour per machine hour	90	80	100	125
Variable overhead per machine hour	12	12	20	20

Fixed overheads are Rs.4lacs per annum. An additional expenditure involving a fixed overhead of Rs.25,000 per annum will convert the machine P and Q into a versatile centre such that any four of the products can be manufactured on these two machines. The rate of output on these machines and direct wage rate will, however, remain the same. Required:

(i)   Set an optimal product mix subject to minimum market commitments both before and after the conversion of the machines into a versatile centre.

(ii)   Evaluate the profitability under the two sets or product mixes.

(iii)   Advise the management whether the conversion of machine should be undertaken or not.

Solution:

Statement showing computation of Contribution per machine hour & ranking thereon :

		A	B	X	Y
		Rs.	Rs.	Rs.	Rs.
I	Selling Price	200	250	300	256
II	Variable Cost				
	Direct Material	80	100	100	80
	Direct Labour	90	100	125	100
	Variable Overhead	12	15	25	16
		182	215	250	196
III	Contribution	18	35	50	60
IV	Contribution per hour	18	28	40	75
V	Priority	IV	III	II	I

Statement showing optimum product mix and profit thereon under the given condition before conversion of machines into Versatile:

		A	B	X	Y	Total
	Minimum units to be produced	1500	1500	1200	1200	
	Units in remaining hours	--	900	--	3300	
I	No. of units	1500	2400	1200	4500	
II	Contribution per unit	18	35	50	60	
III	Total contribution	27000	84000	60000	270000	441000
IV	Fixed Cost					400000
V	Profit					41000

Working Notes

		P		Q
Available Hours		**4500**		**5100**
A	1500 x 1		1200 x 1.25	
B	1500 x 1.25	3375	1200 x 0.8	2460
		1125		2640
No. of Units	= 1125/1.25	900	2640/0.8	3300

Statement showing optimum mix under the given condition & computation of profit at that mix after conversion of machines into Versatile:

			A	B	X	Y	Total
	Minimum units to be produced		1500	1500	1200	1200	
	Units in remaining hours		--	--	--	4706.25	
I	No. of units		1500	1500	1200	5906.25	
II	Contribution per unit	Rs.	18	35	50	60	
III	Total contribution	Rs.	27000	52500	60000	354375	493875
IV	Fixed Cost	Rs.					425000
V	Profit	Rs.					68875

Working Notes:

Total No. of hours		=	9600	
Hours utilized (3375 + 2460)		=	5835	
			3765	
Units of Y	= 3765 / 0.8	=	4706	Units

As the profit is increased by 27875/- it is advised to convert the machines into versatile centers.

Problem No.43.

Novelties Ltd. seeks your advice on production mix in respect of the three products Super, Bright and Fine. You have the following information:

Data for Standard Costs per Unit:

	Super	Bright	Fine
Direct Materials	Rs.320	Rs. 240	Rs.160
Variable overhead	16	40	24

Direct Labour:

Department:	Rate per Hour	Hours	Hours	Hours
A	Rs.8.00	6	10	5
B	16.00	6	15	11

From current budget, you have further details as below:

	Super	Bright	Fine
Annual production (No.s)	5,000	6,000	10,000
Selling price per unit (Rs.)	624	800	480
Fixed Overhead: Rs.16,00,000			
Sales department's estimate of maximum			
possible sales in the coming year (No.s)	6,000	8,000	12,000

You are also to note that there is a constraint on supply of labour in Department A and its manpower cannot be increased beyond its present level. Suggest the best production and sales mix from the standpoint of maximum profitability. Prepare statements setting out the profits resulting from the budgeted production and the best alternative suggested by you.

Solution:

Statement showing computation of Contribution per hour in Dept-A & determination of priority for profitability.

		Super	Bright	Fine
		Rs.	Rs.	Rs.
I	Selling Price	624	800	480
II	Variable Cost			
	Direct Material	320	240	160
	Variable Overhead	16	40	24
	Direct Labour			
	Dept – A	48	80	40
	Dept – B	96	240	176
		480	600	400
III	Contribution	144	200	80
IV	Contribution per labour hour in Dept. A	24	20	16
V	**Priority**	**I**	**II**	**III**

Statement showing computation of profit at current budgeted production:

			Super	Bright	Fine	Total
I	No. of units		5000	6000	10000	
II	Contribution	Rs.	144	200	80	
III	Total Contribution	Rs.	720000	1200000	800000	2720000
IV	Fixed Cost	Rs.				1600000
V	Profit	Rs.				1120000

No. of hours in Department A at budget = 6 x 5000 + 10 x 6000 + 5 x 10000 = 140000.

Statement showing optimum mix under the given condition & computation of profit at that mix:

			Super	Bright	Fine	Total
I	No. of units		6000	8000	4800	
II	Contribution Per unit	Rs.	144	200	80	
III	Total Contribution	Rs.	864000	1600000	384000	2848000
IV	Fixed Cost	Rs.				1600000
V	Profit	Rs.				1248000

Available hours   1,40,000

(-) used for super (6000x6)   36,000

                                   1,04,000

(-) used for Bright (8000x10)   80,000

                                   24,000

No. of units of fine = 24,000/5 = 4800 Units

Problem No.44.

ABC Ltd. manufactures only one product which are identical in every respect.

The following information relates to April and May 1986:

i)   Budgeted costs and selling prices:

	April	May
Variable manufacturing cost per unit	Rs. 2.00	Rs.2.20
Total fixed manufacturing cost		
(based on budgeted sales of	25,000 units	
per month)	40,000	44,000
Total fixed marketing cost (based on		
budgeted sales of 25,000 units per month)	14,000	15,400
Selling price per unit	5.00	5.50
ii) Actual production and sales achieved:	units	units
Production	24,000	24,000
Sales	21,000	26,500

(iii) There was no stock of finished goods at the beginning of April 1986. There was no wastage or loss of finished goods during either April or May 1986.

(iv) Actual costs incurred corresponded to those budgeted for each month.

Required:

Calculate the relative effects on the monthly operating profits of applying the following methods:

   (i)   Absorption costing and

   (ii)   Marginal costing.

Solution:

(i)   Profit under Absorption Costing

	April	May
	Rs.	Rs.
Variable Manufacturing cost	48000	52800
Fixed Manufacturing cost	38400 (40000/25000 x 24000)	42240 (44000/25000 x 24000)
Total production cost	86400	95040
(+) Op. Stock	--	10800
	86400	105840
(-) Cl. Stock	10800 (86400 x 3/24)	1980 (95040 x 5/24)
Production cost of goods sold	75600	103860
(+) Under recovery (40000 – 38400)	1600 (40000-38400)	1760 (44000-42240)
	77200	105620
(+) Marketing costs	14000	15400
	91200	121020
Profit	**13800**	**24730**
Sales	105000	145750

(ii)   Profit under Marginal Costing

			April		May
		Units	Rs.	Units	Rs
I	Sales		105000		145750
II	Variable Cost				
	Manufacturing	48000		52800	
	(+) Op. Stock	--		6000	
		48000		58800	
	(-) Cl. Stock	6000	42000	1100	57700
III	Contribution		63000		88050
IV	Fixed Cost		54000		59400
V	**Profit**		**9000**		**28650**

DECISION MAKING

Problem No.45.

(a) A machine which originally cost Rs.12,000 has an estimated life of 10 years and it depreciated at the rate of Rs.1,200 per year. It has been unused for some time, however, as expected production orders did not materialise. A special order has now been received which would require the use of the machine for two months. The current net realisable value of the machine is Rs.8,000. If it is used for the job, its value is expected to fall to Rs.7,500. The net book value of the machine is Rs.8,400. Routine maintenance of the machine currently costs Rs.40 per month. With use, the cost of maintenance and repairs would increase to Rs.60 per month. What would be the relevant cost of using the machine for the order so that it can be charged as the minimum price for the order?

(b) X Ltd. has been approached by a customer who would like a special job to be done for him and is willing to pay Rs.22,000 for it. The job would require the following materials:

Materials	Total units required	Units already in stock	Book Value of units in stock	Realisable Value	Replacement Cost
			Rs./unit	Rs./unit	Rs./unit
A	1,000	0	—	—	6
B	1,000	600	2	2.5	5
C	1,000	700	3	2.5	4
D	200	200	4	6	9

(i)   Material B is used regularly by X Ltd. and if stocks were required for this job, they would need to be replaced to meet other production demand.

(ii)   Materials C and D are in stock as the result of previous excess purchase and they have a restricted use. No other use could be found for material C but material D could used in another job as substitute for 300 units of material which currently cost Rs.5 per unit (of which the company has no units in stock at the moment.)

What are the relevant costs of material, in deciding whether or not to accept the contract? Assume all other expenses on this contract to be specially incurred besides the relevant cost of material is Rs.550.

Solution: a) Computation of relevant cost of using the machine for the order

		Rs
Fall in sale value, if used	(8000-7500)	500.00
Incremental maintenance cost	[(60-40)x2]	40.00
		540.00

b) Computation of relevant cost of the job

		Rs.
A	(1000x6)	6,000.00
B	(1000x5)	5,000.00
C	[(700x2.5)+(300x4)]	2,950.00
D	(300x5)	1,500.00
		15,450.00
Add : other expenses		550.00
		Rs. 1,6000.00

As the revenue from the order, which is more than the relevant cost of Rs.16000 the order should be accepted

Problem No.46.

Reel and Roll Ltd. manufactures a range of films extensively used in the cinema industry. The films once manufactured are packed in a circular container and stored in specially constructed crates lined with 'Protecto'. These crates are manufactured and maintained by a special department within the company and the department costs last year are as under :

	Rs	Rs
Direct materials (Including 'Protecto')		1,40,000
Direct Labour		1,00,000
		2,40,000
Overheads:		
Department manager	16,000	
Depreciation of machine	30,000	
Maintenance of machine	7,200	
Rent(portion of warehouse)	9,000	
Other miscellaneous costs	31,500	
		93,700
		3,33,700
Administration overhead (20% of direct costs)		48,000
		3,81,700

Pack Knack Associates have approached the Reel and Roll Ltd., offering to make all the crates required on a four year contract for Rs.2,50,000 per annum and/or to maintain them for further Rs.50,000 per annum.

The following data are relevant:

(i) The machine used in the department costs Rs. 2,40,000 four years ago and will last for four more years. It could be currently sold for Rs. 50,000.

(ii) A stock of 'protecto' was acquired last year for Rs.2,00,000 and one-fifth was used last year and included in the material cost. It originally cost Rs. 1,000 per tonne but the replacement cost is Rs.1,200 per tonne; and it could be currently sold for Rs.800 per tonne.

(iii) The department has acquired warehouse space for Rs.18,000 per annum. It uses only one-half of the space; the rest is idle.

(iv) If the department were closed, the Manager will be transferred to another department and the terminal benefits be met will amount to Rs. 15,000 per annum. In that event, Pack Knack Associates will undertake to manufacture and maintain the crates.

If the Reel and Roll Ltd., continued to maintain the crates, but left their manufacture to Pack Knack Associates.

(i) The machine will not be required.

(ii) The manager will remain in the department.

(iii) The warehouse space requirements will not be reduced.

(iv) Only 10% of all materials will be used.

(v) Only one worker will be dispensed with and taking the terminal benefit to be met into account, the saving will be Rs. 5,000 per annum.

(vi) The miscellaneous costs will be reduced by 80%.

If Reel and Roll Ltd., continue manufacture the crates but left their maintenance to Pack Knak Associates;

(i) The machine will be reduced.

(ii) The manager will remain in the department.

(iii) The warehouse space will be required.

(iv) 90% of all the materials will be required.

(v) The labour force will continue.

(vi) The miscellaneous costs will be reduced by 20%

Assuming that for the four-year period, there is no significant change envisaged in the pattern of other costs, you are required to evaluate the alternative courses of action with supporting figures of cash flows over the four-year period and advise accordingly.

Solution:

Statement showing evaluation of alternatives

	Manufacture & Maintenance	Only Manufacture	Only Maintenance
	Rs.	Rs.	Rs.
i) Outflows	**1,200,000.00**	**1,000,000.00**	**200,000.00**
ii) Inflows			
Direct material	100,000.00	90,000.00	10,000.00
direct labour	85,000.00	5,000.00	
Maintenance of machinery	7,200.00	7,200.00	
Rent	18,000.00		
Miscellaneous cost	31,500.00	252,000.00	6,300.00
Annually	241,700.00	127,400.00	16,300.00
Four yearly savings	966,800.00	509,600.00	65,200.00
Sale value of machine	50,000.00	50,000.00	
Sale of protecto	128,000.00	115,200.00	12,800.00
	1,144,800.00	674,800.00	78,000.00
iii) Net gain\(loss)	-55200	-325200	-122000

In all the three alternatives, outflows are more than inflows and therefore it is advisable not to close the operations of manufacture and maintenance

Problem No.47.

The Officers' Recreation Club of a large public sector undertaking has a cinema theater for the exclusive use of themselves and their families. It is a bit difficult to get good motion pictures for show and so pictures are booked as and when available. The theater has been showing the picture 'Blood Bath' for the past two weeks. This picture, which is strictly for adults only has been a great hit and the manager of the theater is convinced that the attendance will continue to be above normal for another two weeks, if the show of 'Blood Bath' is extended. However, another popular movie, eagerly looked forward to by both adults and children alike, 'Appu on the Airbus' is booked for next two weeks. Even if 'Blood Bath' is extended the theater has to pay the regular rental on 'Appu on the Airbus' as well. Normal attendance at theater is 2,000 patrons per week, approximately one fourth of whom are children under the age of 12. Attendance of 'Blood Bath' has been 50% greater than the normal total. The manager believes that this would taper off during the second two weeks, 25% below that of the first two weeks, during the third week

and 33 1/3 % below that of the first two weeks, during the fourth week. Attendance for 'Appu on the Airbus' would be expected to be normal throughout its run regardless of the duration.

All runs at the theater are shown at a regular price of Rs.2 for adults and Rs.1.20 for children fewer than 12. The rental charge for 'Blood Bath' is Rs.900 for one week or Rs.1,500 for two weeks. For 'Appu on the Airbus' it is Rs. 750 for one week or Rs. 1,200 for two weeks. All other operating costs are fixed - Rs.4,200 per week, except for the cost of potato wafers and cakes, which average 60% of their selling price, sales of potato wafers and cakes regularly average Rs.1.20 per patron, regardless of age. The Manager can arrange to show 'Blood Bath' for one week and 'Appu on the Airbus' for the following week or he can extend the show of 'Blood Bath' for two weeks or else he can show 'Appu on the Airbus' for two weeks as originally booked.
Show by computation, the most profitable course of action he has to pursue.

Solution:

Statement showing evaluation of alternatives

		Blood bath	Blood bath & Appu on the airbus	Appu on the airbus
		Rs.	Rs.	Rs.
No. of spectators				
Adults:				
Third week	3,000 x 75%	2,250.00	2,250.00	1,500.00
fourth week	3,000 x 2/3	2,000.00	1,500.00	1,500.00
		4,250.00	**3,750.00**	**3,000.00**
Children:				
Third week				500.00
fourth week			500.00	500.00
			500.00	**1,000.00**
Total spectators:		**4,250.00**	**4,250.00**	**4,000.00**
Revenue:				
By sale of tickets		8,500.00	8,100.00	7,200.00
				(3,000 x 2 + 1000 x 1.2)
Add : contribution from snacks		2,040.00	2,040.00	1,920.00
		10,540.00	**10,140.00**	**9,120.00**
Less : Incremental cost		1,500.00	900.00	
		9,040.00	**9,240.00**	**9,120.00**

It is found that the net revenue is more at the option of running blood bath and Appu on the Air bus a week each, it must be chosen.

Problem No.48.

A review, made by the top management of Sweat and Struggle Ltd. which makes only one product, of the result of the first quarter of the year revealed the following:

Sales in units	10,000
Loss	Rs. 10,000
Fixed cost (for the year Rs.1,20,000)	Rs. 30,000
Variable cost per unit	Rs. 8.00

The Finance Manager who feels perturbed suggests that the company should at least break-even in the second quarter with a drive for increased sales. Towards this, the company should introduce better packing which will increase the cost by Rs.0.50 per unit.

The Sales Manager has an alternative proposal. For the second quarter additional sales promotion expenses a can be increased to the extent of Rs.5,000 and a profit of Rs. 5,000 can be aimed at during the period with increased sales.

The Production Manager feels otherwise. To improve the demand, the selling price per unit has to be reduced by 3%. As a result the sales volume can be increased to attain a profit level of Rs. 4,000 for the quarter.

The Manager Director asks you as a Cost Accountant to evaluate the three proposals and calculate the additional sales volume that would be required in each case, in order to help him to take a decision.

Solution:

Calculation of Selling Price

		Rs.
Variable cost	(8x10,000)	80,000.00
Add : Fixed cost		30,000.00
Total cost		1,10,000.00
Profit		(10,000.00)
Sales		1,00,000.00
Selling price	(100000/10000)	Rs. 10

Statement showing evaluation of alternatives and the number of units required to attain the targets of respective managers

	Finance Manager	Sales Manager	Production Manager
i) Selling price (Rs.)	10.00	10.00	9.70
ii) Variable cost (Rs.)	8.50	8.00	8.00
iii) Contribution per unit (Rs.)	1.50	2.00	1.70
iv) Fixed cost (Rs.)	30,000.00	35,000.00	30,000.00
v)Target (Rs.)	B.E.P	Profit or Rs.5000	Profit of Rs.4000
	(30000/1.5)	(40000/2)	(34000/1.7)
	20,000.00	20,000.00	20,000.00
Additional units required	10,000.00	10,000.00	10,000.00

Problem No.49.

A Company manufacturing agricultural tractors has a capacity to produce 6,000 tractors annually. The capital employed in the project as on date is Rs.20 crores. With increasing cost of production and reducing margins, the company is fast narrowing its margin of safety. The return on capital employed fell from 10% in the previous year to 6% in the current year. i.e., the current year profit is 1.20 crores. The company wants to maintain the original cut-off rate of 12% and various possibilities have been examined for this purpose. The company is at present manufacturing and marketing 6,000 tractors annually though there is imbalance in the plant. The company has the following major production departments wit percentage capacity utilisation for the present production: -

Production Department	Capacity utilised
Machine shop	75%
Assembly shop	100%
Heat treatment shop	75%
Induction hardening	50%

The company operates a single shift of 8 hrs per day on an average for 300 days in a year. For technical reasons the plant will have to operate on single shift basis only.

The two alternatives which have emerged after a detailed study are:

(a) To hire out the surplus capacity in the production shop for which constant demand exists. The following income and expenditure projections are drawn out:

	Hire charge per hour	Incremental cost per hour
Machine shop	Rs.10,000	Rs.2,000
Heat treatment shop	Rs. 7,500	Rs.1,500
Induction hardening	Rs. 5,000	Rs.1,000

(b) To increase the installed capacity to 8,000 tractors by spending Rs.2 crores on additional machinery for the assembly shop. The incremental revenue form the additional sales will be Rs. 5,000 per tractor. The cost of additional finance will be 12% being the cost of existing capital employed, In addition, tax benefits on an average will work out to 1% of additional investment.

You are required:

    (i)   To work out the profitability, i.e., average rate of return of the two alternatives; and

    (ii) To comment on the advisability of maintaining an imbalance plant from a long-term point of view.

Solution:

Computation of hire charges and return on capital employed

		Rs.
Machine shop	[2400x25%x(10000-2000)]	4,800,000.00
Heat treatment	[2400x25%x(7500-1500)]	3,600,000.00
Induction hardening	[2400x50%(4000)]	4,800,000.00
		13,200,000.00
Present profit		12,000,000.00
Total profit		25,200,000.00
Return on investment	[(25200000/20000000)x100]	12.6%

Computation of profit under alternative 2

		Rs.
Profit from sale of tractors	(5000x2000)	10,000,000.00
Hire charges		3,200,000.00
Tax benefit (1% on 2 crores)		200,000.00
		13,400,000.00
Add : existing profit		12,000,000.00
		254,00.000
Return on investment	[(25400000/220000000)x100]	11.55%

Working notes:
Computation of surplus capacity in the production shop

Machine shop	{[(300x8)x75%]x100/75}	2,400.00
		(no extra capacity)
Heat treatment	{[(300x8)x75%]x100/75}	2,400.00
		(no extra capacity)
Induction	{[(300x8)x50%x(8000/6000)]}	1,600.00
Extra capacity in induction	(1600x50%)	800 hours
Therefore hire charges (Rs.)	(800x4000)	3,200,000.00

As the required cut off rate is 12%, it is better to hire out the balance capacity instead of increasing capacity

Problem No.50.

A Modern Packing Corporation specialises in the manufacture of one-liter plastic bottles. The firm's customers include dairy processors, fruit juice manufactures and manufactures of edible oils. The bottles are produced by a process called blow moulding. A machine heats plastic to the melting point. A bubble of molten plastic is formed inside a mould, and a jet of hot air is forced into the bubble. This blows the plastic into the shape of the mould. The machine releases the moulded bottle, an employee trims off any flashing (excess plastic around the edge), and the bottle is complete.

The Firm has four moulding machines, each capable of producing 100 bottles per hour. The firm estimates that the variable cost of producing a plastic bottle is 20 paise. The bottles are sold for 50 paise each.

Management has been approached by a local toy company that would like the firm to produce a moulded plastic toy for them. The toy company is willing to pay Rs. 3.00 per unit for the toy. The variable cost of manufacture the toy will be Rs.2.40. In addition, Modern Packing Corporation would have to incur a cost of Rs.20,000 to construct the needed mould exclusively for this order. Because the toy uses more plastic and is of a more intricate shape than a bottle, a moulding machine con produce only 40 units per hour. The customer wants 1,00,000 units. Assume that Modern Packing Corporation has the total capacity of 10,000

machine hours available during the period in which the toy company wants the delivery of toys. The firm's fixed costs, excluding the costs to construct the toy mould, during the same period will be Rs.2,00,000.

Required:

(a) If the management predicts that the demand for its bottles will require the use of 7,500 machine hours or less during the period, should the special order be accepted? Give the reasons.

(b) If the management predicted that the demand for its bottles would be higher than its ability to produce bottles, should the order be accepted? Why?

(c) The management has located a firm that has just entered the moulded plastic business. The firm has considerable excess capacity and more efficient moulding machines and is willing to subcontract the toy job, or any portion of it for Rs. 2.80 per unit. It will construct its own toy mould. Determine Modern Packing Corporation's minimum expected excess machine hour capacity needed to justify producing any portion of the order itself rather than subcontracting it entirely.

(d) The management predicated that it would have 1,600 hours of excess machine hour capacity available during the period. Consequently, it accepted the toy order and subcontracted 36,000 units to the other plastic company. In fact demand for bottles turned out to be 9,00,000 units for the period. The firm was able to produce only 8,40,000 units because it had to produce the toys. What was the cost of the prediction error failure to predict demand correctly?

Solution:

Contribution From M bottle per hour   [100(0.5-.2)]   Rs.30

Contribution from toy per hour   [40(3-2.4)]   Rs.24

a) When the demand for the bottles is 7500 or less hours, it is better to accept, toy order because it gives additional profit of Rs.40000

b) When the capacity for bottles is more than 7500 hours, the toy order should not be accepted because the contribution of bottle Rs.30, is more than the contribution per hour of toy Rs.24

c) The level at which it is necessary tom sub contract the toy order is
[20000/(2.8-2.4)] = 50000 units

d) Computation of cost of prediction error

I) Statement showing computation of profit if 36000 toys are given for sub contract

	Bottles	Toy Manufacture	Toy Sub contract	Total
i. No. of units	840,000.00	64,000.00	36,000.00	
ii. Contribution per unit (Rs.)	0.30	0.60	0.20	
iii. Total contribution (Rs.)	252,000.00	38,400.00	7,200.00	297,600.00
iv. Fixed cost (Rs.)	200,000.00	20,000.00		220,000.00
v. Profit (Rs.)	52,000.00	18,400.00	7,200.00	77,600.00

II) Computation of profit at actual position

	Bottles	Toys	Total
i. No. of units	900,000.00	100,000.00	
ii. Contribution per unit (Rs.)	0.30	0.20	
iii. Total contribution (Rs.)	270,000.00	20,000.00	290,000.00
iv. Fixed cost (Rs.)	200,000.00		200,000.00
v. Profit (Rs.)	70,000.00	20,000.00	90,000.00
Therefore cost of prediction error	(90000-77600)		Rs.12400

Problem No.51.

Tiptop Textiles manufactures a wide range of fashion fabrics. The company is considering whether to add a further product that 'Superb' to the range. A market research survey recently undertaken at a cost of Rs.50,000 suggests that demand of the 'Superb' will last for only one year, during which 50,000 units could be sold at Rs.18 per unit. Production and sale of 'Superb' would take place evenly throughout the year. The following information is available regarding the cost of manufacturing 'Superb'.

Raw Materials: Each 'Superb' would require 3 types of raw materials Posh, Flash and Splash. Quantities required, current stock levels and cost of each raw material are shown below. Posh s used regularly by the company and stocks are replaced as they are used. The current stock of Flash is the result of over buying for an earlier contract. The material is not used regularly by Tiptop Textiles and any stock that was not used to manufacture 'Superb' would be sold. The Company does not carry a stock of splash and the units required would be specially purchased.

Raw	Quantity regd. per unit of superb (Meters)	Current stock (meters)	Costs per metre of raw material		
			Original Cost	Current replacement cost	Current resale cost
			Rs.	Rs.	Rs.
Posh	1.00	1,00,000	2.10	2.50	1.80
Flash	2.00	60,000	3.30	2.80	1.10
Splash	0.50	0	5.50	5.00	5.00

Labour; Production of each 'Superb' would require a quarter of an hour of skilled labour and two hours of unskilled labour and Rs.2 per hour for unskilled labour. In addition, one foreman would be required to devote all his working time for one year in supervision of the production of superb. He s currently paid an annual salary of Rs.15,000. Tiptop Textiles is currently finding it very difficult to get skilled labour. The skilled workers needed to manufacture 'Superb' would be transferred form another job on which they are earning a contribution surplus of Rs.1.50 per labour hour, comprising sales revenue of Rs.10.00 less skilled labour wages of Rs.3.00 and other variable costs of Rs.5.50. It should not be possible to employ additional skilled labour during the coming year. If 'Superb' are not manufactured, the company expects to have available 2,00,000 surplus unskilled labour hours during the coming year. Because the company intends to

expand in the future, it has decided not to terminate the services of any unskilled worker in the foreseeable future. The foreman is due to retire immediately on an annual pension payable by the company of Rs.6,000. He has been prevailed upon to stay on for a further year and to differ his pension for one year in return for his annual salary.

Machinery: Two Machines would be required to manufacture 'Superb' MT 4 and MT 7. Details of each machine are as under:

	Start of the year	End of the year
	Rs.	Rs.
MT 4		
Replacement cost	80,000	65,000
Resale Value	60,000	47,000
MT 7		
Replacement cost	13,000	9,000
Resale Value	11,000	8,000

Straight-line depreciation has been charges on each machine for each year of its life. Tiptop Textiles owns a number of MT 4 machines, which are used regularly or various products. Each MT 4 is replaced as soon it reaches the end of its useful life. MT 7 machines are no longer used and the one which would be used for 'Superb' is the only one the company now has. If it were not used to produce 'Superb' it would be sold immediately.

Overheads: A predetermined rate of recovery for overheads is in operation and the fixed overheads are recovered fully from the regular production at Rs.3.50 per labour hour. Variable overhead costs for Superb are estimated at Rs. 1.20 per unit produced.

For decision-making, incremental costs based on relevant costs and opportunity costs are usually computed.

You are required to compute such a cost sheet for 'Superb' with all details of material, labour overhead etc., substantiating the figures with necessary explanations.

Solution:

For each of the element the relevant cost will be as follows for preparing cost sheet

i) **Market survey cost is a sunk cost and not relevant for decision making**

ii) **Raw materials**
   a) Raw material 'posh', is used regularly and stocks are replenished and hence current replacement cost is relevant i.e.(5000x1x2.5) = Rs. 125,000.00
   b) Current stock of 'flash' is a result of over buying and will not be used for other than 'superb' and hence relevant cost is net releasable value
      Material required (50000x2)=100000 units

      (60000x1.1)   Rs. 66,000.00

      (40000x2.8)   Rs. 112000   Rs. 178,000.00
   c) Material 'splash' has no stock and has to be bought and relevant cost is hence not relevant in decision making
      (50000x0.5x5) = Rs. 125,000.00

iii) **Labour:**
- a) Due to unskilled labour , no work has been suffered and so no extra cost and hence not relevant in decision making
- b) Skilled labour is scarce therefore not only the cost, but also the contribution forgone, being opportunity cost, should be considered for decision making (50000x0.25x4.5) = Rs. 56,250.00
- c) Effective cost of pension (15000-6000) = Rs. 9,000.00

iv) **Machinery:**
- a) MT-4 are regularly used and therefore the difference between replacement cost at the start and at the end of the year is relevant (80000-65000) = Rs. 15,000.00
- b) MT-7 is not used regularly and the difference between resale value at the start and at the end of the year should be taken (11000-8000) = Rs. 3,000.00

v) **Variable overheads are relevant (50000x1.2) = Rs. 60,000.00**

vi) **Fixed overheads are not relevant because it is recorded fully at regular production**

Cost sheet of 50000 units of superb

		Rs.
Raw material:		
Posh	125,000.00	
Flash	178,000.00	
Splash	125,000.00	428,000.00
Labour:		
Skilled	56,250.00	
Pension	9,000.00	65,250.00
Machinery:		
MT-4	15,000.00	
MT-7	3,000.00	18,000.00
Variable overheads		60,000.00
		571,250.00
Profit (b/f)		328,750.00
Sales (50000x18)		**900,000.00**

Problem No.52.

Forward and Foundry Ltd. is feeling the effects of a general recession in the industry. Its budget for the coming half year is based on an output of only 500 tones of casting a months which is less than half of its capacity. The prices of casting vary with the composition of the metal and the shape of the mould, but they average Rs. 175 a tonne. The following details are from the Monthly Production Cost Budget at 500 tone levels:

	Core making	Melting and Pouring	Moulding	Cleaning and Grinding
	Rs.	Rs.	Rs.	Rs.
Labour	10,000	16,000	6,000	4,500
Variable overhead	3,000	1,000	1,000	1,000
Fixed overhead	5,000	9,000	2,000	1,000
	18,000	26,000	9,000	6,500
Labour and O.H. rate per direct labour hour	9.00	6.50	6.00	5.2

Operation at this level has brought the company to the brink of break-even. It is feared that if the lack of work continues, the company may have to lay off some of the most highly skilled workers whom it would be difficult to get back when the volume picks up later on. No wonder, the workers Manager at this Juncture, welcome an order for 90,000 casting, each weighing about 40 lbs., to be delivered on a regular schedule during the next six months. As the immediate concern of the Works Manager is to keep his work force occupied, he does not want to lose the order and is ready to recommended a quotation on a non-profit and no-loss basis.

Materials required would cost Re. 1 per casting after deducting scrap credits. The direct labour hour per casting required for each department would be:

Core Making	0.09
Melting and pouring	0.15
Moulding	0.06
Cleaning and grinding	0.06

Variable overheads would bear a normal relationship to labour cost in the melting and pouring department and in the moulding department. In core making, cleaning and grinding however, the extra labour requirements would not be accompanied by proportionate increases in variable overhead. Variable overhead would increase by Rs.1.20 for every additional labour hour in core making and by 30 paise for every additional labour hour in cleaning and grinding. Standard wage rates are in operation in each department and no labour variances are anticipated.

To handle an order as large as this, certain increases in factory overheads would be necessary amounting to Rs. 1,000 a month for all departments put together. Production for this order would be spread evenly over the six months period.

You are required to:

(a) Prepare a revised monthly labour and overhead cost budget, reflecting the addition of this order.

(b) Determine the lowest price which quotation can be given for 90,000 castings without incurring a loss.

Solution:

Computation of labour and overhead rate

	Core making	Melting & pouring	Moulding	Cleaning & grinding
Labour & overheads (Rs.)	18,000.00	26,000.00	9,000.00	6,500.00
Labour & overheads per hour (Rs.)	9.00	6.50	6.00	5.20
No. of hours	2,000.00	4,000.00	1,500.00	1,250.00
Variable overhead per hour (Rs.)	1.50	0.25	0.67	0.80
Labour rate per hour (Rs.)	5.00	4.00	4.00	3.60
Hours required for new order	1,350.00	2,250.00	900.00	900.00
Labour cost required for order (Rs.)	6,750.00	9,000.00	3,600.00	3,240.00
Variable overhead cost for order (Rs.)	1,620.00	563.00	600.00	270.00

Revised monthly labour and overheads cost budget reflecting the additions of the order

	Core making	Melting & pouring	Moulding	Cleaning & grinding	Total
	Rs.	Rs.	Rs.	Rs.	Rs.
Labour	10,000.00	16,000.00	6,000.00	4,500.00	
Labour for the order	6,750.00	9,000.00	3,600.00	3,240.00	
	16,750.00	**25,000.00**	**9,600.00**	**7,740.00**	
Variable overheads	3,000.00	1,000.00	1,000.00	1,000.00	
Variable overheads for the order	1,620.00	563.00	600.00	270.00	
	4,620.00	**1,563.00**	**1,600.00**	**1,270.00**	
Fixed cost	**5,000.00**	**9,000.00**	**2,000.00**	**1,000.00**	
Total	**26,370.00**	**35,563.00**	**13,200.00**	**10,010.00**	85,143.00
Add : additional fixed cost					1,000.00
				Total:	**86,143.00**

Computation of Total price for the order

		Rs.
Material	(15000x1)	15,000.00
Labour & overheads	(86143-59500)	26,643.00
		41,643.00
Total price for the order	**(41643x6)**	**249858**

Problem No.53.

A small scale manufacture produces an article at the operated capacity of 10,000 units while the normal capacity of his plant is 14,000 units. Working at a profit margin of 20% on sales realization, he has formulated his Budget as under:

	10,000 units	**14,000 units**
	Rs.	**Rs.**
Sales Realization	2,00,000	2,80,000
Variable overheads	50,000	70,000
Semi-variable overheads	20,000	22,000
Fixed Overheads	40,000	40,000

He gets an order for a quantity equivalent to 20% of the operated capacity and even this additional production, profit margin is desired at the same percentage on Sales realization as for production to operated capacity. Assuming prime cost is constant per unit of production, what should be the minimum price to realise this objective.

Solution:

Computation of prime cost

		Rs.
Sales		200,000.00
Less : Profit(20% n sales)		40,000.00
Total cost		160,000.00
Less : overheads		
Variable	50,000.00	
Semi variable	20,000.00	
Fixed	40,000.00	110,000.00
Prime cost		50,000.00

Computation of differential cost at two levels of output

Output	10000	12000	Differential Cost
Prime cost (Rs.)	50,000.00	60,000.00	10,000.00
Variable overheads (Rs.)	50,000.00	60,000.00	10,000.00
Semi variable overheads (Rs.)	20,000.00	21,000.00	1,000.00
			Rs. 21,000.00

Computation of minimum selling price at desired margin

		Rs.
Total cost	(21000/2000)	10.50
Add : profit	(20% on sales = 25% on cost)	2.63
Required selling price		**13.13**

Problem No.54.

A theatre with some surplus accommodation proposes to extend its catering facilities to provide light meals to its patrons.

The Management Board is prepared to make initial funds available to cover capital costs. It requires that these be repaid over a period of five years at a rate of interest of 14% and discount factors at this interest rate are indicated below.

Year	0	1	2	3	4	5
Discounting factor	1	0.88	0.77	0.67	0.59	0.52

The capital costs are estimated at Rs.60,000 for equipment that will have a life of five years and no residual value . Running costs of staff, etc., will be Rs. 20,000 in the first year, increasing by Rs.2,000 in each subsequent year. The board proposes to charge Rs. 5,000 per annum for lighting, heating and other property expenses and wants a nominal Rs. 2,500 per annum to cover any unforeseen contingencies. Apart from this, the Board is not looking for any profit, as such from the extension of these facilities because it believes that this will enable more theatre seats to be sold. It is proposed that costs should be recovered by setting prices for the food at double the direct costs.

It is not expected that the full sales level will be reached until year 3. The proportions of the level estimated to be reached in years 1 and 2 are 35% and 65% respectively.

Calculate the sales that need to be achieved in each of the five years to meet the Board's targets. Ignore taxation and inflation.

<u>Solution:</u>

Statement showing calculation of present value of outflows

	1	2	3	4	5	Total
Running cost (Rs.)	20,000.00	20,000.00	24,000.00	26,000.00	28,000.00	
Lighting, heating & other property expenses (Rs.)	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00	
Cost of contingencies (Rs.)	2,500.00	2,500.00	2,500.00	2,500.00	2,500.00	
	27,500.00	29,500.00	31,500.00	33,500.00	35,500.00	
Present value factor	0.88	0.77	0.67	0.59	0.52	
Present values (Rs.)	24,200.00	22,715.00	21,105.00	19,765.00	18,460.00	106,245.00
Initial investment						Rs. 60,000.00
						Rs.166,245.00

In order to recover outflows in five years, income must be equal to the present value of inflows over the five years

Year	Capacity	Discount factor		Present value
1	0.35	0.88		0.31
2	0.65	0.77		0.50
3	1.00	0.67		0.67
4	1.00	0.59		0.59
5	1.00	0.52		0.52
				2.59

		Rs.
Average out flow	(166245 ÷ 2.5)	64,187.00
Sales required for the year	(64187x2)	128,374.00
Sales in the first year	(128375x35%)	44,931.00
Sales in the second year	(128375x65%)	83,444.00
Sales in the third year		128,375.00
Sales in the fourth year		128,375.00
Sales in the fifth year		128,375.00
Sales during five years		**5,13,500.00**

Problem No.55.

A local Government authority owns and operates a leisure centre with numerous sporting facilities, residential accommodation, a cafeteria and a sports shop. The summer season lasts for 20 weeks including a peak period of 6 weeks corresponding to the school holidays. The following budgets have been prepared for the next summer season:

Accommodation:

      60 single rooms let on a daily basis.

      35 double rooms let on a daily basis at 160% of the single room rate.

Room rate:

      Fixed costs Rs.29,900.

      Variable costs Rs. 4 per single room per day and Rs.6.40 per double room per day

Sports centre:

Residential guests each pay Rs. 2 per day and casual visitors Rs. 3 per day for the use of facilities.

Fixed costs Rs.15,500.

Sports Shop:

      Estimated contribution Re.1 per person per day.

      Fixed costs RS. 8,250.

Cafeteria:

      Estimated contribution Rs. 1.50 per person per day.

      Fixed costs Rs.12,750.

      During the summer season the centre is open7 day a week and the

Following activity levels are anticipated.

      Double rooms fully booked for the whole season.

      Single rooms fully booked for the peak period but at only 80% of

Capacity during the rest of the season.

      30 casual visitors per day on average.

You are required to:

(a)   Calculate the charges for single and double rooms assuming that the authority wishes to make a Rs. 10,000 profit on accommodation.

(b)   Calculate the anticipated total profit for the leisure centre as a whole for the season.

(c)   Advise the authority whether an offer of Rs.2,50,000 form a private leisure company to operate the centre for five years is worth while, assuming that the authority uses a 10% cost of capital and operations continue as outlined above.

Solution:

Computation of usage of room days

		Rs.
Single room		
(60x7x6)	2,520.00	
(60x7x14x80%)	4,704.00	
		7,224.00
Double room (35x7x20)		4,900.00
i) Total sale value of accommodation		
Variable cost		
Single room (7224x4)	28,896.00	
Double room (4900x4)	31,360.00	60,256.00
Fixed cost		29,900.00
Required profit		10,000.00
		100,156.00

Let 'S' be the room rent of single room and 1.6'S' is the rent of double room Therefore

7224S+4900(1.6S)= 100516

7224S+7840S=100516 = S= 6.65

Double room Rent =(6.65x1.6) = 10.64

ii)   Statement showing computation of total profit to leisure centre: **Rs.**

a. Accommodation			10,000.00
b. sports centre:			
Total	[(7224x2)+(4900x2x2)+(30x7x20x3)]	46,648.00	
Less : fixed		15,550.00	31,148.00
c. Sports centre:			
Contribution	[(7224x1)+(4900x2x1)+(30x7x20x1)]	21,224.00	
Less : fixed		8,250.00	12,974.00
d. cafeteria			
Contribution	[(7224x1.5)+(4900x2x1.5)+(30x7x20x1.5)]	31,836.00	
Less : fixed		12,750.00	19,086.00
			73,208.00

iii) Present values

Present value compound factor @ 10% for 5 years   3.79

P.V. of profit for 5 years (73208x3.7906)   Rs. 277,500.00

As the present value of profit for 5 years is Rs. 277500, which is more than the lease rent of Rs. 250000, it is not worthwhile to give leisure centre for lease

Problem No.56.

A2Z p.l.c supports the concept of tero technology or life cycle costing for new investment decisions covering its engineering activities. The financial side of this philosophy is now well established and its principles extended to all other areas of decision making. The company is to replace a number of its machines and the Production Manager is torn between the Exe Machine, a more expensive machine with a life of 12 years, and the Wye machine with an estimated life of 6 years. If the Wye machine is chosen it is likely that it would be replaced at the end of 6 years by another Wye machine. The patter of maintenance and running costs differs between the two types of machine and relevant data are shown below:

	Exe	Wye
Purchase price	Rs.19,000	Rs. 13,000
Trade-in value/brakeup/scrap	Rs. 3,000	Rs.3,000
Annual repair costs	Rs.2,000	Rs.2,600
Overhaul costs	(at year 8) Rs.4,000	(at year 4) Rs.2,000
Estimated financing costs averaged over machine life		
	10% p.a -Exe; 10% p.a. -Wye	

You are required to: recommend with supporting figures, which machine to purchase, stating any assumptions made.

Solution: **Computation of present value of outflows and equivalent annual**

		Exe machine		WYE machine
Initial cost (Rs.)		19,000.00		13,000.00
Less : Scrap at the end of the life (Rs.)	(3000x0.32)	960.00	(3000x.56)	1,680.00
		18,040.00		11,320.00
Present value of total annual cost (Rs.)	(2000x6.81)	13,620.00	(2600x4.36)	11,336.00
Overhaul cost (Rs.)	(4000x.47)	1,880.00	(2000x.68)	1,360.00
		33,540.00		24,016.00
Capital recovery factor	(1/6.81)	0.15	(1/4.36)	0.23
Equivalent annual cost (Rs.)		4,925.00		5,508.00

As the equivalent annual cost is less for exe machine, it is better to purchase the same.

Problem No.57.

Chakra Ltd. manufactures Mixer Grinders. The manufacture involves an assembly of various parts which are proceeds in the machine shop and purchased components. The on/off switch is presently being purchased form a vendor at Rs. 4.50 each, annual requirement being 20,000 pieces.   The production manager has put up a proposal two months back to make the switch in the machine shop. He had suggested that

the company would make profit and save taxes on bought out switch. The costing department was asked to make an estimate of making the item which showed that the cost of making was Rs. 4.73. The purchase department continues buying the item on the basis of the cost estimate given to them. Recently, the Vendor has sent a letter requesting the purchase department to grant increase in price of 10% minimum per switch as the input costs had gone up. The costing department was once again requested to estimate cost of making the switch.

The costing department re-estimated the costs using current prices and observed that the cost of making has gone up to Rs. 5.33. Purchase department again decided to continue buying as it was cheaper to buy than make. The cost estimate prepared by the costing department was as under:

	Annual costs	
	Previous (Rs.)	Current (Rs.)
Direct Materials	40,000	48,000
Direct Labour Rs.2 per hour	20,000	22,000
Overheads at Rs.3 per hour	30,000	31,500
Total cost at current price	90,000	1,01,500
Add: expected increase 5%	4,500	5,075
Expected manufacturing cost	94,500	1,06.575
Cost per price	4.73	5.33

Twenty-five per cent of the overheads are fixed.

Required: Do you agree with the decision of buying considering the relevant costs? If the cost of making or buying is more or less same, what factors other than cost will influence making decision?

Solution:

Statement showing computation of making on/off switch before and after price increase.

Particulars	Previous (Rs.)	Current (Rs.)
Materials	40000	48000
Labour	20000	22000
Overhead	22500	23625
	82500	93625
Cost per Switch	4.125	4.68
	(82500/20000)	(93625/20000)
Cost of Buying	4.50	4.95
		(4.50 x 110/100)

It is not agreeable that purchase department continue to buy the switch because variable cost of making are less than buying cost.

Note: Expected increased cost is not relevant cost.

   Problem No.58.

A Company manufacturing a highly successful line of cosmetics intends to diversify the product line to achieve fuller utilization of its plant capacity. As a result of considerable research made the company has been able to develop a new product called 'EMO'.

EMO is packed in tubes of 50 grams capacity and is sold to the wholesalers in cartons of 24 tubes at Rs. 240 per carton. Since the company uses its spare capacity for the manufacturer of EMO, no additional fixed expenses will be incurred. However, the cost account has allocated a share of Rs. 4,50,000 per month as

fixed expenses to be absorbed by EMO as a fair share of the company's present fixed costs to the new production for costing purposes.

The company estimated the production and sale of EMO at 3,00,000 tubes per month and on this basis the following cost estimates have been developed.

	Rs. per carton
Direct Materials	108
Direct Wages	72
All overheads	54
Total costs	234

After a detailed market survey the company is confident that the production and sales of EMO can be increased to 3,50,000 empty tubes and the cost of empty tubes, purchased from outside will result in a saving of 20% in material and 10% in direct wages and variable overhead costs of EMO. The price at which the outside firm is willing to supply the empty tubes is Rs. 1.35 per empty tube. If the company desires to manufacture empty tubes in excess of 3,00,000 tubes, new machine involving an additional fixed overheads Rs. 30,000 per month will have to be installed. Required:

(i) State by showing your working whether company should make or buy the empty tubes at each of the three volumes of production of EMO namely 3,00,000; 3,50,000 and 4,50,000 tubes.
(ii) At what volume of sales will it be economical for the company to install the additional equipment for the manufacture of empty tubes?
(iii) Evaluate the profitability on the sale of EMO at each, of the aforesaid three levels of output based on your decision and showing the cost of empty tubes as a separate element of cost.

Solution:

Total Cost per tube including EMO:

Direct Material	108/24	=	Rs. 4.50
Direct Wages	72/24	=	Rs. 3.00
Variable Overheads	[54/24 – 450000/300000]	=	Rs. 0.75

Particulars	Total Cost (Rs.)	Tube Cost (Rs.)	Product Cost (Rs.)
Material	4.5	0.9	3.60
Wages	3.0	0.3	2.70
Variable Overhead	0.75	0.075	0.675
	8.25	1.275	6.975

Statement showing computation of manufacturing cost of 300000 tubes

Cost of making (300000 x 1.275)	=	Rs. 3,82,500
Cost of buying (300000 x 1.35)	=	Rs. 4,05,000

It is better to make the tubes at 300000 level of output.

Computation of Cost for additional tubes:

Particulars	50000	150000
Cost of Making (Rs.)	93,750 [(50000 x 1.275) + 30000]	2,21,750 [(150000 x 1.275) + 30000]
Cost of Buying (Rs.)	67,500 (50000 x 1.35)	2,02,500 (150000 x 1.35)

From the above, it is better to buy at these levels.

(ii)   The level at which it is beneficial to make the tubes over and above 300000 units.

$$[Indifference\, Point]\frac{Fixed\, Cost}{Diff.\, in\, Variable\, Cost\, Per\, unit} = \frac{30000}{1.35 - 1.275} = 400000\ units$$

The Company will be justified to install the additional Equipment for the manufacture of Empty tubes at a sales volume of 700000 units.

Statement showing computation of Profit at three levels of output:

	Particulars	300000	350000	450000
I.	Sales [240/24] (Rs.)	3000000	3500000	4500000
II.	Cost (Rs.)	2092500 (300000x6.975)	2441250 (350000x6.975)	3138750 (450000x6.975)
III.	Tube Cost (Rs.)	382500 (300000x1.275)	472500 (350000x1.35)	607500 (450000x1.35)
IV.	Fixed cost (Rs.)	450000	450000	450000
V.	Total Cost (Rs.)	2925000	3363750	4196250
VI.	Profit (I – V) (Rs.)	75000	136250	303750

Problem No.59.

Z Ltd. manufactures a range of products which it sells through manufacture's agents to whom it pays commission of 20% of the selling price of the products. Its budgeted profits and loss statement for 1987 is as follows:

	Rs.	Rs.
Sales		22,50,000
Production costs:		
Prime costs and variable overhead	7,87,500	
Fixed Overhead	3,62,500	
		11,50,000
		11,00,000
Selling costs:		
Commission to manufacturer's agents	4,50,000	
Sales office expenses (fixed)	20,000	
		4,70,000
		6,30,000
Administration costs (fixed)		3,00,000
Profit		3,30,000

Subsequent to the preparation of the above budgeted profit and loss statement, the company is faced with a demand from its agents for an increase in their commission to 22% of selling price. As a result, the company is considering whether it might achieve more favorable results if it were to discontinue the

use of manufacturer's agent and, instead employ its own sales force. The costs that this could involve are budgeted as follows: **Rs.**

Sales manager (salary and expenses)	75,000
Salesmen's expenses (including traveling costs)	20,000
Sales office costs (additional to present costs)	50,000
Interest and depreciation on sales department cars	35,000

In addition to the above, it will be necessary to hire four salesmen at a salary of Rs.40,000 per annum each plus commission of 5% on sales plus car allowance of Re.1 per Kilometer to over all costs except interested and depreciation.

On the assumption that the company decided to employ its own sales force on the above terms are you are required to ascertain:

(a) What is the maximum average kilometer per annum that salesmen could travel if the company is to achieve the same budgeted profit as it would have obtained by retaining the manufacturer's agents and granting them the increased commission they had requested. Assume that sales in each case would be as budgeted.

(b) At what level of sales would the original budgeted profit be achieved if each salesmen were to travel on average of 14,000 kilometers per annum. Assume that all other assumptions inherent in the budgets were maintained.

(c) What is the maximum level of commission on sales that the company could afford to pay if it wished to achieve a 16% increase in its original budgeted profit and expected a 16% increase in sales (at budgeted selling prices) and average of 16,000 kilometers per annum to be traveled by each salesmen.

Solution:

a) **Computation of amount available for car allowance:**

		Rs.	Rs.
Commission			495000
(+)	Costs	180000	
	Commission (2250000 x 5%)	112500	
	Salaries of salesmen	160000	452500
Amount available for payment to car allowance			**42500**

No. of KMS that each salesmen can travel = 42500/4 = 10625.

b) **Computation of Required sales to earn desired profit:**

		Rs.	Rs.
I.	Sales		2250000
II.	Variable Cost		
	Material	787500	
	Commission @ 5%	112500	900000
III	Contribution		1350000
IV	Fixed Cost:		
	Existing Fixed Overheads	362500	
	Existing sales office expenses	20000	
	Existing Admn. Overheads	300000	
	New Selling Expenses	180000	
	Sales men salaries	160000	
	Car allowance (14000 x 4)	56000	1078500
V	P/V Ratio = C/S x 100 = 1350000/2250000 x 100 = 60%		
VI	Required sales to get desired Profit (budgeted Profit) = 1078500 + 330000 / 0.6 = Rs. 2347500		

c) Computation of maximum commission that the Co. would be able to pay at the increased quantum of sales:

		Rs.
I.	Sales (2250000 x 116/100)	2610000
II.	Variable Cost (787500 x 116/100)	913500
III	Contribution	1696500
	(-) Fixed Cost other than car allowance (1078500 – 56000)	1022500
		674000
	(-) Car allowance (16000 x 4)	64000
		610000
	(-) Profit Expected (330000 x 116/100)	382800
	Amount available for payment of commission	227200

% of commission on sales = 227200 / 2610000 x 100 = 8.7%

Problem No.60.

Navyug Enterprises is considering the introduction of a new product. Generally, the Company's products have a life of about five years, after which they are usually dropped form the range of products the company sells. The new product envisages the purchase of new machinery costing Rs.4,00,000 including freight and installation charges. The useful life of the equipment is five years with an estimated average value of Rs.1,57,500 at the end of that time. The machine will be depreciated for tax purpose by the reducing balance method at a rate of 15% on the book value.

The new product will be produced in a factory which is already owned by the company. The company built the factory some years age at Rs.1,50,000. The book value on the written down value basis is zero.

Today the factory has a resale value of Rs.3,50,000 which should remain fairly stable over the next five years. The factory is currently being rented to another company under a lease agreement, which has five years to run, and which provides for annual rental of Rs.5,000. Under the lease agreement if the lessor wishes to cancel the lease, can do so by paying the lessee compensation equal to one year's rental payment. This amount is not deductible for income tax purposes.

Additions to current asset will require Rs.22,500 at the commencement of the proposal which, it is assumed, is fully recoverable at the end of year 5. The company will have to spend Rs. 50,000 in year towards market research.

The net cash inflows from operations before depreciation and income tax are:

Year	Rs.
1	2,00,000
2	2,50,000
3	3,25,000
4	3,00,000
5	1,50,000

It may be assumed that all cash flows are received or paid at the end of each year and that income tax and paid in the year in which the inflow occurred.

The company's tax rate may be assumed to be 50% and the company's required return after tax is 10%.

Required: Evaluate the proposal.

Solution:

Computation of outflows:

		Rs.
I.	Cost of Machinery	400000
	Working capital	22500
	Payment on Account of cancellation of lease	5000
		427500
II	Market research cost (50000 x 0.5)	25000
III	Yearly rental cost (opportunity cost) Rs.5000	
	(-) Tax Advantage Rs. 2500	2500

Computation of Inflows:

Year	PBD after Tax	Dep @ 15%	PAD	Inflows after tax	(Inflow + Dep) Net cash inflow
	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
1	200000	60000	140000	70000	130000
2	250000	51000	199000	99500	150500
3	325000	43350	281650	140825	184175
4	300000	36848	263152	131576	168424
5	100000	31320	118680	59340	90660

Loss on Sale = 177482 – 157500   = Rs. 19,982

            (-) Tax Advantage   = Rs. 9,991

Statement showing computation of Net Present Value:

Year	Cash Inflows (Rs.)	Discount factor @ 10%	Present Value (Rs.)
1	102500 [130000-25000-2500]	0.909	93172
2	148000 [150500-2500]	0.826	122248
3	181675 [184175-2500]	0.751	136438
4	165924 [168424-2500]	0.683	113326
5	278151 [90660+157500+22500+9991-2500 = 278151]	0.621	172731
	(-) Outflows		427500
NPV			**210416**

Since, the NPV is positive, the new product can be launched.

Problem No.61.

A Company proposes to install a machine for the manufacture of a component which at present is being purchased at Rs.24 each. There are two alternatives, namely

- (a) Installation of an automatic machine and
- (b) Installation of a semi-automatic machine.

The details of the two machines are as under:

	Automatic machine	Semi-Automatic machine
Initial cost of machine (Rs.)	9,00,000	6,00,000
Life	10 years	10 years
Fixed overheads other than depreciation on machines (per annum) (Rs.)	1,62,000	84,000
Component (Rs.)	12	15

The company charges depreciation on straight-line method. Scrap value of the machine at the end of life is nil.

The demand for the components at present is 20,000 units per annum. This demand is expected to increase to 40,000 units.

Required:

(a) For each of the two volumes of output namely 20,000 and 40,000 units, state with supporting calculations whether the components should be purchased or manufactured by installation of machine. If your decision is in favor of installation of machine, which model will you advise?
(b) At what volume of output should the company change over form purchase of components to manufacture by installation of (i) semi-automatic machine and (ii) automatic machine?
(c) At what volume of manufacture of the components will the company switch over from installation of the type machine to the other?

Solution:
Statement showing evaluation of two alternatives:

Particulars	20000 Units			40000 Units		
	Buying	Automatic	Semi-automatic	Buying	Automatic	Semi-automatic
Variable cost (Rs.)	480000	240000	300000	960000	480000	600000
Fixed cost (Rs.)	--	252000	144000	--	252000	144000
Total cost (Rs.)	480000	492000	444000	960000	732000	744000

- i) At 20000 units it is better to install semi-automatic machine as costs are less.
- ii) At 40000 units, it is better to install automatic machine as costs are less.
- iii) The Break-Even level of machines (or) Indifference Level:

$$\frac{Difference\ in\ Fixed\ cost}{Difference\ in\ Variable\ Cost\ per\ unit} = \frac{108000}{3} = 36000\ units$$

Problem No.62.

Shri Kiran manufactures lighters. He sells his product at Rs.20 each, and makes profit of Rs.5 on each lighter.

He worked 50 per cent of his machinery capacity at 50,000 lighters. The cost of each lighter is as

Direct material	Rs.	6	
Wages	Rs.	2	
Workers overhead	Rs.	5 (50 per cent fixed)	
Sales expenses	Rs.	2 (25 per cent variable)	

His anticipation for the next year is that the cost will be go up as under:

Fixed cost	10%
Direct wages	20%
Material	5%

There will not be any change in selling price. There is an additional order for 20,000 lighters in the next year. What is the lowest rate he can quote so that he can earn the same profit as the current year?

Solution:

Present profit	= 50000 x 5	=	Rs. 250000
Present Fixed cost	= 50000 (2.5+1.5) =		Rs. 200000

Computation of Profit after increase in prices:

	Particulars	Amount (Rs.)	Amount (Rs.)
I.	Selling Price		20-00
II.	Variable Cost		
	Material [6 x 105/100]	6.30	
	Wages [2 x 120 / 100]	2.40	
	Works Overhead	2.50	
	Sales Expenses	0.50	11-70
III	Contribution		8-30
IV	Total Contribution [50000 x 8.30]		415000
V	Fixed Cost [200000 x 110/100]		220000
VI	Profit		195000

Computation of Selling Price of the order:

Contribution of profit required for unit	55000/20000	=	Rs. 2.75
(+) Variable cost per unit		=	Rs. 11.70
Therefore, Required Selling Price		=	Rs. 14.45

Problem No.63.

A manufacturing company currently operating at 80% capacity has received an export order from Middle East, which will utilise 40% of the capacity of the factory. The order has to be either taken in full and executed at 10% below the current domestic prices or rejected totally.

The current sales and cost data are given below.

Sales	Rs.16.00 lakhs.
Direct Material	Rs. 5.80 lakhs.
Direct Labour	Rs. 2.40 lakhs.
Variable Overheads	Rs. 0.60 lakhs.
Fixed Overheads	Rs. 5.20 lakhs.

The following alternatives are available to the management:

a.   Continue with domestic sales and reject the export order.

b.   Accept the export order and allow the domestic market to starve to the extent of excess of demand.

c.   Increase capacity so as to accept the export order and maintain the domestic demand by

(i)   Purchasing additional plant and increasing 10% capacity and there by increasing fixed overheads by Rs.65,000 and

(ii)   Working overtime at one and half time the normal rate to meet balance of the required capacity.

You are required to evaluate each of the above alternatives and suggest the best one.

Solution:

Statement showing computation of profit at different alternatives:

(In Lakhs)

	Particulars	I Present Sales 80%	II 40% - Foreign 60% - Domestic	III 40% - Foreign 80% - Domestic
I.	Sales (Rs.)	16	19.2 (=7.2 + 12)	23.2 (=7.2+16)
II.	Variable Cost (Rs.)			
	Direct Material (Rs.)	5.8	7.25	8.70
	Direct Labour (Rs.)	2.4	3.00	3.60
	Variable Overheads (Rs.)	0.6	0.75	0.90
	Overtime Premium (Rs.)	--	--	0.15
		8.80	11.00	13.35
III	Contribution (Rs.)	7.20	8.20	9.85
IV	Fixed Cost (Rs.)	5.20	5.20	5.85 (=5.20 + 0.65)
V	Profit (Rs.)	2.00	3.00	4.00

From the above computation, it was found that the profit is more at the III alternative i.e. accepting the foreign order fully and maintaining the present domestic sales, it is the best alternative to be suggested.

Problem No.64.

AB Ltd manufactures a picnic table which has three components, X,Y,Z one of each being required for each table. The company is working to its full machine capacity of 28,000 hours per period and the machinery used is capable of making all the components.

The tables are made in batches of 20 and data relating to current production are:

Components	Machine Hours	Variable Costs Rs.	Per batch of 20 Fixed Costs Rs.	Total Costs Rs.
X	6	15	6	21
Y	10	18	7	25
Z	12	18	13	36
	28			
Assembly		32	13	45
	83	44	127	
			Profit	23
			Selling price	**150**

Over the next budget period the machine capacity cannot be increased although the assembly capacity can be increases as required. The budget for the next period is being prepared. Because sales are buy and purchase of one of the components is being considered and the following quotation has been received:

Batches of 20

Component	Price
X	Rs.22
Y	28
Z	32

The company has decided that only one component will be bought outside in any one period. The sales director thinks that he could sell at least 50% more tables than at present and probably 75% more provided that the production capacity was available.

You are required to:

(a) Recommend which component should be bought outside if production is increased by 50% and how many components should be bought;

(b) Recommend which component should be bought outside if production is increased by 75% and how many components should be bought.

Solution:

No. of units being produced at present = 28000/28 = 1000

Statement showing Contribution (or) buying cost per machine hour

	Particulars	X	Y	Z
I	Price quoted (Rs.)	22	28	32
II	Variable cost (Rs.)	15	18	18
III	Contribution (Rs.)	7	10	14
IV	Contribution (or) Buying cost per Machine hour (Rs.)	1.17 (7/6)	1.00 (10/10)	1.17 (14/12)

Since, the buying cost per machine hour is less in case of Y it should be bought from outside. No. of units that may be bought from outside.

If 50% capacity is increased:

Hours utilized for	X	=	1500 x 6	=	9000 hours
(1000 x 150%)	Z	=	1500 x 12	=	18000 hours
					27000 hours

Remaining hours = 28000 – 27000 = 1000 hours

No. of units that can be manufactured by Y = 1000/10 = 100 units

No. of units to be bought from outside = 1500 – 100 = 1400 units

If 75% capacity is increased:

Hours utilized for	X	=	1750 x 6	=	10500 hours
	Z	=	1750 x 12	=	21000 hours

This is not possible because if Y is bought from outside, the available hours are not sufficient to manufacture X & Z and it is also given that only one component should be bought from outside. We have to buy from outside either X (or) Z and it will not matter if we buy any one of these because the buying cost per machine hour is same. In that event, we shall try to purchase from outside which take more machine hours, at present i.e. Z. On calculation no. of units of Z to be bought from outside is as follows:

Hours utilized for making	X	=		1750 x 6 =	10500 hours
	Y	=		1750 x 10 =	17500 hours
					28000 hours

No. of units of Z to be bought from outside = 1750 units.

DECISIONS OF TRANSFER PRICING AND USE OF COSTS IN PRICING

Problem No.65.

PH Ltd. manufactures and sells two products, namely BXE and DXE. The company's investment in fixed assets is Rs.2 lakh. The working capital investment is equivalent to three months' cost of sales of both the products. The fixed capital has been financed by term loan lending institutions at an interest of 11% p.a. Half of the working capital is financed through bank borrowing carrying interest at the rate of 19.4%, the other half of the working capital being generated through internal resources.

The operating data anticipated for 1982-83 is as under:

	Product BXE	Product DXE
Production per annum (in units)	5,000	10,000
Direct Material/unit:		
Material A (Price Rs.4 per kg)	1 Kg	0.75 Kg
Material B (Price Rs.2 per kg)	1 Kg	1 Kg
Direct labour hours	5	3

Direct wage rate Rs.2 per hour. Factory overheads are recovered at 50% of direct wages. Administrative overheads are recovered at 40% of factory cost. Selling and distribution expenses are Rs.2 and Rs.3 per unit respectively of BXE and DXE. The company expects to earn an after tax profit of 12% on capital employed. The income tax rate is 50%.

Required:

(i) Prepare a cost sheet showing the element wise cost, total cost profit and selling price per unit of both the products.

(ii) Prepare a statement showing the net profit of the company after taxes for the 1982-83.

Solution:

(a) Cost sheet

	BXE		DXE		TOTAL
	UNIT	TOTALS	UNIT	TOTAL	
	Rs.	Rs.	Rs.	Rs.	Rs.
Direct material	6	30000	5	50000	80000
Direct wages	10	50000	6	60000	110000
Prime cost	16	80000	11	110000	190000
Factory OHs	5	25000	3	30000	55000
Factory cost	21	105000	14	140000	245000
Office OHs	8.40	42000	5.60	56000	98000
Cost of production	29.40	147000	19.60	196000	343000
Selling & dist. OHs	2.00	10000	3.00	30000	40000
Cost of sales	31.40	157000	22.60	226000	383000
Profit as % on					
Fixed capital		21818		26182	48000
Working capital		9420		13560	22980
Sales/S.P	**37.6476**	**188238**	**26.5742**	**265742**	**453980**

Working notes   Rs.

| | Return after tax | [{383000 x 0.25} + 200000] 12% | 35490 |
| | ∴ Sales | 383000 + 35490 x (1/50%) | 453980 |

(b) Statement showing net profit:

Sales		453980
(-) cost of sales		(383000)
Gross profit		70980
(-) interest	{22000 + (95750/2) 19.4%}	(31288)
profit before tax		39692
(-) tax @ 50%		(19846)
Profit after tax		19846

Problem No.66.

Megatron Ltd. has entered into a collaboration agreement with Kozuki of Japan for import of TV Kit in completely knocked down (CKD) condition. The terms of agreement are as under:

(a) Megatron will import 40% items by value (interms of FOB price of complete T.V. set) and balance 60% will be locally manufactured / purchased.

(b) For all non-standard items which are to be produced locally, Kozuki will provide drawings.

(c) Megatron will pay a lump sum of Rs.30 lakh for supply of technical know-how and drawing.

(d) Megatron will also pay a royalty at 10% of selling price fixed by it for sale in the local market less landed cost of imported Kit, less cost of standard items purchased locally.

(e) Megatron will send a six monthly return to Kozuki showing No. sets sold, sale value, standard components costs, landed cost of CKD, etc.

Considering the above terms and additional information given below, calculate the selling price that should be fixed for local sale so as to get 20% profit on selling price (Round off the answer to nearest rupee).

(a)   Agreement expires on production of 3 lakhs sets.

(b)   FOB price quoted is 1,20,000 yen.

(c)   Insurance and freight Rs. 200 per CKD.

(d)   Customs Duty at 140% of CIF price. However, effective rate of duty is only 40% as per Government notification.

(e)   Estimated cost of 60% items to be manufactured/procured locally, will be 1.5 items as compared to cost of manufacture by Kzuki. The quoted price by Kzuki contains 20% margin on cost.

(f)   The ratio of standard and non-standard parts is 2:3 (interms of rupee value).

(g)   Assembling and other overhead costs will be Rs.1000 per set.

(h)   Exchange rate is Rs.5 per 100 yen.

Solution: **Computation of landed cost of CKT kit:**

FOB price		Yen 120000
		Rs.
FOB price in rupees	(120000/20)	6000
FOB price of import content	6000 x 40%	2400
(+) freight & insurance		200
CIF value		2600
(+) customs duty@40%		1040
Landed cost of imported CKD kit		**3640**

Cost estimate of locally manufactured items:

		Rs.
FOB price of local purchase	6000 x 60%	3600
(-) profit	3600 x (1/6)	600
		3000
Cost of in business manufacture:	3000 x 1.50	4500
Cost of standard part	{4500 x (2/5)}	1800
Non- standard part	{4500 x (3/5)}	2700

Computation of cost & selling price:

		Rs.
Landed cost of imported CKD kit		3640
Cost of indigenous manufacture		4500
Assembling and other OHs costs		1000
Cost of technical know – how	(3000000/300000)	10
		9150
(+) Royalty		685
		9835
(+) return	{9835 x (1/4)}	2459
Selling price		**12294**

Working notes:

Let X be the selling price

$\Rightarrow$ 9150 + (X – 3640 – 1800) 10% + X (1/5) = X

$\Rightarrow$ X = Rs12294/-

Problem No.67.

P.H. Ltd. has two manufacturing departments organised into separate profit centres known as the Basic unit and Processing unit. The Basic unit has a production capacity of 4,000 tonnes per month of Chemvax but at present its sales are limited Rs. 2,000 tonnes to outside market and 1,200 tonnes to the Processing unit.

The transfer price for the year 1986 was agreed at Rs. 400 per tonne. This price has been fixed in line with the external wholesale trade price on 1st January 1986. However due to heavy competition the Basic unit has been forced to reduce the wholesale trade price to Rs. 360 per tonne with effect from 1st June, 1986. This price however was not made applicable to the sales made to the Processing unit of the company. The Processing unit applied for revision of the price as applicable to the outside market buyers as from 1st June 1986 but the same was turned down by the basic unit.

The Processing unit refines Chemvax and packs the output Known as Colour-X in drums of 50kgs each. The selling price of colour-X is Rs. 40 per drum. The Processing unit has a potential of selling a further quantity of 16,000 drums of colour-X provided the overall price is reduced to Rs.32 per drum. In that event it can buy the additional 800 tonnes of Chemvex from the basic unit whose capacity can be fully utilised. The outside market will not however absorb more than the present quantity of 2,000 tonnes.

The cost data relevant to the operations are:

	Basic Unit	Processing Unit
	Rs.	Rs.
Raw Materials/tonne	70	Transfer price
Variable Cost/tonne	140	170
Fixed Costs/month	Rs.3,00,000	1,20,000

You are required:

(i)   Prepare statement showing the estimated profitability for June 1986 for each uint and the company as a whole on the following bases:

(a)   At 80% and 100% capacity utilisation of the Basic unit at the market price and transfer price to the Processing unit of Rs.400 per tonne.

(b)   At 80% capacity utilisation of the basic unit at the market price of Rs.360 per tonne and the transfer price to the Processing unit of Rs. 400 per tonne.

(c)   At 100% capacity utilisation of the Basic unit at the market price and transfer price to the Processing unit of Rs.360 per tonne.

ii)   Comment on the effect of the company's transfer pricing policy on the profitability of the Processing Unit.

Solution:

(a) **Statement showing computation of profit at 80% capacity when transfer price is Rs400/- ton:**

		Basic unit	Processing unit	Total
i) No. of units		3200	(1200x1000)/50	24000
ii) Contribution per unit	Rs.	{400-(140 + 70)} = 190	{40 – (570/20)}	11.50
iii) Total contribution	Rs.	608000	276000	884000
iv) Fixed cost	Rs.	300000	120000	420000
v) Profit	Rs.	308000	156000	464000

At 100% capacity:

		Basic unit	Processing unit	Total
i) No. of units		4000	40000	
ii) Contribution per unit	Rs.	190	3.50	
iii) Total contribution	Rs.	760000	140000	900000
iv) Fixed cost	Rs.	300000	120000	420000
v) Profit	Rs.	460000	20000	480000

(b) **Computation of profit:**

		Basic unit		Processing unit	Total
		Out side sale	Internal transfer		
i) No of units		2000	1200	24000	
ii) Contribution per unit	Rs.	150	190	11.50	
iii) Total contribution	Rs.	300000	228000		
	Rs.		528000	276000	804000
iv) Fixed cost	Rs.		300000	120000	420000
v) Profit	**Rs.**		**228000**	**156000**	**384000**

(c) Computation of profit:

		Basic unit	Processing unit	Total
No of units		4000	40000	
Contribution per unit	Rs.	150	5.50	
Total contribution	Rs.	600000	220000	820000
Fixed cost	Rs.	300000	120000	420000
Profit	Rs.	300000	100000	400000

Overall profit is more at 100% capacity of basic unit with a transfer price of Rs400/- per ton being the market price if individual interests are not considered this may adopted. However, from the view point of the processing unit, it will not be interested to buy more than 1200tonnes from the basic unit, because its profit gets reduced when it takes additional units. Therefore, the present policy of the management is not at all attractive to the processing unit.

Problem No.68.

Division A is a profit centre which produces three products X, Y and Z. Each product has an external market.

	X	Y	Z
External market price per unit	Rs.48	Rs.46	Rs.40
Variable cost of production in division A	Rs.33	Rs.24	Rs.28
Labour hours required per unit in division A	3	4	2

Product Y can be transferred to Division B, but the maximum quantity that might be required for transfer is 300 units of Y.

	X	Y	Z
The maximum external sales are :	800 units	500 units	300 units

Instead of receiving transfers of Product Y from Division A, Division B could buy similar product in the open market at a slightly cheaper price of Rs.45 per unit.

What should the transfer price be for each unit for 300 units of Y, if the total labour hours available in Division A are?

(a) 3800 hours
(b) 5600 hours.

Solution:

Computation of contribution per labour hour from external sales:

	X	Y	Z
Market price(Rs.)	48	46	40
Variable cost(Rs.)	33	24	28
Contribution(Rs.)	15	22	12
Labour hours required	3	4	2
Contribution per labour hour(Rs.)	5	5.50	6
Priority	III	II	I

Computation of transfer price when

(a) The capacity is 3800 hours:

Hours required for Z = 300 x 2		=	600
	Y = 500 x 4	=	2000
			2600
	X = 800 x 3		2400
			5000

The existing capacity is not sufficient to produce the units to meet the external sales. In order to transfer 300 units of Y, 1200 hours are required in which division A will give up the production of X to this extent.

	Rs.
Variable cost of Y	24
(+) contribution lost by giving up production of X to the extent of 1200 hours	
= 1200 x 5 = 6000	
∴ Opportunity cost per unit = (6000/300)	20
Required transfer price	**44**

(b) If the capacity is 5600 hours:

Variable cost	24
Contribution cost of giving up X to the extent of 600hours = 600 x 5= 3000	
Opportunity Cost Per unit = (3000/300)	10
Required transfer price	**34**

Problem No.69.

SV Ltd. Manufactures a product which is obtained basically from a series of mixing operations. The finished product is packaged in the company made glass bottles and packed in attractive cartons.

The company is organized into two independent divisions viz. one for the manufacture of the end product and the other for the manufacture of glass bottles. The Product manufacturing division can buy all the bottle requirements from the bottle manufacturing division. The General Manager of the bottle manufacturing division has obtained the following quotations from the outside manufacturers for the empty bottles.

Volume empty bottles	Total cost (Rs.)
8,00,000	14,00,000
12,00,000	20,00,000

A cost analysis of the bottle manufacturing division for the manufacture of empty bottles reveals the following production costs:

Volume empty bottles	Total purchase value (Rs.)
8,00,000	Rs.10,40,000
12,00,000	14,40,000

The production cost and sales value of the end product marketed by the product manufacturing division are as under.

Volume	Total cost of end product[*]	Sales Value
(Bottle of end product)		(Packed in bottles)
8,00,000	Rs.64,80,000	Rs. 91,20,000
12,00,000	Rs.96,80,000	Rs.1,27,80,000

There has been considerable discussion at the corporate level as to the use of proper price for transfer of empty bottles from the bottle manufacturing division to product manufacturing division. This interest is heightened because a significant portion of the Divisional General Manager's salary is in incentive bonus based on profit centre results. As the corporate management accountant responsible for defining the proper transfer prices for the supply of empty bottles by the bottle manufacturing division to the product manufacturing division, you are required to show for the two levels of volume of 8,00,000 and 12,00,000 bottles, the profitability by using (i) market price and (ii) shared profit relative to the cost involved basis for the determination of transfer prices. The profitability position should be furnished separately for the two divisions and the company as a whole under each method. Discuss also the effect of these methods on the profitability of the two divisions.

[*] (Excluding cost of empty bottles)

Solution:

Statement showing Computation of transfer price on the basis of profit shared on cost basis:

	Output (800000)	Output (1200000)
	(Rs.)	(Rs.)
Sales	9120000	12780000
Costs:		
Product manufacturing division	6480000	9680000
Bottle manufacturing division	1040000	1440000
	7520000	11120000
Profit	1600000	1660000
Share of bottle manufacturing division	221276	214964
Product manufacturing division	1378724	1445036
Transfer price	1261276	1654964
Transfer price per bottle	1.5777	1.379

Profitability on the basis of market price:

	Output (800000)	Output (1200000)
	(Rs.)	(Rs.)
Bottle manufacturing division		
Sale value	1400000	2000000
(-)cost	1040000	1440000
Profit	360000	560000

Product manufacturing division			
Sale value		9120000	12780000
(-)cost of product	6480000		
Cost of bottle	1400000		
Profit		7880000	11680000
		1240000	1100000
Total profit		1600000	1660000
Transfer price		1.75	1.67

Problem No.70.

A Company with two manufacturing divisions is organised on profit centre basis. Division 'A' is the only source for the supply of a component that is used in Division B in the manufacture of a product KLIM. One such part is used each unit of the product KLIM. As the demand for the product is not steady. Division B can obtain orders for increased quantities only by spending more on sales promotion and by reducing the selling prices. The Manager of Division B has accordingly prepared the following forecast of sales quantities and selling prices.

Sales units per day	Average Selling price per unit of KLIM
	Rs.
1,000	5.25
2,000	3.98
3,000	3.30
4,000	2.78
5,000	2.40
6,000	2.01

The manufacturing cost of KLIM in Division B is Rs.3,750 first 1,000 units and Rs.750 per 1,000 units in excess of 1,000 units.

Division A incurs a total cost of Rs.1,500 per day for an output to 1,000 components and the total costs will increase by Rs.900 per day for every additional 1,000 components manufactured. The Manager of Division A states that the operating results of his Division will be optimised if the transfer price of the component is set at Rs.1.20 per unit and he has accordingly set the aforesaid transfer price for his supplies of the component to Division A

You are required:

(a)   Prepare a schedule showing the profitability at each level of output for Division A and Division B.
(b)   Find the profitability of the company as a whole at the output level which
(i)   Division A's net profit is maximum.
(ii)   Division B's net profit is maximum.
(c)   If the Company is not organised on profit centre basis, what level of output will be chosen to yield the maximum profit.

Solution:

i. **Statement showing profit of division A:**

Sale per day(units)	Sale value	Cost	Profit/(loss)
	Rs.	Rs.	Rs.
1000	1200	1500	(300)
2000	2400	2400	-
3000	3600	3300	300
4000	4800	4200	600
5000	6000	5100	900
6000	7200	6000	1200

Profit of division B:

No of units	Sales	Transfer price	Other manufacturing cost	Total cost	Profit/(loss)
	Rs.	Rs.	Rs.	Rs.	Rs.
1000	5250	1200	3750	4950	300
2000	7960	2400	4500	6900	1060
3000	9900	3600	5250	8850	1050
4000	11120	4800	6000	10800	320
5000	12000	6000	6750	12750	(750)
6000	12060	7200	7500	14700	(2640)

ii. **Profitability of the company at the output level where division A's net profit is maximum**

	Rs.
Profit of division A at 6000units	1200
Profit of division B at 6000units	(2640)
Profit /(loss)	(1440)
Division B's net profit is maximum:	
Profit of division A at 2000 units	-
Profit of division B at 2000units	1060
	1060

(c) When the company is not organized on profit centre basis

Profit at different levels of output

Units	Division A	Division B	Total
	Rs.	Rs.	Rs.
1000	(300)	300	-----
2000	-----	1060	1060
3000	300	1050	1350
4000	600	320	920
5000	900	(750)	150
6000	1200	(2640)	(1440)

Best output level is 3000 units

Problem No.71.

Transferor Ltd. has two processes Preparing and Finishing. The normal output per week is 7,500 units (Completed) at a capacity of 75%

Transferee Ltd. had production problems in preparing and requires 2,000 units per week of prepared material for their finishing processes.

The existing cost structure of one prepared unit of Transferor Ltd. at existing capacity

Material	Rs.2.00 (variable 100%)
Labour	Rs.2.00 (Variable 50%)
Overhead	Rs.4.00 (variable 25%)

The sale price of a completed unit of Transferor Ltd is Rs.16 with a profit of Rs.4 per unit.

Construct the effect on the profits Transferor Ltd., for six months (25 weeks) of supplying units to Transferee Ltd. with the following alternative transfer prices per unit:

(i) Marginal Cost
(ii) Marginal Cost + 25%
(iii) Marginal Cost + 15% Return on capital(assume capital employed Rs.20 lakhs)
(iv) Existing Cost
(v) Existing Cost + a portion profit on the basis of (preparing cost / Total Cost) x Unit Profit
(vi) At an agreed market price of Rs.8.50 Assume no increase in fixed cost.

Solution:

Transferred units   25 x 2000 =   50000
Existing profit   7500 x 25 x 4= Rs.   750000

Effect on profit if transfer price is

i. Marginal cost

	Rs.
Material	2.00
Labour	1.00
OHs	1.00
	4.00

At this transfer price there is no effect on profit of transferor ltd.

ii. Profit   = 50000

iii. Profit per unit   = 4 + {(2000000 x 15% x 0.5)/50000} = 7

Under this method profit of transferor ltd is increases by 150000 i.e., 50000 x (7-4)

iv. Profit increases by 50000 x (8-4) = 200000

v. Transfer price: Rs.

{8 + (8/12)4}   = 10.67

(-) profit   = 4.00

6.67

Profit increases by 50000 x 6.67 = Rs333500/-

vi. Transfer price = 8.50

Profit increase by 4.5 x 50000 = Rs. 2,25,000

Problem No.72.

A manufacture has three products A, B, C Current sales; cost and selling price details and processing time requirements are as follows:

	Product A	Product B	Product C
Annual sales (units)	6000	6000	750
Selling Price (Rs.)	20	31	39
Unit Cost (Rs.)	18	24	30
Processing time required per unit (hour)	1	1	2

The firm is working at full capacity (13,500 processing hours per year.) Fixed manufacturing overheads are absorbed into unit costs by a charge of 200% of variable costs. This procedure fully absorbs the fixed manufacturing overhead.

Assuming that:

(i) Processing time can be switched from one product line to another.

(ii) The demand at current selling price is:

Product A	Product B	Product C
11,000	8,000	2,000

(iii) The selling prices are not be altered, you are required to calculate the best production programme for the next operating period and to indicate the increase in net profit that this should yield. In addition identify the shadow price of processing hour.

Solution:

Computation of contribution per labour hour & priority:

		A	B	C
i) Selling price	Rs.	20	31	39
ii) Variable cost(1/3rd of total cost)	Rs.	6	8	10
iii) Contribution per unit	Rs.	14	23	29
iv) Contribution per hour	Rs.	14	23	14.5
v) Priority		III	I	II

Computation of current profit:

		A	B	C	TOTAL
i) No of units		6000	6000	750	
ii) Contribution per unit	Rs.	14	23	29	
iii) Total contribution	Rs.	84000	138000	21750	243750
iv) Fixed cost	Rs.	72000	96000	15000	183000
v) Profit	Rs.				60750

Statement showing optimum mix & profit at that mix:

		A	B	C	Total
i) No of units		1500	8000	2000	
ii) Contribution per unit	Rs.	14	23	29	
iii) Total contribution	Rs.	21000	184000	58000	263000
iv) Fixed cost	Rs.				183000
v) Profit	Rs.				80000

Working notes:

Hours available	13500
(-) used for B = 8000 x 1	8000
	5500
(-) used for C = 2000 x 2	4000
Used for A	1500

Increase in profit = 80000 – 60750 = 19250

Shadow price of processing hour:

The shadow price is the opportunity cost of one unit of resource for the decision maker. In the present case every extra processing hour will increase contribution by Rs.14/-

Therefore the shadow price of processing hour is Rs14.

Problem No.73.

Your company fixes the inter-divisional transfer prices for its products on the basis of cost, plus a return on investment in the division. The Budget for Division A for 1981-82 appears as under:

	Rs.
	Rs.
Fixed Assets	5,00,000
Current assets	3,00,000
Debtors	2,00,000
Annual Fixed Cost of the Division	8,00,000
Variable Cost per unit of Product	10
Budgeted Volume	4,00,000 units per year
Desired ROI	28%

Determine the transfer Price for Division A.

Solution:

		Rs.
Variable Cost		10.00
Fixed Cost per unit	8,00,000 ÷ 4,00,000	2.00
required Return	$\dfrac{10,00,000 \times 28\%}{4,00,000}$	0.70
Total cost or Transfer price		**12.70**

Problem No.74.

You have just taken up the position as the first full-time accountant for a jobbing engineering company. Previously the accounting work had been undertaken by the company's auditors who had produced the following summarised profit and loss statement for the financial year which ended on 31st March of this year:

	Rs.	Rs.	Rs.
Sales			24,00,000
Direct material		10,00,000	
Direct labour-Grinding Dept.	2,00,000		
Direct labour-Finishing Dept.	2,60,000		
		4,60,000	

Production overhead-Grinding	1,75,000	
Production overhead-Finishing	2,08,000	
		3,83,000
Administration costs		1,18,500
Selling costs		1,92,000
		21,53,500
Net profit		2,46,500

The sales manager is currently negotiating a price for an inquiry for a job which has been allotted number '878' and he has been given the following information by his staff:

Preferred price to obtain a return of 16-2/3% on selling price	Rs.22,656
Lowest acceptable	Rs.18,880

These prices have been based on the following estimated costs for proposed job '878':

		Rs.
Direct material		9,000
Direct labour-Grinding Dept.	400 hours @ Rs. 5 =2,000	
Direct labour-Finishing Dept.	300 hours @ Rs. 6 =1,800	
		3,800
		12,800
Add 47.5% to cover all other costs		6,080
Total cost		18,880

The sales manager seeks your advice about the validity of the method he is using to quote for job '878'.

The company is currently busy with a fairly full order book but the Confederation of British Industry has forecast that a recession is imminent for the engineering industry.

You are required: as the accountant.

(a) To criticise the method adopted for estimating the costs which are used as the basis for quoting prices for jobs;

(b) To suggest a better method of estimating job costs and to calculate a revised job cost and price based on the information available.

Solution:

The predominant mistake in estimating cost for the job is the application of absorbing all types of Over Heads. It is the general practice to recover production overhead on the basis of Overhead rate for Direct Labour Hour of the department, to recover Administration Over Head at certain percentage on Factory Cost and to recover selling Over Heads as percentage of Cost of production.

In view of the above, the major mistake is recovery of Over Head at a flat rate of 47.5%. If the cost is estimated on the above lines the revised job cost and price for job No. 878 would be as follows:

Labour Hours as per Profit & Loss Statement:
Grinding Department 2,00,000/5 = 40,000
Finishing Department 2,60,000/6 = 43,333

Calculation of Production Overhead rate per Labour Hour:

Grinding Department 1,75,000/ 40,000 =4.375

In Finishing Department 2,08,000/ 43,333 = 4.8

Percentage of Administration Overhead on Factory Cost = 1,18,000/18,43,000 x 100 = 6.43%

Percentage of Selling Overhead on Cost of Production = 1,92,000/19,61,500 x 100 = 9.788%

Computer of Revised Job Cost and Price:

		Rs.
Direct Material		9000
Direct Labour:		
Grinding Department	400 x 5 = 2000	
Finishing Department	300 x 6 = 1800	3800
Prime Cost		12,800
Add: Production Overhead:		
Grinding Department	400 x 4.375 = 1750	
Finishing Department	300 x 4.8 = 1440	3190
Works Cost		15,990
Add: Administration Overhead 6.43% on works cost		1,028
Cost of Production		17,018
Add: Selling Overhead @ 9.788% on Cost of Production		1,666
Cost of Sales		18,684
Add: (1/6th of sales i.e., 1/5th of cost)		3,737
Selling Price		**22,421**

Problem No.75.

S.V.Ltd budgets to make 1,00,000 units of product P. The variable cost per unit is Rs. 10. Fixed costs are Rs.6,00,000.The finance Director suggested that the cost-plus approach should be used with a profit mark-up of 25%. However, the Marketing Director disagreed and has supplied the following information:

Price per unit (Rs.)	Demand (Unit)
18	84,000
20	76,000
22	70,000
24	64,000
26	54,000

As Management Accountant of the Company analyse the above proposals and comment.

Solution:

Calculation of selling price as per Finance Director's approach

	Rs
Variable Cost	10
Fixed Cost (6,00,000/1,00,000)	6
Total Cost	16
Add: Profit mark up 25%	4
Selling Price	20

Evaluation of marketing Director's Proposal:

Selling Price	Contribution per unit	No. of units	Total contribution	Fixed Cost	Profit
Rs.	Rs.		Rs.	Rs.	Rs.
18	8	84,000	6,72,000	6,00,000	72,000
20	10	76,000	7,60,000	6,00,000	1,60,000
22	12	70,000	8,40,000	6,00,000	2,40,000
24	14	64,000	8,96,000	6,00,000	2,96,000
26	16	54,000	8,64,000	6,00,000	2,64,000

At the selling price of Rs. 24 per unit, the profit is maximum and hence that price must be fixed for the product.

Problem No.76.

Look Ahead Ltd. wants to fix proper selling prices for their products 'A' and 'B' which they are newly introducing in the market. Both these products will be manufactured in Department D, which is considered as a Profit Centre.

The estimated data are as under: -

	A	B
Annual Production (unit)	1,00,000	2,00,000
	Rs.	Rs.
Direct Materials per unit	15.00	14.00
Direct Labour per unit	9.00	6.00
(Direct Labour Hour Rate = Rs.3)		

The proportion of overheads other than interest, chargeable to the two products are as under:

Factory overheads (50% fixed) 100% of Direct Wages. Administration overheads (100% fixed) 10% of factory costs. Selling and Distribution overheads (50% variable) Rs. 3 and Rs. 4 respectively per unit of products A and B.

The fixed capital investment in the Department is Rs.50 lakhs. The working capital requirement is equivalent to 6 months stock of cost of sales of both the product. For this project a term loan amounting to Rs.40 lakhs has been obtained from Financial Institutions on a interest rate of 14% per annum. 50% of the working capital needs are met by bank borrowing carrying interest at 18% per annum. The Department is expected to give a return of 20% on capital employed.

You are required to:

(a) Fix the selling price of products A and B such that the contribution per direct labour hour is the same for both the products.

(b) Prepare a statement showing in details the overall profit that would be made by the Department.

Solution:

Statement of Cost

Material	A	B
	Rs.	Rs.
Direct Material	15	14
Direct Labour	9	6
Price Cost	24	20
Factory Overhead (100% Direct Labour	9	6
Factory Cost	33	26
Administration Overhead (10% of Factory Cost)	3.30	2.6
Cost of production	36.30	28.6
Selling and Distribution	3	4
Cost of Sales (or) Unit Cost	39.30	32.60

Variable Cost:

	A	B
	Rs.	Rs.
Prime Cost	24	20
Factory Overhead (Variable) (9 x 50%) (6 x 50%)	4.5	3
Selling (Variable)	1.5	2
Total	30	25

Computation of Total capital Employed:

		Rs.
Fixed Capital		50,00,000
Working Capital:		
A = 1,00,000 x 39.3	39,30,000	
B = 2,00,000 x 32.6	65,20,000	
	1,04,50,000 x 6/12	52,25,000
Total Capital employed		1,02,25,000
Required Return @ 20% on Total Capital employed		20,45,000
Total Cost		1,04,50,000
Add: EBIT		20,45,000
Sales Value		1,24,95,000
Less: Variable Cost	1,00,000 x 30 + 2,00,000 x 25	80,00,000
Contribution		44,95,000
Contribution per hour	44,95,000/7,00,000	6.4214
Contribution for unit of 'A"	3 x 6.4214	19.2463
Contribution per hour	44,95,000/7,00,000	
Contribution for unit of 'B"	2 x 6.4214	12.8429

Computation of Selling Price:

	A	B
	Rs.	Rs.
Variable cost	30	25
Add: Required Contribution	19.4643	12.8429
Selling Price	**49.4643**	**37.8429**

b)

		Rs.
I	Sales	1,24,95,000
II	Cost	1,04,50,000
III	EBIT (Profit)	20,45,000
IV	Interest on term loan (40,00,000 x 14%)	(5,60,000)
V	Interest on bank borrowing 52,25,000 x ½ x 18/100	(4,70,250)
VI	Profit	10,14,750

Problem No.77.

L Ltd. and M Ltd. are subsidiaries of the same group of companies.

L ltd produces a branded product sold in drums (10,000 in number) at a price of Rs.20 per drum.

Its direct products cost per drum are:

  -Raw material from M Ltd. AT a transfer price of Rs.9 for 25 liters.

  -Other products and services from outside the group : At a cost of Rs.3.

L Ltd's fixed costs are Rs.40,000 per month. These costs include process labour whose costs will not alter until L Ltd's output reaches twice its present level. A market research study has indicate that L Ltd's market could increase by 80% in volume if it were to reduce its price by 20%. M Ltd produces a fairly basic product which can be converted into a wide range of end products. It sells one third of its output to L Ltd and the remainder to customers outside the group.

M Ltd production capacity is 1,000 kiloliters per month, but competition is keen and it budgets to sell no more than 750 kiloliters per month for the year 31st December 1990. Its variable costs are Rs.200 per kiloliter and its fixed costs are Rs.60,000 per month.

The current policy of the group is to market prices, where known, as the transfer price between its subsidiaries. This is the basis of the transfer price between M Ltd and L Ltd.

You are required:

(a) To calculate the monthly profit position for each of L Ltd and M Ltd if sales of L Ltd are :
   (i)   At their present level and
   (ii) At the higher potential level indicated by the market research, subject to a cut in price of 20%.

(b) To explain why the use of market price as the transfer price produces difficulties under the conditions outlined in (a) (ii) above

(c) To recommend, with supporting calculations, what transfer price you would propose.

Solution:

Statement showing computation of cost at division and total and present level

	'M' Ltd.	'N' Ltd	Total
No. of Units	750 Ki. Ltrs	10000 Drums	
	Rs.	Rs.	Rs.
Selling Price	360	20	
Variable Cost per unit	200	12	
Contribution per unit	160	8	
Total contribution	1,20,000	80,000	2,00,000
Fixed Cost	60,000	40,000	1,00,000
Profit	60,000	40,000	1,00,000

Statement showing computation of profit when 'L' Ltd. Capacity increased by 80%

	'M' Ltd.	'L' Ltd	Total
No. of Units	950 K. Ltrs.	18000 Drums	
	Rs.	Rs.	Rs.
Contribution per unit	160	4	
Total contribution	15,20,000	72,000	2,24,000
Fixed Cost	60,000	40,000	1,00,000
Profit	92,000	32,000	1,24,000

Usually, the market price is the most satisfactory basis for inter company transfer prices as it avoids an extensive arbitration system. However, in the present case, 'L' Ltd. By increasing its sales to 80% reduces it profit by 8000 and at the same to 80% reduces it profit by 'M' Ltd increases by Rs. 32,000.

Therefore No increases to 'L' Ltd to take extra business though the overall profit increased by Rs. 24,000 i.e., 24,000 i.e., 24%. There is decrease in profit of 'L' Ltd. Thus there will be no goal congruence between 'L' Ltd and the group.

Under the circumstances, the proposed Transfer Price will be fired in the following lines. At present level, the profit of Rs. 1,00,000 is shared by two divisions in the ratio of 60:40. Therefore it is fair and appropriate to share the additional profit of Rs. 24,000 in the same ratio.

Then share of 'L' Ltd = 24,000 x 40/100 = Rs.9,600

Then share of 'M' Ltd = 24,000 x 60/100 = Rs.14,400

The transfer price is fired in such a way that 'L' Ltd will get a profit of Rs. 49,600.

Rs. (40,000 + 9,600). The profit to be increased to 'L' Ltd = 49,600 – 32,000 = 17,600

No. of units transferred from 'L' Ltd. To 'M' Ltd. Is 2,00,000 Ltrs. i.e., 8000 drums

Transfer price to be reduced per drum = 17600/8000 = Rs.2.2

Proposed Transfer price = 9.0 – 2.2 = Rs.6.80

Therefore Proposed Transfer Price for additional production / sales to be fired at Rs. 6.8 per drum.

Problem No.78.

A group has two companies:

   K Ltd. which is operating at just above 50% capacity, and

   L Ltd. which is operating at full capacity (7,000 production hours).

L Ltd. produces two products, X and Y, using the same labour for each product. For the next year its budgeted capacity involves a commitment to the sale of 3,000 kgs of Y, the remainder of its capacity being used on X.

Direct costs of these two products are:

	X	Y
	Rs.per kg	Rs.per kg
Direct materials	18	14
Direct wages	15 (1 production hour)	10 (2/3 production hour)

The company's overhead is Rs.1,26,000 per annum relating to X and Y in proportion to their direct wages. At full capacity Rs.70,000 of this overhead is variable. L Ltd prices its products with a 60% mark up on its total costs.

For the coming year, K Ltd. wishes to buy from L Ltd. 2,000 kgs of product X which it proposes to adopt and sell as product Z for Rs.100 per kg. The direct costs of adaptation are Rs.15 per kg. K Ltd's total fixed costs will not change, but variable overhead of Rs.2 per kg will be incurred.

You are required to recommend: as group management accountant:

(a) At what range of transfer prices, if at all 2,000 kgs of product X should be sold to K Ltd.

(b) What other points should be borne in mind when making any recommendations about transfer prices in the above circumstances?

Solution:

Computation of Transfer price of product 'X'

	Rs.
Direct materials	18
Direct Wages	15
Variable Over Heads (70,000/7,000 x 1)	10
Fixed Overhead	8
Total Cost	51
Add: Markup for profit @ 60%	30.6
Transfer Price	81.6

Profit of 'K' Ltd on the sale of 'Z' = 100-(15+2+81.6) = Rs.1.4

Total profit on 2000 units = 1.4 x 2000 = Rs.2,800

From the view point of 'L' Ltd.:

It is charging a profit of 60% i.e., a price of Rs. 81.6, which it charges to outsiders. Market price is normally considered as the best transfer price because it avoids extensive arbitration and also it gives the Buyer and seller an equitable basis for inter company trading.

From the view point of 'K'Ltd.

It is making a small merger of Rs. 1.4 per Kg. on the incremental cost if Rs. 17 which just equal to 8.24% (1.4/17 x 100) this is very much below the 'L' Ltd's margin included in the transfer price. 'K' Ltd may point out that 'L' Ltd will save some variable overhead. For example Transport, Advertisement, Credit control etc. This is likely to be more than Rs. 2 per Kg. out of Rs. 10 (Variable Overhead) categorized as 'L' Ltd. S Overhead which is included in selling and Administrative expenses. In that went the transfer price can be reduced by Rs. 3.2 (2+2 x 60%) to Rs. 78.4. Then the new profit of 'K' Ltd = Rs.4.6 per Kg. Then percentage of profit = 27% (4.8/78.4 x 100)

This may justify for the view point of 'K' Ltd. Therefore, the recommended Transfer price may range from Rs.78.4 to Rs.81.6.

DECISIONS RELATING TO JOINT AND BY PRODUCTS

   Problem No.79.

A manufacturing unit imports Raw Material and processes it to produce three different products viz. Bright, Light and White. The raw material has F.O.B. value of Rs.5 per kg. freight and insurance are charged at 10% F.O.B. price. Customs duty at 120% of C.I.F. is levied at the time of import.   Auxiliary duty at 20% is also charged on C.I.F. price.   Countervailing duty is charged on C.I.F. plus duty at 10%. The landed cost includes 5% for clearing charges.

Bright and Light are joint products while white emerges as a by-product.   The value of by-product after deducting 30% (10% being notional profit and 20% for selling expenses) from sale value is credited to process account. The unit consumed 4,000 kgs raw materials during a year. The relevant data is as under:

	Bright	Light	White
Production and sale Kg.	1,400	1,600	1,000
Selling price Rs. per kg.	30	26	12
Further processing cost Rs.	1,500	1,000	—

Assuming additional processing cost other than material at Rs.15,800 for all products (include Rs.800 for White), prepare a statement showing:

   (a) Credit to process A/c for by-product sale;
   (b) Allocation of joint costs on relative sale value basis; and
   (c) Profit on each product.

Solution:

   i.   **Calculation of amount to be credited to main product from sale of by product:**

	Rs.
Sale value of white 1000 x 12	12000
(-) profit @ 10%	1200
Total cost	10800
(-) 20% of 12000 towards selling expenses	2400
Total manufacturing cost	8400
(-) Separation expenses	800
Sale value at split off	7600

   There fore amount to be credited to the process account is Rs7600.

   ii.   **Computation of joint cost**

		Rs.
Material	4000 x 5	20000
Freight and insurance	20000 x 10%	2000
CIF value		22000
(+) customs duty @ 120% (+) Auxiliary duty @ 20% i.e.,	22000 x 140%	30800
		52800
(+) countervailing duty	52800 x 10%	5280
		58080
(+) clearing charges	(58080 x 5%)	2904
Landed cost of material		60984
(+) joint process cost		15000
		75984
(-) Sale value of by product		7600
JOINT cost		**68384**

Statement showing apportionment of joint expenses:

	Bright	Light	Total
Sale value (Rs.)	42000	41600	83600
Joint cost (Rs.)	34356	34028	68384

iii. **Statement showing computation of profit:**

	Bright	Light	White	Total
	Rs.	Rs.	Rs.	Rs.
Sales	42000	41600	12000	95600
(-) costs				
Joint costs	34356	34028	7600	75984
Further costs	1500	1000	800	3300
Selling expenses	----	-----	2400	2400
Total costs	35856	35028	10800	81684
Profit	6144	6572	1200	13916

Problem No.80.

A chemical factory produces four products from a single raw material.   The cost of raw material for a year is Rs.67,000 and the initial processing costs amounted to Rs.1,28,200. All the four products viz. A, B, C and D are produced simultaneously at a single split off point. Product C is sold immediately without any further processing. A,B and D are processed further.

The output, sales and further processing costs are:

Product	Output in units	Sales Rs.	Further Processing Cost Rs.
A	4,00,000	1,92,000	40,000
B	89,725	58,000	32,000
C	5,000	8,000	—-
D	9,000	60,000	1,000

If these products were sold out at the split off point the prices attained per unit would be A=Rs.0.32; B=Rs.0.40; C=Rs.1.60; D=Rs.5.00

Using the concepts of relevancy of costs and differential costs, advise your management whether further processing should be undertaken or not.

Solution:

Statement showing computation of profit before further processing :

	A	B	C	D	Total
No of units	400000	89725	5000	9000	
Selling price (Rs.)	0.32	0.40	1.60	5.00	
Sales (NRV) (Rs.)	128000	35890	8000	45000	216890
Joint cost (Rs.)	115199	32301	7200	40501	195200
Profit/ (Loss) (Rs.)	12801	3589	800	4499	21690

Statement showing profit after further processing:

	A	B	C	D	Total
Final sales (Rs.)	192000	58000	8000	60000	318000
Further processing costs (Rs.)	40000	32000	---	1000	73000
Sale value at split off (Rs.)	152000	26000	8000	59000	245000
Joint cost (Rs.)	121104	20715	6374	47007	195200
Profit/(loss) (Rs.)	30896	5285	1626	11993	49800

Statement showing computation of additional (cost) / profit:

	A	B	C	D	Total
Final sales (Rs.)	4192000	58000	8000	60000	318000
Sale value of split off (Rs.)	128000	35890	8000	45000	216890
Additional sales (Rs.)	64000	22110	---	15000	101110
Further costs (Rs.)	40000	32000	---	1000	73000
Additional profit / (loss) (Rs.)	24000	(9890)	----	14000	28110

From the above computations, it is advisable to further process products A & D as there is additional profit and not to further process products B & C as there is no additional profit.

Problem No.81.

The Management Team of Exe Ltd. is considering the possibility of undertaking a single production process which jointly produces four products in standard proportions. The output from each 10kg.batch of raw material input into the process together with net realisable value per kg. of output immediately after the split-off point is:

Material	Output per 10kg.	Input Net realisable value per kg. of output
A	4 kg	Rs. 8
B	3 kg	Rs. 4
C	2 kg	Rs.10
D	1 kg	Rs. 2

The cost of processing each 10 kg. input batch are Rs.12 and cost of the raw material input is Rs.4 per kg.

For each of the four materials jointly produced there is the possibility of further processing before sale. The further processing will entail both manful operation and mechanical processing as well as incurring some costs directly attributable to each product. Details of resources used in, and costs incurred by, the further processing as well as the final price per kg. are:

Material	Machine hours	Labour hours	Other direct costs	Sales price
A	2	1	Rs. 4	Rs. 17
B	6	1	Rs. 2	Rs. 13
C	4	5	Rs. 3	Rs. 36
D	2	2	Rs. 2	Rs. 9

"Other direct costs" are variable costs but exclude the cost of labour, also a variable cost at Rs.3 per labour hour. A part from "other direct cots" and labour costs, all other costs of this further processing are fixed and are expected to amount to Rs.3,40,000 per annum.

Exe Ltd. has the opportunity to process 1,00,000 kg. of the basic raw material per year and machine capacity is capable of fully processing this amount.

The Managing Director feels that all products which are subjected to further processing must be treated as joint products and all products sold immediately after the split-off point without further processing are to be treated as by products of the original process. The net costs of the joint process are allocated to the joint products in proportion to the contribution of each product line, after considering the marginal costs after the split-off point and sales revenues.

However, the Managing Director is uncertain whether the Rs.3,40,000 fixed production cots of further processing should be allocated to products in accordance with machine or labour hours.

Required:

(a) Specify which of the jointly produced materials should be subject to further processing if the joint process is carried out.

(b) Produce a product profitability report for the joint products, utilizing the Managing Director's approach to the determination of joint and

(c) Byproducts for each of the methods of allocating fixed production over head, he has mentioned. You may assume all production will be sold.

Solution:

a) **Statement showing profitability after further processing:**

	A	B	C	D
Selling price (Rs.)	17	13	36	8
Variable cost:				
Labour (Rs.)	3	3	15	6
Others (Rs.)	4	2	3	2
	7	5	18	8
Contribution (Rs.)	10	8	18	1
NRV (Rs.)	8	4	10	2
Gain /(loss) (Rs.)	2	4	8	(1)

Products A, B & C should be subject to further processing and hence treated as joint products and product D as by product

b) **Working note**

Joint cost	Amount Rs.
Material 100000 x 4	400000
Processing cost 100000 x (12/10)	120000
	520000
(-) Sale value of by product [100000 x (2/10)	20000
Joint cost	500000

Ratio of apportionment of Joint Cost

Labour hour Contribution	Amount Rs.	Ratio
A (40000 x 10)	400000	10
B (30000 x 8)	240000	6
C (20000 x 18)	360000	9
Machine hour		
A 40000 x 2	80000	FOH / Machine hour = 340000 / 340000 = Re. 1
B (30000 x 6)	180000	
C (20000 x 4)	80000	
	340000	

Profit when fixed costs are distributed on machine hour basis

	A	B	C	Total
No of units	40000	30000	20000	
Sales (Rs.)	680000	3900000	720000	1790000
Joint cost (Rs.)	200000	120000	180000	500000
Labour (Rs.)	120000	90000	300000	510000
Other direct costs (Rs.)	160000	60000	60000	280000
Fixed cost (Rs.)	80000	180000	80000	340000
	560000	450000	620000	1630000
Profit / (loss) (Rs.)	120000	(60000)	100000	160000

Profit when fixed costs are distributed on the basis of labour hours

	A	B	C	Total
Sales (Rs.)	680000	390000	720000	1790000
Variable cost (Rs.)	480000	270000	540000	1290000
Contribution (Rs.)	200000	120000	180000	500000
Fixed cost (Rs.)	80000	60000	200000	340000
Profit /(loss) (Rs.)	120000	60000	(20000)	160000

Working notes:

Labour hours

A	40000 x 1	40000
B	30000 x 1	30000
C	20000 x 5	100000
		170000 hours

Fixed cost per labour hour   (340000 / 170000) = Rs. 2.00

Problem No.82.

A chemical factory processes raw material R and produces three similar products P1,P2 and P3 out of a joint process. The joint cost of processing 5,000 kg of R are as under:

Labour Cost	Rs.6,000
Overhead cost	Rs. 2,000
Total	Rs. 8,000

The raw material R is purchased at Rs.2.40 per kg. This rate is after a trade discount of 20% on list price. Normal loss is estimated at 10% of input weight. The scrap generated from processing R is recovered to the extent of 25% by weight and sold as such in the market at Rs.4 per kg. The products P1,P2,P3 can be sold at Rs.5.00, Rs.6.00 and Rs.6.50 per kg respectively without any further processing.

However, products P1 and P2 can also be further jointly processed at an additional cost of Rs.2 per kg of, input to get product J1. The further processing cost of J1 will be Rs1 per kg of output weight.

Similarly, products P2 and P3 can be jointly processed to get a product J2 at an additional cost of Rs.5 per kg of Input. The further processing cost of J2 will be Rs.2 per kg of output weight. The normal loss of processing J1 out of P1 and P2 will be 5% of input weight. No processing loss is expected on processing J2. The selling prices of J1 and J2 including the input composition is given below:

Input	Output	
	J1	**J2**
P1	40%	
P2	60%	50%
P3		50%
Price per kg	Rs.10.00	Rs. 12.00

The output weights of P1, P2 and P3 will be in the proportion of 3:4:2.

Required to:

(a) Show profitability of processing P1, P2 and P2 from 5,000kg. of R assuming the sale of split-off point.

(b) Profitability after both J1 and J2 are further processed and marketed using P2 in the ratio of 3:2 for J1 and J2 respectively.

(c) Recommend the processing decision among the alternatives i.e. to use whole output of P2 for processing J1 or J2 to yield maximum profit and the amount of such maximum profit.

Solution:

(a) **Statement showing profitability of P$_1$, P$_2$ and P$_3$ at spilt off:**

	P$_1$	P$_2$	P$_3$	TOTAL
NO OF UNITS	1500	2000	1000	
SELLING PRICE (Rs.)	5	6	6.50	
SALES (Rs.)	7500	12000	6500	26000
JOINT COST (Rs.)	5625	9000	4875	19500
PROFIT (Rs.)	1875	3000	1625	6500

JOINT COST:

		Rs.
Raw Material	2.4 x 5000	12000
Labour and O.H	6000+2000	8000
(-) scrap realised	125 Kg x 4	500
		19500

b) Computation of profit from J_1, J_2:

J_1:

Units of P_2 Required	2000 x (3/5)	1200
Joint cost	2000 ----- 9000 1200 ------?	Rs. 5400
Units of P_1 Required	60 ------ 1200 40 --------?	800
Joint cost	1500 ----- 5625 800 --------?	Rs. 3000
Units of J_1	1200 **+** 800	2000
Joint cost of J_1	5400 + 3000	Rs. 8400
Joint Processing cost	2000 x 2	Rs. 4000
Total cost		Rs. 12400
Units	(2000 – 100)	1900
Further processing cost	1900 x 1	Rs. 1900
TOTAL COST		Rs. 14300
Profit		Rs. 4700
Sales	1900 x 10	Rs. 19000

J_2:

		Units	Amount Rs.
P_2	(2000 – 1200) X 9000/(2000)	800	3600
P_3	1000 ---- 4875 800 ------?	800	3900
		1600	7500
(+)joint processing cost	1600 x 5		8000
(+)further processing cost	1600 x 2		3200
Total cost			18700
Profit			500
Sales	1600 x 12		19200

Profit from the remaining units of P_1 (1500 – 800) = 700 units

1500 --- 1875

700 -----?   Rs.   875

Units of P_3 (1000 - 800) = 200 units

1000 ----- 1625

200 -------?   Rs.   325

Total profit = 4700 + 500 + 875 + 325 = Rs. **6400**

(c) Profit per unit of P_2 from J_1= 4700/1200 =   Rs. 3.916

   Profit per unit of P_2 from J_2 = 500 / 800 =   Rs. 0.625

As the profit per unit of P_2 is more when it is used in J_1 the entire P_2 should be used in J_1.

Profit from J_1:

	Units	Amount (Rs.)
Units of P_2 required	2000	9000
units of P_1 (40/60) x 2000	1333	5000
	3333	14000
(+)joint processing cost(3333 x 2)	----	6666
(-) weight loss (3333 x 5%)	166	---
(+)further processing cost	-----	3167
	3167	23833
Profit (9671-1625-209)	------	7837
Sales	**3167**	**31670**
Profit from the remaining units of P_1 (1500 -1333) x(1875/1500)		209
P_3 Profit		1625
Total profit		9671

Problem No.83.

Progressive Process Industries manufactures two products P and Q.   Under present operations , raw materials are processed in Department A and the two products are separated at the end of this process. For every unit of P, two units of Q are obtained.   P is then finished in Dept. B and Q in Dept.C.   Actual operating data for 1984 are as under: -

	Dept. A	Dept. B	Dept. C	Total
Units produced				
P	40,000	40,000		40,000
Q	80,000		80,000	80,000
Cost incurred (Rs.)				
Raw Material (Rs.)	1,20,000			1,20,000
Direct Labour (Rs.)	70,000	50,000	60,000	1,80,000
Variable Overheads (Rs.)	40,000	20,000	20,000	80,000
Avoidable fixed overheads (Rs.)	20,000	10,000	10,000	40,000
Common fixed overheads allocated on basis of floor space (Rs.)	50,000	25,000	25,000	1,00,000

At present P is sold for Rs.6.25 and Q for Rs.4 per unit.   Both products are also readily marketable at the completion of processing in Department A-p for Rs.4.50 per unit and Q for Rs.2.75 per unit.   Department B and /or Department C could be closed down completely if P and/or Q, respectively were sold at the split-off point.

   (a) Under an absorption Costing System, what would be the average unit cost of P and Q during 1984?
   (b) From the point of view of short-run profits maximization, when should each product be sold during 1984-after final completion or at the split-off point?

Solution:

a. **Statement showing computation of unit cost price:**

	P	Q	TOTAL
sales at spilt off (Rs.)	180000	220000	400000
Joint cost (Rs.)	135000	165000	300000
Separate cost (Rs.)	105000	115000	220000
Total cost (Rs.)	240000	280000	520000
Cost per unit (Rs.)	**6.00**	**3.50**	

b. **Profit at spilt off point (before further processing):**

	P	Q	TOTAL
Sales at spilt off (Rs.)	180000	220000	400000
Joint cost (Rs.)	135000	165000	300000
Profit (Rs.)	45000	55000	100000
(-)common FOHs (Rs.)			(50000)
			Rs. 50000

Incremental profit:

	P	Q	TOTAL
Incremental sales (Rs.)	70000	100000	170000
(-)separate costs (Rs.)	80000	90000	170000
Profit/(loss) (Rs.)	(10000)	10000	----------

From the above it is better to sell P at spilt off and Q after further processing.

Profit statement if product Q is further processed.

		P	Q	TOTAL
Sales	(Rs.)	180000	320000	500000
Joint cost	(Rs.)	135000	165000	300000
Separate cost	(Rs.)	-------	115000	115000
Profit	(Rs.)	45000	40000	85000
(-)fixed cost of Dept B	(Rs.)			25000
Actual profit	(Rs.)			60000

Problem No.84.

Chem and Co. Ltd. produces two products 'J' and 'K' in Department 'A' from a basic raw material. The input output ratio of Department A is 100:90. Product 'J' which becomes the input of Department 'B' can be further processed in Department 'B' to make one of the most popular industrial product 'N'. The input-output ratio of Department 'B' is 100:95. Alternatively product 'J' can also be sold at the split off stage.

The selling prices are

Product	Rs./Kg.
J	29.40
K	26.00
N	31.50

The departmental expenses, production data in selling expenses envisaged in the budget for 1986 are as under:

(a) Departmental expenses:

	A Rs. lacs	B Rs. lacs
Raw Materials Rs.16 per kg.		
Direct Materials	10.00	3.00
Direct Wages	15.00	5.00
Variable Overheads	20.00	7.00
Fixed Overheads	25.00	10.00

(b) Production data:

Product	kg.
N	4,75,000
K	8,50,000

(c) Selling expenses:

Product	Rs.
J	1,00,000
K	2,00,000
N	2,00,000

You are required to:

(i)   Prepare a statement showing the apportionment of joint costs between products 'J' and 'K'.

(ii)   Advise whether the company should process 'j' further into product 'N' or not. Show workings.

(iii)   Present a statement of profitability based on your decision.

Solution:

Input of 'B' and Output of 'A'   [475000 x 100/95]   =   500000

Input of 'A'   [(500000 + 850000) x 100/90]   =   1500000

Total Joint Expenses   [1500000 x 16] + 70,00,000   =   Rs. 31000000

		J	K	Total
I	Output	500000	850000	
II	Selling Price (Rs.)	29.4	26.0	
III	Sales Value (Rs.)	14700000	22100000	36800000
	Less: Selling Expenses (Rs.)	1000000	200000	
		14600000	21900000	36500000
	Joint Expenses (Rs.)	**12400000**	**18600000**	**31000000**
		(310 x 146/365)		

Computation of Profit or Loss by further processing Produce J and N:

Sales Value (Rs.)	475000 x 31.5		14962500
(-) Cost:			
Joint Cost (Rs.)		12400000	
Cost in Dept 'B' (Rs.)		2500000	
Selling Expenses (Rs.)		200000	15100000
			Rs. (137500)

Further processing of 'J' into 'N' is not advisable as there is loss.

Problem No.85.

Fine Chemicals Ltd. produces A, B, C from a common mixing process. The products are made in batches and from an input of 1,100kg of material the standard output is:

A	400 kg.
B	300 kg.
C	200 kg.
By-product	100 kg.

Waste has no value.

The common costs per batch for the mixing process are:

Direct Material (1,100kg)	Rs.440
Direct labour (100 hrs)	Rs.300
Variable overhead	Rs.200

Fixed overheads in the mixing department are budgeted at Rs.26,000 per month. The normal production is 100 batches per month.

The products are all capable of further processing and the company has idle space available. Additional capital equipment would be required at a cost of Rs.1,20,000 to be depreciated over a 10 year period on a straight line basis with no residual value. Rent, rates and other fixed costs of further processing are budgeted to Rs.15,000 per month.

	A per kg.	B per kg.	C per kg.
	Rs.	Rs.	Rs.
Direct Materials	1.00	0.50	0.80
Direct labour	1.50	3.00	2.25
Variable overhead	1.00	2.00	1.50

Direct wages are Rs.3 per hour and variable overhead is calculated at Rs.2 per hour. The sales value of products before and after further processing are:

	A split-off point per kg	After further processing per kg
	Rs.	Rs.
A	1.25	5.35
B	1.50	7.15
C	2.00	7.55
By-product	0.50	0.50

Only 25,000 direct labour hours will be available for further processing during the coming year.

Required:

 (a) A statement showing the budgeted monthly results if further processing is not undertaken.
 (b) Assuming that at the end of financial year 20% of the output for one month from the mixing department was in stock, show the valuations, which two alternative methods of valuation would give.
 (c) Give calculations and recommendations on the most profitable use of direct labour hour in further processing.

Solution:

a) **Statement showing profitability at present:**

	A	B	C	By-Prod.	Total
Units	40,000	30,000	20,000	10,000	
Sales (Rs.)	50,000	45,000	40,000	5,000	1,40,000
Total Cost (Rs.)	48,000	36,000	24,000	12,000	1,20,000
Profit/Loss (Rs.)	2,000	9,000	16,000	(7,000)	20,000

b) **Valuation of Stock:** [If joint-cost are distributed on the basis of weight.]

	A	B	C	By-Prod
Value of stock (Rs.)	9,600 (48000x20%)	7,200	4,800	1,000 (5000x20%) Subject to Market Price

Valuation of Stock if joint costs are distributed on the basis of sale value at split off:

	A	B	C	By-Prod.	Total
Sale Value at split off (Rs.)	50,000	45,000	40,000	5,000	1,40,000
Total Cost (Rs.)	42,857 (120/140 x 50000)	38,571	34,286	4,286	(1,20,000)
Value of Stock (Rs.) (Cost or Market Price)	8571.4	7714.2	6857	857.2	

c) **Computation of profit from further processing:**

	Particulars	A	B	C
I.	Selling Price after further processing (Rs.)	5.35	7.15	7.55
II.	Selling Price at split off (Rs.)	1.25	1.50	2.00
III.	Incremental Selling Price (I-II) (Rs.)	4.10	5.65	5.55
IV.	Incremental (or) Differential Variance cost (Rs.)	3.50	5.50	4.55
V.	Incremental Contribution (Rs.)	0.60	0.15	1.00
VI.	Time required for unit of product	0.5 hrs	1.0 hrs	0.75 hrs
VII.	Incremental Contribution per hour (V/VI) (Rs.)	1.20	0.15	1.33
	Ranking	II	III	I

Total Contribution in available hours = 25000 x 1.33   =   Rs. 33,333

Fixed Cost (15000 x 12 + 12000)   =   Rs. (1,92,000)

Profit (or) Loss   =   Rs. (1,58,669)

Hence it is recommended that further processing should not be carried out.

Problem No.86.

A company's plant process 6,00,000 kg. of raw material in a month to produce two products viz. Allex and Ballex. The cost of raw materials is Rs.3.00 per kg. The process costs per month are:

Direct Materials	Rs.90,000
Direct wages	Rs. 1,20,000
Variable overheads	Rs. 1,00,000
Fixed overheads	Rs. 1,00,000

The loss in process is 5% of input and the output ratio of Allex and Ballex which emerge simultaneously is 1:2. The selling prices of the two products at the point of split-off are: Allex Rs.3 per kg. and Ballex Rs.5 per kg. A proposal is available to process Allex further by mixing it with other purchased materials. The entire current output of the factory can be so processed further to obtain a new product SA. The price per kg. of SA is Rs.3.75 and each kg. of output of SA will require one kg. of input of Allex. The cost of processing of Allex into SA including other materials is Rs.1,85,000 per month.

Alternatively, another proposal available is to introduce a new material for the manufacture of Allex and Ballex. The new raw material will bring down the process loss to 4% and change the output mix of Allex and Ballex to 2:3. The company's capacity to process the new raw material is also 6,00,000 kg. p.m. The cost of new raw material is Rs.2.90 per kg. All other costs will remain the same.

Required:

(i) Present a statement showing the monthly profitability based on the existing manufacturing operations.

(ii) Evaluate the two proposals independently and present statements showing the respective monthly profitability.

Solution:

Statement showing computation of profit at existing manufacturing operation.

Particulars		Allex	Bullex	Total
No. of units		1,90,000	3,80,000	5,70,000
Sales	(Rs.)	5,70,000	19,00,000	24,70,000
Joint Cost	(Rs.)	5,10,000	17,00,000	22,10,000
Profit	(Rs.)	60,000	2,00,000	2,60,000

Computation of profit from B1

			Rs.
Joint Cost of 'A'		=	5,10,000
(+) Additional further process cost		=	1,85,000
		=	6,95,000
Profit (B/F)		=	17,500
Sales from SA (1,90,000 x 3.75)		=	7,12,500
Total Profit = 2,00,000 + 17,500		=	2,17,500

Computation of Profit at Proposal

Particulars		A	B	Total
No. of units		2,30,400	3,45,600	5,76,000
Sales	(Rs.)	6,91,200	17,28,000	24,19,200
Joint Cost	(Rs.)	6,14,286	15,35,714	21,50,000
Profit	(Rs.)	76,914	1,92,286	2,69,200

This proposal can be accepted because the overall profit is increased by Rs. 9,200.

4
TREATMENT OF UNCERTAINTY IN DECISION MAKING

1.   What is Risk Management?

Ans:

Risk management is a systematic process of identifying and assessing company risks and taking actions to protect a company against them. Some risk managers define risk as the possibility that a future occurrence may cause harm or losses, while noting that risk also may provide possible opportunities. By taking risks, companies sometimes can achieve considerable gains. However, companies need risk management to analyze possible risks in order to balance potential gains against potential losses and avoid expensive mistakes. Risk management is best used as a preventive measure rather than as a reactive measure. Companies benefit most from considering their risks when they are performing well and when markets are growing in order to sustain growth and profitability.

The task of the risk manager is to predict, and enact measures to control or prevent losses within a company. The risk-management process involves identifying exposures to potential losses, measuring these exposures, and deciding how to protect the company from harm given the nature of the risks and the company's goals and resources. While companies face a host of different risks, some are more important than others. Risk managers determine their importance and ability to be affected while identifying and measuring exposures. For example, the risk of flooding in Arizona would have low priority relative to other risks a company located there might face. Risk managers consider different methods for controlling or preventing risks and then select the best method given the company's goals and resources. After the method is selected and implemented, the method must be monitored to ensure that it produces the intended results.

2.   What are the types of Risk Managers?

Ans: Types of Risk Managers:

Company managers have three general options when it comes to choosing a risk manager:

a)   Insurance agents who provide risk assessment services and insurance advice and solutions to their clients;

b)   Salaried employees who manage risk for their company (often chief financial officers or treasurers); And

c)   Independent consultants who provide risk-management services for a fee.

Because risk management has become a significant part of insurance brokering, many insurance agents work for fees instead of for commissions. To choose the best type of risk manager for their companies, managers should consider the company's goals, size, and resources.

3.   What are the types of Risks?

Ans: Types of Risk:

a)   Business risks, or those associated with an organization's particular market or industry;

b)   Market risks, or those associated with changes in market conditions, such as fluctuations in prices, interest rates, and exchange rates;

c)   Credit risks, or those associated with the potential for not receiving payments owed by debtors;

d)   Operational risks, or those associated with internal system failures because of mechanical problems (e.g., machines malfunctioning) or human errors (e.g., poor allocation of resources); and

e)   Legal risks, or those associated with the possibility of other parties not meeting their contractual obligations.

4.   Write a short note on Enterprise Risk Management.

Ans: Enterprise risk Management seeks to implement risk awareness and prevention programs throughout the company, thus creating a corporate culture able to handle the risks associated with a rapidly changing business environment. Enterprise Risk Management deals with risks and opportunities affecting value creation and preservation. Enterprise risk management encompasses: -

a)   aligning risk appetite and strategy

b)   enhancing risk response decisions

c)   reducing operational surprises and losses

d)   identifying and managing multiple and cross enterprise risk

e)   seizing opportunities

f)   improvement in deployment of capital

5.   "Purpose of Sensitivity Analysis is to identify the critical variable in the project analysis." – Discuss.

Ans:

In management accounting parlance, all quantitative and financial figures are best estimates, made on the basis of experience and of the study of macro-economic factors and industry-specific matters. In actual practice, while executing the project, all factors are subject to variation.

Sensitivity Analysis is one of the objective methods to ascertain the impact on final probability by taking specific changes in each critical factor variable. Thus if a company is to operate in a highly competitive market, with many rivals, Sales volumes and Price will be critical variables and hence, one would like to assess how sensitive the project is to changes in Sales volume and price.

Sensitive Analysis, when applied to a capital project, will allow the margin of error in various parameters of a project which can be allowed before the project ceases to be profitable. Sensitivity Analysis does not directly measure risk and it is limited by being able to examine the effect of a change in one variable while the others, remaining constant, are unlikely occurrence in practice.

6.   What is Decision tree? What are the rules to be followed while drawing a decision tree?

Ans: DECISION TREE: Decision Tree is a tool which helps to choose between several courses of action. It provides a highly effective structure within which options can be laid out and the possible outcomes of choosing those options can be investigated. It also helps to form a balanced picture of the risks and rewards associated with each possible course of action.

It is a graphic representation of the sequence of action-event combinations available to the decision-maker. It depicts in a systematic manner all possible sequences of decisions and consequences. Each alternative course of action is represented by a branch, which leads to subsidiary branches for further courses of action or possible events. Decision trees are designed to illustrate the full range of alternatives and events that can occur under all envisaged conditions. Decision tree brings out logical analysis of a

problem and enables a complete strategy to be drawn up to cover all eventualities before a firm becomes committed to a scheme. Following rules and conventions are kept in view in drawing a decision tree:

a) First of all, decisions (i.e., all alternatives) should be identified and they should be arranged in an order in which they are likely to occur.
b) Chance events that can occur after each decision should also be identified.
c) A tree diagram should be developed showing the sequence of decisions and chance events. The tree is constructed starting from left and moving towards right. The square box '□' denotes a decision point at which all the available strategies are considered. The circle '○' represents chance mode or event the various states of nature or the outcome.
d) Probability estimate of the chances of each outcome's occurrences should be obtained.
e) Expected value of all possible outcomes and actions should be obtained.
f) The action offering most attractive expected value should be selected.

7. What is the modified IRR?

Ans: Modified I.R.R: Evaluation of projects are considered to be done best by accountants and investors by applying the tool 'time value of money', provided the data and information gathered for it are dependable. Investments involve cash flows. Profitability of an investment project is determined by evaluating the cash flows NPV and IRR are the discounted cash flow (DCF) criteria or time-adjusted methods of measuring investment worth.

NPV tells an investor by how much he/she is becoming wealthier; IRR shows the rate of return he/she is earning. Some are happier knowing the rate of return than the amount of return. That is one reason why IRR is used more often than NPV in evaluating projects.

However, there is difference between the assumptions on which these two techniques are based. NPV assumes that over the life of the project intermediate cash flows are reinvested at the hurdle rate*; IRR assumes that intermediate cash flows are reinvested at the IRR rate**. Because of the use of these two different rates, two projects with same initial investments but different intermediate cash flows over their different economic lives will show different results. It will provide an anomaly for decision making.

Its here that MIRR steps in:
MIRR is a mixture of hurdle rate and IRR. 'It is neither fish nor meat'. Under this method, cash flows are assumed to be reinvested at the weighted average cost of the hurdle rate the, firm uses and the IRR on that project. The weights depend on the magnitude and timing of the cash flows – the larger and earlier the cash flows on the project, the greater the weight attached to the hurdle rate. Furthermore, the MIRR approach will yield the same choices as the NPV approach for projects of the same scale
and lives. More weights are given to the cash flows when they are more in the initial years than in the later years of the project life.

[* Hurdle rate is the minimum acceptable rate of return on the investment or (opportunity) cost of capital]
[** IRR is defined as marginal efficiency of capital, which has to be determined, at which the net present value is zero. It is 'internal' – a rate not determined 'outside' the investment; it depends solely on the outlay and proceeds associated with the investment.]

Objective and Bit Questions:

8. Risk calculation measure three kinds of internal pressure _____, _____ and _____.
9. Using risk calculator, manager can determine if their company has a _____ or _____.
10. Primary methods of risk management are _____, _____, _____ and _____.
11. _____ refers to avoiding products, services or business activities with the potential for losses.
12. _____ seeks to minimize the effect of risks through response system that neutralize the effect of a disaster or mishap.
13. Company work with risk manager in so far as possible to avoid _____.
14. _____ example of a retained loss.
15. _____ constitute leading method of risk management.
16. Insurance Policy usually cover _____, _____ and _____.
17. Insurance companies are called _____.
18. Risk manager distinguish between _____ and _____ financing.
19. Pre loss risk financing includes _____.
20. Post loss risk financing includes _____ .
21. RIMS _____
22. Non traditional insurance policies provide coverage of financial risk associated with _____ and _____.
23. Risk manager can also help alleviate losses resulting from _____.
24. ERM stands for _____
25. COSO stands for _____
26. ERM deals with_____ and _____ affecting value creating or presentation.
27. The underlying premise of enterprise risk management is that very entity exist to provide value for its _____
28. ERM enables management to effectively deals with _____ and _____ and _____enhancing the capacity to build.
29. _____ is maximized when management set strategy.
30. ERM objective is to strike an optimal balance between _____, _____ and _____.
31. Enterprise Risk Management encompasses i) _____ ii)_____iii)_____iv)_____.
32. Business continuity planning addresses the prospect that a _____ might interrupt an organization.
33. Firm should evaluate their degree of exposure to disaster both_____ and _____.
34. Business continuity and disaster recovery planning can demand a greater deal of ____.
35. VAR's _____
36. _____ has become a standard practice among many organizations as a way to add flexibility to chain.
37. In a bank technology new article titled _____ must extend to vendor.
38. Thon Honge argues that client – vendor relationship are _____
39. Succession planning is critical part of the _____.
40. HRP is process of hiring _____ of employees _____ in the organization at the time that they are needed.

41. _____ who manage risk for their company.
42. _____ who provide risk assessment services and insurance advice and solutions to their clients.
43. _____ who provide risk management services for a fee.
44. _____, or those associates with the potential for not receiving payments owed by debtors.
45. _____, or those associated with an organizations particular market or industry.
46. _____, or those associated with changes in market conditions, such a fluctuations in prices, interest rates, and exchange rates.
47. _____, or those associated with internal system failures because of mechanical problems or human errors.
48. _____, or those associated with the possibility of other parties not meeting their contractual obligations.
49. HRP involves _____ or____ the organisation's needs for labour and supply of labour.
50. Succession planning is _____ process of defining _____ requirements and _____ who best meet those requirements.
51. Succession planning involves using the _____ within organization for future staffing needs.
52. Succession planning is typically used in _____ position.
53. Internal selection may not reduce _____ and _____ cost.
54. Succession planning is typically used to the _____ in its _____ planning.
55. _____ is which occur when upper management only consider for advancement those employee who have become visible to them.
56. _____ second potential problem that may occur in succession planning.
57. __ is evaluated by calculating the cash flow during the life of the project working out __
58. The cash flow is subject to _____ assumptions.
59. S.A. is _____ method.
60. In material intensive industry _____ or _____ key factor.
61. S.A. is neither a _____ nor a _____ technique.
62. _____ gives greater visibility to weak spots in investment.
63. _____ is when there is absolutely no doubt about which event will occur.
64. Decisions under _____ are not always obvious.
65. A relative measure of dispersion is the _____
66. _____ help you to form a balanced picture of risk and reward associated with each possible course of action.
67. _____ is systematic process of identifying and assessing company's risk and taking action to protect the company against them.
68. Risk manager define _____ as the possibility that future occurrence may cause harm or losses.
69. Risk management is best used as _____ rather than _____
70. The field of risk management evolving from the older field of _____ management.
71. The form risk management was adopted because the new field has much wider focus than simply _____
72. Insurance agent often serve as _____
73. Insurance Management focused on protecting companies from _____ and _____.

74. Companies face no. of risks that stems primarily from _____

75. Company manager have three general options when he comes to choosing a risk manager _____, _____, _____

76. Risk management process involves._____, _____, _____, _____

Answers to Objective and Bit Questions:

8. Risk stemming from growth, corporate culture and information management.
9. Safe or dangerous amount of risk.
10. Exposure or risk avoidance, less prevention, loss reduction and risk financing.
11. Exposure avoidance.
12. Loss reduction
13. Risk retention
14. Insurance Policy
15. Insurance
16. Property risk, liability risk, transportation risk.
17. Captive insurer.
18. Pre loss, post loss
19. Financing obtaining in preparation of potential losses
20. Obtaining funds after losses are incurred
21. Risk and Insurance Management Society System
22. Corporate profits and currency fluctuations
23. Merger
24. Enterprise Risk Management
25. Commission's committee sponsoring organization
26. Risks and opportunities
27. State holders
28. Uncertainty, associated risk, opportunity, value
29. Business value
30. Growth, return goals and related risks.
31. i) Aligning risk appetite and strategy, ii) enhancing risk decision iii) reducing operational surprise and losses iv) seizing opportunities.
32. Disaster, Business operation.
33. Externally, Internally.
34. Resources
35. Value Added Resellers
36. Outsourcing
37. Business Continuity planning

38. Symbiotic
39. Human Resource planning process

40. Right number of employees, right position.
41. Salaried employees.
42. Insurance agents
43. Independent consultants
44. Credit risks
45. Business risks
46. Market risks
47. Operational risks
48. Legal risks
49. Forecasting or predicting
50. Systematic, future management, identifying conditions
51. Supply of labour
52. Higher level organization
53. Recruitment and selection
54. Organization, human resource planning.
55. Crowned price syndrome.
56. Talent drain
57. Investment proposal, the IRR
58. Selling price, raw material cost, other costs
59. Objective
60. Fluctuation in raw material, free availability.
61. Risk measuring, risk reducing technique
62. Sensitivity analysis.
63. Certainty.
64. Uncertainty
65. Coefficient of variation
66. Decision tree
67. Risk Management
68. Risk
69. Preventive measure, relative measure
70. Insurance
71. Insurance risk management
72. Risk manager
73. Natural disaster and basic kind of exposure

74. Nature of doing business
75. Insurance agents, salaried employees, Independent consultants.
76. i) Identifying exposure to potential losses
    ii) Measuring exposure
    iii) Company goods and resources
    iv) Decision how to protect company from harm given the nature of risk.

PROBLEMS AND SOLUTIONS

MATHEMATICAL/STATISTICAL APPLICATIONS TO MANAGERIAL PROBLEMS

Problem No.1.

A dealer of perishable product earns a Profit of Rs. 3 per kg. if he can sell within two days, but incurs a loss of Rs.2 per kg. if fails to do so. The estimated demand for the product and the relative probabilities are as given below:

Estimated Demand	Probability
0 kg	5%
1 kg	20%
2 Kg	40%
3 kg	25%
4 kg	10%

In order to maximize his profit, what should be the quantity of stock that he should hold?

Solution:

Statement showing expected profit at different levels of stock:

Stock level	Expected profit			Expected loss			Net expected profit/(loss)
	Profit	P	Exp profit	Loss	P	Exp loss	
			Rs			Rs	Rs
0	--	--	---	--	--	--	----
1	3	0.95	2.85	2	0.05	0.1	2.75
				4	0.05	0.2	
2	6	0.75	4.5	2	0.2	0.4	3.9
						0.6	
						0.3	
				6	0.05	0.8	
3	9	0.35	3.15	4	0.2	0.8	1.25
				2	0.4	1.9	
				8	0.05	0.4	
				6	0.2	1.2	
				4	0.4	1.6	
4	12	0.1	1.2	4	0.25	0.5	(2.5)
				2		3.7	

Expected level of stock to hold is 2 units because expected profit is more.

Problem No.2.

TTD Ltd. is now considering the purchase of a new machine for Rs.350. The Directors feel quite confident that they can sell the goods produced by the machine so as to yield a yearly cash surplus of Rs.100. There is, however, some uncertainty as to the machine's working life. A recently published Trade Association survey shows that members of the association have among them owned 250 of these machines and have found the lives of the machine to vary as follows:

Number of years of machine life	Numbers of machines having given life
3	20
4	50
5	100
6	70
7	10
	Σ=250

Assuming a discount rate of 10%, the net present value for each different machine life is as follows :

Machine life	Net Present Value (Rs)
3	(101)
4	(33)
5	29
6	86
7	137

As a Management Accountant, You are asked to advise whether the company should purchase a new machine or not.

Solution:

Life of machine	NPV	Probability	Expected NPV
	Rs.		Rs.
3	(101)	0.08	(8.08)
4	(33)	0.2	(6.6)
5	29	0.4	11.6
5	86	0.28	24.08
7	137	0.04	5.48
			26.48

As there is the expected NPV of TTD ltd should go ahead with purchase of new machine.

Problem No.3.

Dry Twigs and Fresh Blossoms Ltd. is always discarding old lines and introducing new lines of products and is at present considering three alternative promotional plans for ushering in new products. Various combinations of prices, development expenditures and promotional outlays are involved in these plans. High, medium and low forecasts of revenues under each plan have been formulated; and their respective probabilities of occurrence have been estimated. These budgeted revenues and probabilities along with other relevant data are summarised as under:

			Rs. in lakhs
	Plan I	Plan II	Plan III
Budgeted Revenue with probability			
High	30(.3)	24(.2)	50(.2)
Medium	20(.3)	20(.7)	25(.5)
Low	5(.4)	15(.1)	0(.3)

Variable cost as % of Revenue	60%	75%	70%
Initial Investment	25	20	24
Life in years	8	8	8

The company's Cost of Capital is 12%; the income tax rate is 40%. Investments in promotional programmes will be amortised by the straight-line method. The company will have net taxable income in each year, regardless of the success or failure of the new products. The present value of an annuity of Rs. 1/- at 12% for 8 years is 4.9676.

a) Substantiating with figures makes a detailed analysis and find out which of the promotional plans is expected to be the most profitable.

b) In the event the worst happened, which of the plans would result in the maximising profit.

Solution:

(a) **Statement showing present values & profitability index:**

Rs. In Lakhs

	Plan I	Plan II	Plan III
Expected probability	17.000	20.300	22.50
Contribution (PBT @40%)	6.800	5.075	6.75
(-)tax@40%	2.720	2.030	2.70
PAT@60%	4.080	3.045	4.05
(+)tax savings(25/8)x0.4	1.250	1.000	1.20
Total inflows	5.330	4.045	5.24
Present value of inflows(4.9676)	26.477	20.094	26.08
(-)outlays	25.000	20.000	24.00
NPV	1.477	0.094	2.08
Profitability index (inflows/outflows)	1.039	1.005	1.087

Plan III is better one.

(b) **If worst happens:**

Rs. In Lakhs

	Plan I	Plan II	Plan III
Sales	500000	1500000	----
Contribution	200000	375000	----
PAT	120000	225000	----
(+)tax advantage	125000	100000	120000
Inflows	245000	325000	120000
Present value of inflow(4.9676)	1217062	1614470	596112
(-) outlays	2500000	2000000	2400000
(NPV)	1282938	385530	1804000

If worst happens plan I is better.

Problem No.4.

(a) A company has estimate the following demand level of its product :

Sales Volume units	Probability
10,000	0.10
12,000	0.15
14,000	0.25
16,000	0.30
18,000	0.20

It has assumed that the sales price will be Rs.6 per unit. Marginal cost Rs.3.50 per unit and fixed cost Rs.34,000

What is the probability that

(i)   The company will be break-even in the period?

(ii)   The company will make a profit of at least Rs.10,000.

(b) Frusted Ltd., observes that its sales for the past few years and its profits have been around the following figures:

Sales	Rs.15,00,000
Marginal cost	5,00,000
Contribution	10,00,000
Fixed cost	8,00,000
Profit	2,00,000

In preparing the budget for the next year there is uncertainty about several important points :

(i) It has submitted offer for two contracts, each to an overseas customer;

	Sales Value
Contract A	Rs.8,00,000
Contract B	3,00,000

For each of these orders, variable costs (including selling and shipping costs) would be 40% of sales value. Total fixed costs would be unaffected by the order. The company hopes to win both orders but thinks it more likely that it will win Contract A but not Contract N.

* Expected sales x contribution per unit.

(ii) A new product is due to be introduced next year. Expected sales are Rs.30,000 per month with variable costs 50% of sales and fixed costs of Rs.5,000 per month. The most likely date for introduction of the new product is middle of next year but could be introduced at the end of fourth month or as late at the end of nine month.

(iii) Although it is expected on balance that sale price and costs will not go up there is a reasonable possibility that variable costs on the current product range will go up by 10%.

Prepare a pessimistic and an optimistic budget of the company for the next year.

Solution:

(a)

i.   Break even point = 34000/2.5 = 13600 Units
       Probability is 0.75 for break even

ii.   Required sales to earn desired profit = (10000 + 34000)/2.5   = 17600
       Probability is 0.2 to make a profit of Rs10000/-

(b)   Statement showing computation of expected profit at both situations:

	Pessimistic	Optimistic
	Rs.	Rs.
I. Sales	1500	1500
(-)variable cost	(550)	(500)
Contribution	950	1000
II. Contract:		
Sales	-	800
(-)variable cost	-	(320)
Contribution	-	480
III. New product:	(3 months)	(8 months)
Sales	90	240
(-) variable cost	(45)	(120)
Total contribution	995	1600
Fixed cost	815	840
Profit	**180**	**760**

Problem No.5.

DB p.l.c operates a conventional stock control system based on re-order levels and Economic Ordering Quantities. The various control levels were set originally based on estimates which did not allow for any uncertainty and this has caused difficulties because, in practice, lead times, demands and other factors do vary.

As part of a review of the system, a typical stock item, Part No. X206, has been studied in detail as follows:

Data for Part No. X206	
Lead times.	Probability
15 working days	0.2
20 working days	0.5
25 working days	0.3
Demand per working day	Probability
5,000 units	0.5
7,000 units	0.5

Note: It can be assumed that the demands would apply for the whole of the appropriate lead time.

DB p.l.c works for 240 days per year and it costs Re. 0.15 p.a. to carry a unit of X 206 in stock. The re-order level for this part is currently 1,50,000 units and the re-order cost is Rs. 1,000.

You are required:
   a) to calculate the level of buffer stock implicit in a re-order level of 1,50,000 units.
   b) To calculate to probability of a stock-out
   c) To calculate the expected annual stock-outs in units;
   d) To calculate the stock out cost per unit at which it would be worth while raising the re-order level to 1,75,000 units;

Solution:
   a) Buffer stock level

   Expected value = lead time x total demand in lead time x joint probability

                                        Rs
                 15x5000x0.2x0.5= 7500
                 15x7000x0.2x0.5=10500
                 20x5000x0.5x0.5=25000
                 20x7000x0.5x0.5=35000
                 25x5000x0.3x0.5=18750
                 25x7000x0.3x0.5=26250
                                 ‾‾‾‾‾‾
                                 123000

   Expected value of demand in lead time = Rs.123000

   Buffer stock = 150000-123000 = 27000 units

   b) Stock out(shortage) = p>150000 = 0.15 joint pr0bability at 17500 units
   c) EOQ = $\frac{\sqrt{2 \times 6000 \times 240 \times 1000}}{0.15}$ = 138564 units

   Demand per working day = (5000x0.5) + (7000x0.5) = 6000 units
   Orders per annum = (6000x240) / 138564 =10.39 (on an average)

   Expected stock out per annum = (175000-150000) x 0.15 x 10.39 = 38962 units

   d) At 150000 reorder level, stock out is 38962 units

   At 175000 reorder level, stock out is nil

   Additional cost is 25000x0.15 = Rs.3750

   Additional cost per unit = 3750/38962 = Rs0.96 (or) 96paise

Problem No.6.

An Engineering Company has been offered a one year contract to supply a motor car component XY at a fixed price of Rs.8 per unit. Its normal capacity for this type of component is 25,000 units a year. The estimated costs to manufacture are shown below. These costs are considered to be firm except for the direct material price.

Cost Data:

Variable Costs per unit:	Rs.
Direct Wages	1.50
Direct Material	2.25
Direct Expenses	0.65

Semi-Variable Costs per annum:

	Output level		
	80%	100%	120%
Indirect Wages	Rs. 15,400	Rs.16,000	Rs.23,100
Indirect Materials	8,600	9,000	9,900
Indirect Expenses	2,000	2,500	3,000

Fixed Costs per annum:	Rs.
Supervisory Salaries	10,000
Depreciation	4,000
Other Overheads	16,000

You are required to:

a) Calculate the cost and profit per unit and total annual profit assuming that the customer's orders in the year total:
   i) 20,000 components or
   ii) 25,000 components or
   iii) 30,000 components, and that direct material is Rs.2.25 per unit.

b) Calculate the estimated profit for the year if it is assumed that the probability of the total order is:

   0.3 for 20,000 components;

   0.6 for 25,000 components;

   0.1 for 30,000 components;

   and that for direct material is:

   0.5 for Rs.2.25 per unit;

   0.3 for Rs.2.50 per unit;

   0.2 for Rs.2.75 per unit;

Solution:

Statement showing computation of profit per unit & cost per unit:

		80%	100%	120%
		20,000	25,000	30,000
		Rs.	Rs.	Rs.
I.	Selling Price	8	8	8
II.	Variable Cost	4.4	4.4	4.4
III.	Contribution	3.6	3.6	3.6
IV.	Total Contribution	72,000	90,000	1,08,000
V.	Semi Fixed Cost	26,000	27,500	36,000

VI	Fixed Cost	30,000	30,000	30,000
VII	Total Fixed Cost	56,000	57,500	66,000
VIII	Profit	16,000	32,500	42,000
IX	Profit per unit	0.8	1.3	1.4
X	Total Cost per unit	7.2	6.7	6.6
		(8 – 0.8)	(8 – 1.3)	(8 – 1.4)

b) **Computation of Expected Profit:**

$$0.3 \times 20,000 + 0.6 \times 25,000 + 0.1 \times 30,000 \quad = \quad 24,000$$

24,000

		Rs.
I.	Selling Price	8
II.	Variable Cost (other than material)	2.15
	Material Cost (0.5 x 2.25 + 0.3 x 2.5 + 0.2 x 2.75)	2.425
		4.575
III.	Contribution	3.425
IV.	Total Contribution	82,200
V.	Fixed Cost	
	Semi Fixed Cost [26000 + (1500/5000 x 4000)	27,200
	Fixed Cost	30,000
		57,200
	Profit (IV – V)	25,000

Problem No.7.

S & V Company is preparing budget for 1989 Data relating to sales, prices and costs are as follows:

Sales Price	Rs. 20 per unit
Variable Cost	Rs. 12 per unit
Fixed Costs	Rs. 2,00,000 per year

Sales forecasts have been prepared, which disclose the following.

Quantity	Probability	Quantity	Probability
15,000	10%	35,000	30%
20,000	10%	40,000	10%
25,000	10%	45,000	10%
30,000	20%		

Required:

a) What is the break-even quantity?
b) How many units must be sold to i) earn a profit of Rs.60,000 ii) incur a loss of Rs.50,000.
c) Based on the sales forecast, what is the probability that the firm can break even?
d) What are the probabilities of achieving sales volume involved in part (b)

<u>Solution:</u>

a) Break Even Units = 2,00,000/20-12 = 25,000 Units

b) (i) No. of units to be sold to get a profit of 60,000 is 60,000 / 8 = 7,500 Units

  25,000 + 7,500 = 32,500 Units

(ii)

$$\frac{F.C - 50,000}{Contribution\ Per\ Unit} = \frac{200000 - 50000}{8} = 18,750\ Units$$

c) Probability of Break Even = 80% = 25,000 Units.

d) Probability of getting Rs.60,000 profit is 50% (30 + 10 + 10)

  Probability of getting Rs.18,750 loss is 10% (by observation)

Problem No.8.

Better Budgets Ltd. are preparing their budget for 1989. In the preparation of the budget they would like to take no chances, but would like to envisage all sorts of possibilities and incorporate them in the Budget. Their considered estimates are as under:

a) If the worst possible happens, sales will be 8,000 units at a price of Rs.19 per unit the material cost will be Rs.9 per unit, direct labour Rs.2 per unit, and the variable overhead will be Rs.1.50 per unit. The fixed cost will be Rs.60,000 per annum.

b) If the best possible happens, sales will be 15,000 units at a price of Rs.20 per unit. The material cost will be Rs.7 per unit, direct labour Rs.3 per unit and the variable overhead will be Re.1 per unit. The fixed cost will be Rs.48,000 per annum.

c) It is most likely, however, that the sales will be 2,000 units above the worst possible level at a price of Rs.20 per unit. The material cost will be Rs.8 per unit, direct labour Rs.3 per unit and the variable overhead will be Re.1 per unit. The fixed cost will be Rs.50,000 per annum.

d) There is a 20% probability that the worst will happen, a 10% probability that the best will happen and a 70% probability that the most likely outcome will occur.

What will be the expected value of Profit as per the Budget for 1989?

Solution:

Statement showing computation of expected profit as per Budget 1989:

		Pessimistic	Most Likely	Optimistic
I.	No. of Units	8000	10,000	15,000
			(8000+2000)	
		Rs.	Rs.	Rs.
II.	Contribution per unit	6.5	8	9
		(19 – 9 – 2 - 1.5)	(20 – 8 – 3 – 1)	
III.	Total Contribution	52,000	80,000	1,35,000
IV.	Fixed Cost	60,000	50,000	48,000
V.	Profit/Loss	(8000)	30,000	87,000
	Probability	0.2	0.7	0.1
	Expected Profit/Loss	(1600)	21,000	8,700

The expected value of profit is Rs. 28,100.

Problem No.9.

X Ltd. has to decide between rentals of two types of machine manufacturing the same product. Machine A, an inexpensive economy model, rents for Rs.1,000 per month, but the variable production cost is Rs.0.25 per unit. Machine B rents for Rs.3,000 per month, but the variable production cost is only Rs.0.10 per unit. Monthly demand varies between 10,000 and 19,000 according to the following probabilities:

Demand	Probability
10,000	0.12
12,000	0.17
15,000	0.41
17,000	0.24
19,000	0.06

Make a comparison of the two machines. Which machine X Ltd. should rent? If the demand is definitely known to be 10,000 units, would the decision reverse?

Solution:

Expected No. of Units = (10,000 x 0.12) + (12,000 x 0.17) + (15,000 x 0.41) +

(17,000 x 0.24) + (19,000 x 0.06)

= 14,610

Statement showing comparative cost of Machines A & B:

	A	B
	Rs.	Rs.
Variable Cost	3,653	1,461
Fixed Cost	1,000	3,000
	4,653	4,461

At this level 'X' Ltd should take on rent Machine B because costs are less.

	A	B
	Rs.	Rs.
Variable Cost	2,500	1,000
Fixed Cost	1,000	3,000
	3,000	4,000

If the demand is definitely known to be as 10,000 units they should take on Rent Machine A because its costs is less.

The level at which costs of both the machines are equal =

$$= \frac{Diff.\,in\,Fixed\,Cost}{Diff.\,in\,Variable\,Cost}$$

(or)

$$= \frac{Change\,in\,Fixed\,Cost}{Change\,in\,Variable\,Cost}$$

$$= \frac{3000 - 1000}{0.25 - 0.10}$$

$$= \frac{2000}{0.15}$$

= 13,333.33 units

QUANTITATIVE TECHNIQUES USED IN BUSINESS DECISIONS

(a) LINEAR PROGRAMMING

INTRODUCTION:
Linear Programming is an optimization technique. It is "*a technique for specifying how to use limited resources or capacities of a business to obtain a particular objective, such as least cost, highest margin or least time, when those resources have alternate uses*".

The situation which require a search for "*best*" values of the variables, *subject to* certain constraints, are amenable to programming analysis. These situations cannot be handled by the usual tools of calculus or marginal analysis. The calculus technique can only handle *exactly equal* constraints, while this limitation does not exist in case of linear programming problem.

A linear programming problem has two basic parts.
- The first part is the objective function, which describes the primary purpose of the formulation – to maximize some return (for example, profit) or to minimize some cost (for example, production cost or investment cost).
- The second part is the constraint set. It is the system of equalities and/or inequalities, which describes the restrictions (conditions or constraints) under which optimization is to be accomplished.

DEFINITION OF LINEAR PROGRAMMING:
According to Kohlar "A method of planning and operation involved in the construction of a model of a real situation containing the following elements: (a) variables representing the available choices, and (b) mathematical expressions (i) relating the variables to the controlling conditions, and (ii) reflecting the criteria to be used in measuring the benefits derivable from each of the several possible plans, and (iii) establishing the objective. The method may be so devised as to ensure the selection of the best of a large number of alternatives".

Samuelson, Dorfman and Solow defines LP as "*The analysis of problems in which a linear function of a number of variables is to be maximized (or minimized) when those variables are subject to a number of restraints in the form of linear inequalities*".

In the words of Loomba, "*LP is only one aspect of what has been called a system approach to management wherein all programmes are designed and evaluated in terms of their ultimate affects in the realization of business objectives*".

TERMINOLOGY AND REQUIREMENTS OF LINEAR PROGRAMMING:
Regardless of the way one defines linear programming, certain basic requirements which are given below are necessary before the technique can be employed for optimization problems.
1. Decision variables and their relationship.
2. Well defined objective function.
3. Presence of constraints or restrictions.
4. Alternative courses of action.
5. Non-negative restrictions

6.   Linearity.
7.   Finiteness.
8.   Additivity.
9.   Divisibility
10. Deterministic.

1.   **Decision variables and their relationship:**
     The decision activity variables refer to candidates (products, services, projects etc.) that are competing with one another for sharing the given limited resources. These variables are usually inter-related in terms of utilization of resources and need simultaneous solutions.   The relationship among these variables should be linear.

2.   **Well defined objective function:**
     A linear programming problem must have a clearly defined objective function to optimize which may be either to maximize contribution by utilizing available
     resources, or it may be to produce at the lowest possible cost by using a limited amount of productive factors. It should be expressed as a linear function of decision variables.

3.   **Presence of constraints or restrictions:**
     There must be limitations on resources (like production capacity, manpower, time, machines, markets etc.) which are to be allocated among various competing activities. These must be capable of being expressed as linear equalities or inequalities in terms of decision variables.

4.   **Alternative courses of action:**
     There must be alternative courses of action. For example, it must be possible to make a selection between various combinations of the productive factors such as men, machines, materials, markets etc.

5.   **Non-negative restrictions:**
     All decision variables must assume non-negative values as negative values of physical quantities is an impossible situation. If any of the variables is unrestricted in sign, a trick can be employed which enforces non-negativity changing the original information of the problem.

6.   **Linearity:**
     The basic requirements of a linear programming problem is that both the objective and constraints must be expressed in terms of linear equations or inequalities. It is well known that if the number of machines in a plant is increased, the production in the plant also proportionately increases.   Such a relationship, giving corresponding increment in one variable for every increment in other, is called linear and can be graphically represented in the form of a straight line.

7.   **Finiteness:**
     There must be finite number of activities and constraints otherwise an optimal solution cannot be computed.

8.   **Additivity:**
     It means that sum of the resources used by different activities must be equal to the total quantity of resources used by each activity for all the resources individually and collectively. In other words, interaction among the activities of the resources does not exist.

9.   **Divisibility:**
     This implies that solutions need not be in whole numbers (integers). Instead, they are divisible and may take any fractional value. If a fraction of a product cannot be produced (like one fourth of a bus), an integer programming problem exists.

10.   **Deterministic:**

We assume that conditions of certainty exist i.e., the coefficients in the objective function and constraints are completely known (deterministic) and do not change during the period being studies e..g, profit per unit of each product, amounts of resources available are fixed during the planning period.

Advantages (utility) of L.P. Approach:

As an administrative tool, linear programming has certain distinct advantages, which are as follows:

1. Insight and perspective into problem solutions.
2. Consideration of all possible solutions to the problem.
3. Better and more successful decisions.
4. Better tools for adjusting to meet changing conditions.
5. Highlighting of bottlenecks in the production process is the most significant advantage of this technique.
6. Other advantages of this approach include optimal use of productive factors by indicating the best use of existing facilities.
7. Flexibility in analyzing a variety of multi-dimensional problems.
8. Provision of an information base from which the allocation of scarce resources can be made.
9. Insight and perspective into problem situations.

Limitations of Linear Programming:

Although linear programming is a very useful technique for solving optimization problems, there are certain important limitations in the application of linear programming. Some of these are discussed below:

1. Firstly, the linear programming models can be applied only in those situations where the constraints and the objective function can be stated in terms of linear expressions.
2. In linear programming problems, coefficients in the objective function and the constraint equations must be completely known and they should not change during the period of study.
3. Yet another important limitation of linear programming is that it may give fractional valued answers.
4. Linear programming will fail to give a solution if management have conflicting multiple goals.
5. Linear programming problem requires that the total measure of effectiveness and total resource usage resulting from the joint performance of the activities must equal the respective sums of these quantities resulting from each activity being performed individually.
6. Many real-world problems are so complex, in terms of the number of variables and relationships constrained in them, that they tax the capacity of even the largest computer.
7. Other limitations of LP includes:-
    -   Does not take into consideration the effect of time and uncertainty.
    -   Parameters appearing in the model are assumed to be constants but in real-life situations they are frequently neither known nor constants.

APPLICATION AREAS OF LINEAR PROGRAMMING:

In practice linear programming has proved to be one of the most widely used technique of managerial decision making in business, industry and numerous other fields.

1.   **Industrial Applications:**

Linear programming is extensively used to solve a variety of industrial problems. In each of these applications, the general objective is to determine a plan for production and procurement in the

time period under consideration. It is necessary to satisfy all demand requirements without violating any of the constraints. Few examples of industrial applications are as follows:

(a) Product Mix-Problem.

(b) Production Scheduling.

(c) Production Smoothing Problem.

(d) Blending Problems.

(e) Transportation Problems.

(f) Production distribution problems.

(g) Trim Loss.

(h) Linear programming is also used by oil refineries to determine the optimal mix of products to be produced by the refinery during a given period.

(i) Communication Industry. LP methods are used in solving problems involving facilities for transmission, switching, relaying etc.

(j) Rail Road Industry: An LP model for optimal programming of railway freight, and train movements has been formulated to handle scheduling problems as found at large terminal switching rail points.

2.   **Management Applications:**

(a) Portfolio Selection.

(b) Financial Mix Strategy.

(c) Profit Planning.

(d) Media Selection.

(e) Travelling Salesmen Problem.

(f) Determination of equitable salaries.

(g) Staffing problem.

3.   **Miscellaneous Applications:**

The additional application of Linear Programming are as follows:

(a) Form planning.

-     The particular crops to be grown or cattle to keep during a period

-     The acreage to be devoted to each, and

-     The particular production methods to be used.

(b) Airline routine.

(c) Administration, Education and Politics have also employed linear programming to solve their problems.

(d) Diet Problems. The diet problem, one of the earliest applications of linear programming was originally used by hospitals to determine the most economical diet for patients.

4.   **Administrative applications of Linear Programming:**

Linear programming can be used for administrative applications. Administrative applications of Linear Programming are concerned with optimal usage of resources like men, machine and material.

5.   **Non-Industrial applications of linear programming:**

Linear programming techniques/tools can be applied in the case of non-industrial applications as well. Examples of the use of L.P techniques for non-industrial applications are given below:

- Agriculture.
- Environmental Protection.
- Urban Department.
- Facilities Location.

6. **Further applications of Linear Programming are:**
- In structural design for maximum product.
- In balancing assembly lines.
- In scheduling of a military tanker fleet.
- In determining which parts to make and which to buy to obtain maximum profit margin.
- In selecting equipment and evaluating methods improvements that maximize profit margin.
- In planning most profitable match of sales requirements to plant capacity that obtains a fair share of the market.
- In design of optimal purchasing policies.

FORMULATION OF LINEAR PROGRAMMING PROBLEM:

The formulation of linear programming problem as a mathematical model involves the following basic steps:

Step 1: Find the key-decision to be made from the study of the solution. (In this connection, looking for variables helps considerably).

Step 2: Identify the variables and assume symbols x_1, x_2 …… for variable quantities noticed in step 1.

Step 3: Express the possible alternatives mathematically in terms of variables. The set of feasible alternatives generally in the given situation is:

$$[(x_1, x_2); x_1 > 0, x_2 > 0]$$

Step 4: Mention the objective quantitatively and express it as a linear function of variables.

Step 5: Express the constraints also as linear equalities/inequalities in terms of variables.

SOME DEFINITIONS:

(a) **Solution:**
Values of decision variables x_j (j = 1, 2 ….., n) which satisfy the constraints of a general L.P.P., is called the solution to that L.P.P.

(b) **Feasible Solution:**
Any solution that also satisfies the non-negative restrictions of the general L.P.P., is called a feasible solution.

(c) **Basic Solution:**
For a set of m simultaneous equations in *n* unknowns *(n>m)*, a solution obtained by setting *(n-m)* of the variables equal to zero and solving the remaining *m* equations in *m* unknowns is called a *basic solution*. Zero variables *(n-m)* are called *non basic variables* and remaining *m* are called *basic variables* and constitute a basic solution.

(d) **Basic Feasible Solution:**
A feasible solution to a general L.P. problem which is also basic solution is called a basic feasible solution.

(e) **Optimal Feasible Solution:**
Any basic feasible solution which optimize (maximize or minimize) the objective function of a general L.P.P. is called an optimal feasible solution to that L.P. problem.

(f) **Degenerate Solution:**
A basic solution to the system of equations is called degenerate if one or more of the basic variables become equal to zero.

<div align="center">**PROBLEMS AND SOLUTIONS**</div>

Problem No.10.

A firm manufacturers and sells two products Alpha and Beta. Each unit of Alpha requires 1 hour of machining and 2 hours of skilled labour, whereas each unit of Rate uses 2 hours of machining and 1 hour of labour. For the coming month the machine capacity is limited to 720 machine hours and the skilled labour is limited to 780 hours. Not more than 320 units of Alpha can be sold in the market during a month.

(i)   Develop a suitable model that will enable determination of the optimal product mix.
(ii)   Determine the optimal product-mix and the maximum contribution. Unit contribution from Alpha is Rs.6 and from Beta is Rs.4.
(iii)   What will be the incremental contribution per unit of the machine hour, per unit of labour, per unit of Alpha saleable?

Solution:

Products	Machining	Skilled Labour	Contribution
Alpha	1 hr	2 hr	6/-
Beta	2 hr	1 hr	4/-
Available hours	720 hr	780 hr	

Let x_1 be the no. of units of Alpha produced
x_2 be the no. of units of Beta produced.
Objective function: Max. $Z = 6x_1 + 4x_2$.
Subject to constraints
$x_1 + 2x_2 \le 720$
$2x_1 + x_2 \le 780$
$x_1 \le 320$ and
$x_1, x_2 \ge 0$
$x_1 + 2x_2 + S_1 = 720$
$2 x_1 + x_2 + S_2 = 780$
$x_1 + s_3 = 320$
Max. $Z = 6x_1 + 4x_2 + 0.S_1 + 0.S_2 + 0.S_3$

		6	4	0	0	0	
C_B	X_B	X_1	X_2	S_1	S_2	S_3	Min. Ratio
0	720	1	2	1	0	0	720/1 = 720
0	780	2	1	0	1	0	780/2 = 390
0	320	1	0	0	0	1	320/1 = 320
	0	6	4	0	0	0	

0	400	0	2	1	0	-1	400/2=200
0	140	0	1	0	1	-2	140/1=140
6	320	1	0	0	0	1	320/0=α
	1920	0	-4	0	0	6	

0	120	0	0	1	-2	3	120/3=40
4	140	0	1	0	1	-2	140/-2=-70
6	320	1	0	0	0	1	320/1=320
	2480	0	0	0	4	-2	

0	40	0	0	1/3	-2/3	1	
4	220	0	1	2/3	-1/3	0	
6	280	1	0	-1/3	2/3	0	
	2560	0	0	2/3	8/3	0	

$\therefore$ $x_1 = 280$; $x_2 = 220$; Z = 2560

Problem No.11.

A Chemical Company produces two compounds A and B. The following table gives the units of ingredients C and D per kg of compounds A and B as well as minimum requirements of C and D and costs/kg of A and B. Using the simplex method, find the quantities of A and B which would give a supply of C and D at a minimum cost.

			Table Compound		Minimum requirement
			A	B	
Ingredient	C		1	2	80
	D		3	1	75
Cost per kg.			4	6	

Solution:

Let x_1 be the no. of units of A
Let x_2 be the no. of units of B
Objective function: Min.Z = $4x_1 + 6x_2$
Subject to Constraints:
$x_1 + 2x_2 \geq 80$
$3x_1 + x_2 \geq 75$
And $x_1, x_2 \geq 0$
$x_1 + 2x_2 - x_3 + A_1 = 80$
$3x_1 + x_2 - x_4 + A_2 = 75$

Max. Z = $4x_1 + 6x_2 - 0.x_3 - 0.x_4 - M.A_1 - M.A_2$
              $x_1, x_2, x_3, x_4, A_1, A_2 \geq 0.$

Problem No.12.

A pension fund manager is considering investing in two shares A and B. It is estimated that:

(i)   Share A will earn a dividend of 12% per annum and share B 4% per annum.
(ii)   Growth in the market value in one year of share A will be 10 paise per Rs.1 invested and in B 40 paise per Rs.1 invested.

He requires investing the minimum total sum which will give:
Dividend income of at least Rs.600 per annum and growth in one year of at least Rs.1,000 on the initial investment.

You are required to:

    (i)   State the mathematical formulation of the problem

    (ii)   Compute the minimum sum to be invested to meet the manager's objective by using the simplex method.

Solution:

Shares	Dividend	Growth in Rs.
A	12%	10/100=0.1
B	4%	41/100 = 0.4
Min-income	600	1000

Let x_1 be the amount invested on share A

Let x_2 be the amount invested on share B

Objective function: Min. $Z = x_1 + x_2$

Subject to constraints:

$0.12 x_1 + 0.04 x_2 \geq 600$

$0.1 x_1 + 0.4 x_2 \geq 1000$

And $x_1, x_2 \geq 0$.

Problem No.13.

A company possesses two manufacturing plants each of which can produce three products x, Y and Z from a common raw material. However, the proportions in which the products are produced are different in each plant and so are the plant's operating costs per hour. Data on production per hour costs are given below, together with current orders in hand for each product.

	Product			Operating cost/hour in Rs.
	X	**Y**	**Z**	
Plant A	2	4	3	9
Plant B	4	3	2	10
Orders on hand	50	24	60	

You are required to use the simplex method to find the number of production hours needed to fulfill the orders on hand at minimum cost.

Interpret the main features of the final solution.

Solution:

Let α be no. of hours of plant A in use

Let β be no. of hours of plant B in use

Objective function: Min Z = 9α + 10β

Subject to constraints:

$2\alpha + 4\beta \geq 50$

$4\alpha + 3\beta \geq 24$

$3\alpha + 2\beta \geq 60$

And $\alpha, \beta \geq 0$

Problem No.14.

A Company produces the products P, Q and R from three raw materials A, B and C. One unit of product P requires 2 units of A and 3 units of B. A unit of product Q requires 2 units of B and 5 units of C and one unit of product R requires 3 units of A, 2 unit of B and 4 units of C. The Company has 8 units of material A, 10 units of B and 15 units of C available to it. Profits/unit of products P, Q and R are Rs.3, Rs.5 and Rs.4 respectively.

    (a) Formulate the problem mathematically,

    (b) How many units of each product should be produced to maximize profit?

    (c) Write the Dual problem.

Solution:

Raw Materials	P	Q	R	Available units
A	2	-	3	8
B	3	2	2	10
C	-	5	4	15

Profits 3/- 5/- 4/-

Let x_1 be the no. of units of P

Let x_2 be the no. of units of Q

Let x_3 be the no. of units of R

Objective function: Max. $Z = 3x_1 + 5x_2 + 4x_3$

Subject to constraints:

$2x_1 + 3x_2 \leq 8$

$3x_1 + 2x_2 + 2x_3 \leq 10$

$5x_2 + 4x_3 \leq 15$

And $x_1, x_2, x_3 \geq 0$.

Primal

Max. $Z = 3x_1 + 5x_2 + 4x_3$

Subject to

$2x_1 + 3x_2 \leq 8$

$3x_1 + 2x_2 + 2x_3 \leq 10$

$5x_2 + 4x_3 \leq 15$

And $x_1, x_2, x_3 \geq 0$

Dual

Min. $Z = 8y_1 + 10y_2 + 15y_3$

Subject to

$2y_1 + 3y_2 \geq 3$

$3y_1 + 2y_2 + 5y_3 \geq 5$

$2y_2 + 4y_3 \geq 4$

And $y_1, y_2, y_3 \geq 0$

$2x_1 + 3x_2 + S1 = 8$

$3x_1 + 2x_2 + 2x_3 + S_2 = 10$

$5x_2 + 4x_3 + S_3 = 15$

Max $Z = 3x_1 + 5x_2 + 4x_3 + 0.S_1 + 0.S_2 + 0.S_3$

		3	5	4	0	0	0	
C_B	X_B	X_1	X_2	X_3	S_1	S_2	S_3	Min.Ratio>0
0	8	2	3	0	1	0	0	8/3=2.67
0	10	3	2	2	0	1	0	10/3=3.33
0	15	0	5	4	0	0	1	15/5=3
	0	-3	-5	-4	0	0	0	

5	8/3	2/3	1	0	1/3	0	0	8/3/0=α
0	14/3	5/3	0	2	-2/3	1	0	14/3/2=7/3
0	5/3	-10/3	0	4	-5/3	0	1	5/3/4=5/12
	40/3	1/3	0	-4	5/3	0	0	
5	8/3	2/3	1	0	1/3	0	0	8/3/2/3=4
0	23/6	10/3	0	0	1/6	1	-1/2	23/6/10/3=23/20
4	5/12	-10/12	0	1	-5/12	0	¼	5/12/-10/12=-1/12
	15	-3	0	0	0	0	1	

5	19/10	0	1	0	3/10	-1/5	11/0	
3	23/20	1	0	0	1/20	3/10	-3/20	
4	11/8	0	0	1	-3/8	¼	1/8	
	2952/160=18.45	0	0	0	3/20	9/10	11/20	

∴ x_1= 23/20 x_2= 19/10 x_3= 11/8

Z = 18.45

Problem No.15.

A Factory manufactures 3 products which are processed through 3 different production stages. The time required to manufacture one unit of each of the three products and the daily capacity of the stages are given in the following table:

State	Time/unit in minutes			
	Product 1	Product 2	Product 3	Stage capacity (minutes)
1	1	2	1	430
2	3	-	2	460
3	1	4	-	420
Profit/unit	Rs.3	Rs.2	Rs.5	

(i)   Set the data in a simplex table.

(ii)   Find the table for optimum solution

(iii)   State from the table - maximum profit, production pattern, and surplus capacity of any stage.

(iv)   What is the meaning of the shadow price? Where is it shown in this table? Explain it in respect of resource of stages having shadow price.

(v)   How many units of other resources will be required so as to completely utilise the surplus resource?

Solution:

Let x_1 be the no. of units of product 1

Let x_2 be the no. of units of product 2

Let x_3 be the no. of units of product 3

Objective function: Max Z = $3x_1+2x_2 + 5x_3$

Subject to constraints:

$x_1+2x_2+ x_3 \leq 430$

$3x_1+2x_3 \leq 460$

$x_1+4x_2 \leq 420$

And $x_1, x_2, x_3 \geq 0$

$x_1+2x_2+ x_3+S_1 = 430$

$3x_1+2x_3 +S_2 = 460$

$x_1+4x_2 + S_3 = 420$

Max Z = $3x_1+2x_2 + 5x_3+0.S_1+0.S_2+0.S_3$

C_B	X_B	3	2	5	0	0	0	
		X_1	X_2	X_3	S_1	S_2	S_3	Min. Ratio>0
0	430	1	2	1	1	0	0	430/1=430
0	460	3	0	2	0	1	0	460/2=230
0	420	1	4	0	0	0	1	420/0=α
	0	-3	-2	-5	0	0	0	

0	200	-1/2	2	0	1	-1	0	200/2=100
5	230	3/2	0	1	0	1	0	230/10=α
0	420	1	4	0	0	0	1	420/4=105
	1150	9/2	-2	0	0	5	0	
2	100	-1/4	1	0	½	-1/2	0	
5	230	3/2	0	1	0	1	0	
0	20	2	0	0	-2	2	1	
	1350	4	0	0	1	4	0	

∴ x_1= 0

x_2= 100

x_3= 230

z=1350

Problem No.16.

The products P, Q and R are being produced in a plant having profit margin as Rs.3, Rs.5 and Rs.4 respectively. The raw materials A, B and C are of scarce supply and the availability is limited to 8, 15 and 10 units respectively. Specific consumption is indicated in the table below:

	P	Q	R	Available units
A	2	3	-	8
B	3	2	4	15
C	-	2	5	10
	3/-	5/-	4/-	

(a) Write down the problem mathematically for maximization of profit margin.
(b) Solve the problem by Simplex Method for obtaining optimum production pattern.
(c) What are the opportunity costs of each of the raw material?

Solution:

Let x_1 be the no. of units of product P
Let x_2 be the no. of units of product Q
Let x_3 be the no. of units of product R

Objective function: Max. $Z = 3x_1 + 5x_2 + 4x_3$
Subject to constraints:
$2x_1 + 3x_2 \leq 8$
$3x_1 + 2x_2 + 4x_3 \leq 15$
$2x_2 + 5x_3 \leq 10$
And $x_1, x_2, x_3 \geq 0$

$2x_1 + 3x_2 + S_1 = 8$
$3x_1 + 2x_2 + 4x_3 + S_2 = 15$
$2x_2 + 5x_3 + S_3 = 10$

Max $Z = 3x_1 + 5x_2 + 4x_3 + 0.S_1 + 0.S_2 + 0.S_3$

		3	5	4	0	0	0	
C_B	X_B	X_1	X_2	X_3	S_1	S_2	S_3	Min. Ratio>0
0	8	2	3	0	1	0	0	8/3=2.67
0	15	3	2	4	0	1	0	15/2=7.5
0	10	0	2	5	0	0	1	10/2=5
	0	-3	-5	-4	0	0	0	

5	8/3	2/3	1	0	1/3	0	0	8/3/0=α
0	29/3	5/3	0	4	-2/3	1	0	29/3/4=29/12
0	14/3	-4/3	0	5	-2/3	0	1	14/3/5=14/15
	40/3	1/3	0	-4	5/3	0	0	

5	8/3	2/3	1	0	1/3	0	0	8/2=4
0	89/15	41/15	0	0	-2/15	1	-4/5	89/41
4	14/15	-4/15	0	1	-2/15	0	1/5	14/-4=-7/2
	256/15	-11/15	0	0	17/15	0	4/5	

5	150/123=50/41		0	1	0	45/123=15/41		-10/41	8/41	
3	89/41		1	0	0	-2/41		15/41	-12/41	
4	62/41		0	0	1	-6/41		4-41	5/41	
	765/41		0	0	0	45/41		11/41	24/41	

$\therefore$ $x_1 = 89/41$
        $x_2 = 50/41$
        $x_3 = 62/41$; $Z = 765/41$

Problem No.17.

Formulate Linear programming model for the following problem and solve the problem using simplex method. A company sells two types of fertilizers, one is liquid and the other is dry. The liquid fertilizer contains 2 units of chemical A and 4 units of chemical B per jar and the dry fertilizer contains 3 units of each of the chemicals A and B per carton. The liquid fertilizer sells for Rs.3 per jar and the dry fertilizer sells for Rs.4 per certain. A farmer requires at least 90 units of chemical A and at least 120 units of the chemical B for his farm. How many of each type of fertilizers should the farmer purchase to minimize the cost while meeting his requirements?

| | Fertilizers | | Required Units |
	Liquid	Dry	
Chemical A	2	3	90
Chemical B	4	3	120
Cost	3/-	4/-	

Let x_1 be the no. of liters of Liquid
Let x_2 be the no. of kilograms of dry

Objective Function:
Min. $Z = 3x_1 + 4x_2$
Subject to constraints:
$2x_1 + 3x_2 \geq 90$
$4x_1 + 3x_2 \geq 120$
And $x_1, x_2 \geq 0$

$2x_1 + 3x_2 - x_3 + A_1 = 90$
$4x_1 + 3x_2 - x_4 + A_2 = 120$

Max $Z = -3x_1 - 4x_2 - o.x_3 - o.x4 - M.A_1 - M.A_2$

		-3	-4	0	0	-M	-M	
C_B	X_B	X_1	X_2	X_3	X_4	A_1	A_2	Min. Ratio>0
-M	90	2	3	-1	0	1	0	90/2=45
-M	120	4	3	0	-1	0	1	120/4=30
	-210M	-6M+3	-6M+4	M	M	0	0	
-M	30	0	3/2	-1	½	1	-1/2	30/3/2=20
-3	30	1	¾	0	-1/4	0	¼	30/3/4=40
	-90-30M	0	-3/2M+7/4	M	-M/2+3/4	0	3M/2-3/4	
-4	20	0	1	-2/3	1/3	2/3	-1/3	
-3	15	1	0	½	-1/2	-1/2	½	
	-125	0	0	7/6	1/6	7/6+M	-1/6+M	

∴ $x_1 = 15$
      $x_2 = 20$;
      $Z = 125$

Problem No.18.

An Investor has Rs. 15 lakhs for investment in four alternatives. Table below gives data on price per share, average growth rate in the price, the annual dividend and the associated risk. Return per share is defined as the difference in current price and price a year later plus the dividend for the year. The following constraints have to be must:

i)   At most Rs. 4,00,000 may be invested in share1.
ii)   At least 100 shares of each stock must be bought.
iii)   At least 15% of the investment made should be in shares 3 and 4 combines;
iv)   The total weighted risk should not exceed 0.08, where total weighted risk = (Σ investment in share j x risk in j)/total investment;
v)   Dividend for the year should be at least Rs. 20,000.

The objective is to maximize the earnings at the end of the first year from both dividends and growth. Formulate a linear program. Model that will determine the optimal no. of shares to be invested in each script.

Share No.	1	2	3	4
Current price per share	90	120	200	180
Expected annual growth rate	0.10	0.08	0.12	0.15
Expected annual dividend per share (Rs.)	5.00	7.50	4.00	3.00
Expected risk	0.07	0.05	0.10	0.08

Let x_1 be the no. of shares in share type 1
Let x_2 be the no. of shares in share type 2
Let x_3 be the no. of shares in share type 3
Let x_4 be the no. of shares in share type 4
No. of shares return type 1 = (current price per share x expected annual growth rate) + expected annual divided per share = 90 x 0.10 + 5 = 9 + 5 = 14

No. of shares return type 2 = 120 x 0.08 + 7.5 = 9.6 + 7.5 = 17.1
No. of shares return type 3 = 200 x 0.12 + 4 = 24 + 4 = 28
No. of shares return type 4 = 180 x 0.15 + 3 = 27 + 3 = 30
Objective function:
Max Z = 14 x_1 + 17.1 x_2+28x_3+30x_4.
Difference in current Price = current price per share x expected annual growth rate
Return: Expected annual divided per share + difference in current price
Subject to Constraints = 90x_1 + 120x_2+200x_3+180x_4 ≤ 15 lakhs

i)   90x_1 ≤ 4 lakhs
ii) x_1, x_2, x_3, x_4 ≥ 100
iii)   200x_3+180x_4 ≥ 0.15 (90x_1 + 120x_2+200x_3+180x_4)
iv)   (90x_1 x 0.07 + 120x_2 x 0.05 + 200x_3x 0.10 + 180x_4 x 0.08) /
        (90x_1 + 120x_2+200x_3+180x_4) ≤ 0.08
v)   5x_1 + 7.5x_2+4x_3+3x_4 ≥ 20,000

Problem No.19.

A Bank is in the process of formulating its loan policy. Involving a maximum of Rs.600 Million. Table below gives the relevant types of loans. Bad debts are not recoverable and produce no interest receive. To meet competition from other Banks the following policy guidelines have been set. At least 40% of the funds must be allocated to the agricultural and commercial loans. Funds allocated to housing must be at least 50% of all loans given to personal, car, Housing. The overall bad debts on all loans may not exceed 0.06.

Formulate a linear program Model to determine optimal loan allocations.

Type of loan	Interest rate %	Bad debts (Probability)
Personal	17	0.10
Car	14	0.07
Housing	11	0.05
Agricultural	10	0.08
Commercial	13	0.06

Solution:

Let x_1 be the amount allocated for personal loan

Let x_2 be the amount allocated for car loan

Let x_3 be the amount allocated for Housing loan

Let x_4 be the amount allocated for agricultural loan

Let x_5 be the amount allocated for Commercial loan

Objective Function: Max Z

$= 0.17x_1+0.14x_2+0.11x_3+0.1x_4+0.13x_5 - (0.10x_1+0.07x_2+0.05x_3+0.08x_4+0.06x_5)$

$= (0.17-0.10) x_1+ (0.14-0.07) x_2 + (0.11 -0.05) x_3 + (0.10 - 0.08) x_4+(0.13 - 0.06) x_5$

$= 0.17x_1+ 0.07x_2 + 0.06x_3 + 0.02x_4+ 0.07 x_5$

Subject to constraints

i) $x_1+ x_2+ x_3+ x_4 + x_5 \leq 600$ Millions

ii) $x_4 + x_5 \geq 0.4 (x_1+ x_2+ x_3+ x_4 + x_5)$

iii) $x_3 \geq 0.5 (x_1+ x_2+ x_3)$

iv) $0.1x_1 + 0.07x_2+0.05x_3+0.08x_40.06 \geq 20,000$

Problem No.20.

Four Products A,B,C and D have Rs. 5, Rs. 7, Rs. 3 and Rs. 0 profitability respectively. First type of material (limited supply of 800 kgs.) is required by A,B,C and D at 4 kgs., 3 kgs, 3 kgs, 8 kgs, and 2 kgs. respectively per unit.

Second type of material has a limited supply of 300 kgs. And is for A,B,C and D at 1 kg, 2 kgs, 0 kgs, and 1 kg per unit. Supply of the other type of materials consumed is not limited. Machine hrs. available are 500 hours and the requirements are 8,5,0 and 4 hours for A,B,C and D each per unit.

Labour hours are limited to 900 hours and requirements are 3,2,1 and 5 hours for A,B,C and D respectively.

How should the firm approach so as to maximize its profitability? Formulate this as a linear programming problem. You are not required to solve the LPP.

Solution:

Let x_1 be the no. of units of product A

Let x_2 be the no. of units of product B

Let x_3 be the no. of units of product C

Let x_4 be the no. of units of product D

Objective function Maximize $Z = 5x_1 + 7x_2 + 3x_3 + 9x_4$

	A	B	C	D	Supply in Kgs.
I type material	4	3	8	2	800
II type material	1	2	0	1	300
Machine	8	5	0	4	500
Labour	3	2	1	5	900
Profit	5	7	3	9	

Subject to constraints

$4x_1 + 3x_2 + 8x_3 + 2x_4 \leq 800$

$x_1 + 2x_2 + 0.x_3 + x_4 \leq 300$

$8x_1 + 5x_2 + 0.x_3 + 4x_4 \leq 500$

$3x_1 + 2x_2 + x_3 + 5x_4 \leq 900$ and

$x_1, x_2, x_3, x_4 \geq 0.$

(b)   ASSIGNMENT

Assignment is a special linear programming problem. There are many situations where the assignment of people or machines etc. may be called for. Assignment of workers to machines, clerks to various check-out counters, salesmen to different sales areas are typical examples of these. The Assignment is a problem because people possess varying abilities for performing different jobs and therefore the costs of performing jobs by different people are different. Thus, in an assignment problem, the question is how the assignments should be made in order that the total cost involved is minimized.

There are four methods of solving an assignment problem and they are

1)   Complete Enumeration Method
2)   Simplex Method
3)   Transportation Method and
4)   Hungarian Method

Hungarian Method:

The following are the steps involved in the minimization of an assignment problem under this method:

Step 1: Row Operation

Locate the smallest cost element in each row of the cost table. Now subtract this smallest element from each element in that row. As a result, there shall be at least one zero in each row of this new table, called the reduced cost table.

Step 2: Column Operation

In the reduced cost table obtained, consider each column and locate the smallest element in it. Subtract the smallest value from every other entry in the column. As a

consequence of this action, there would be at least one zero in each of the rows and columns of the second reduced cost table.

Step 3: Optimality

Draw the minimum no. of horizontal and vertical lines (not the diagonal ones) that are required to cover all the zero elements. If the no. of lines drawn is equal to 'n' (the no. of rows/columns) the solution is optimal and proceeds to step 6. If the no. of lines drawn is smaller than 'n' go to step 4.

Step 4: Improved Matrix

Select the smallest uncovered (by the lines) cost element. Subtract this element from all uncovered elements including itself and add this element to each value located at the intersection of any two lines. The cost elements through which only one line passes remain unaltered.

Step 5: Repeat step 3 and 4 until an optimal solution is obtained.

Step 6: Given the optimal solution, make the job assignments as indicated by the 'zero' elements. This is done as follows:

   a)   Locate a row which contains only one zero element. Assign the job corresponding to this element to its corresponding person. Cross out the zero's if any in the column corresponding to the element, which is indicative of the fact that the particular job and person are no more available.

   b)   Repeat (a) for each of such rows which contain only one zero. Similarly, perform the same operation in respect of each column containing only one 'zero' element, crossing out the zero(s), if any, in the row in which the elements lies.

   c)   If there is no row or column with only a single 'zero' element left, then select a row/column arbitrarily and choose one of the jobs (or persons) and make the assignment. Thus in such a case, alternative solutions exists.

PROBLEMS AND SOLUTIONS

Problem No.21.

Six men are available for different jobs. From past records the time in hours taken by different persons for different jobs are given below.

		Jobs					
		1	2	3	4	5	6
	1	2	9	2	7	9	1
	2	6	8	7	6	14	1
Men	3	4	6	5	3	8	1
	4	4	2	7	3	10	1
	5	5	3	9	5	12	1
	6	9	8	12	13	9	1

Find out an allocation of men to different jobs which will lead to minimum operation time.

Solution:

```
2   9   2   7   9   1
6   8   7   6   14  1
4   6   5   3   8   1
4   2   7   3   10  1
5   3   9   5   12  1
9   8   12  13  9   1
```

Row Operation

```
1   8   1   6   8   0

5   7   6   5   13  0

3   5   4   2   7   0

3   1   6   2   9   0
```

Column Operation

```
0   7   0   4   1   0
4   6   5   3   6   0
2   4   3   0   0   0
2   0   5   0   2   0
3   1   7   2   4   0
7   6   10  10  1   0
```

Improved

```
0   7   0   4   1   1

3   5   4   2   5   0

2   4   3   0   0   1

2   0   5   0   2   1
```

Improved Matrix

```
0   9   0   6   3   1
1   5   2   2   5   0
0   4   1   0   0   1
0   0   3   0   2   1
0   0   4   1   3   0
4   5   7   9   0   0
```

Assignment

```
0   9   0   6   3   3

1   5   2   2   5   0

0   4   1   0   0   1

0   0   3   0   2   1
```

Optimal Assignment, then is

1	→	3	- 2
2	→	6	- 1
3	→	1	- 4
4	→	4	- 3
5	→	2	- 3
6	→	5	- 9

22 Minimum Hours

Problem No.22.

A captain of a cricket team has to allot five middle batting positions to five batsmen. The average runs scored by each batsman at these positions are as follows:

		Batting Position				
		III	IV	V	VI	VII
	A	40	40	35	25	50
	B	42	30	16	25	27
Batsmen	C	50	48	40	60	50
	D	20	19	20	18	25
	E	58	60	59	55	53

Make the assignment so that the expected total average runs scored by these batsmen are maximum.

Solution:

	III	IV	V	VI	VII
A	40	40	35	25	50
B	42	30	16	25	27
C	50	48	40	60	50
D	20	19	20	18	25
E	58	60	59	55	53

Loss Matrix

20	20	25	35	10
18	30	44	35	33
10	12	20	0	10
40	41	40	42	35
2	0	1	5	7

Row Operation

M$_3$

10	10	15	25	0
0	12	26	17	15
10	12	20	0	10
5	6	5	7	0
2	0	1	5	7

Column Operation

10	10	14	25	0
0	12	25	17	15
10	12	19	0	10
5	6	4	7	0
2	0	0	5	7

Improved Matrix

10	6	10	25	0
0	8	21	17	15
10	8	15	0	10
5	2	0	7	0
6	0	0	9	11

Maximum Average Runs

A → VII - 50

B → III - 42

C → VI - 60

D → V - 20

Problem No.23.

Average time taken by an operator on a specific machine is tabulated below. The management is considering replacing one of the old machines by a new one and the estimated time for operation by each operator on the new machine is also indicated.

	Machines						
Operation	M$_1$	M$_2$	M$_3$	M$_4$	M$_5$	M$_6$	New
01	2	3	2	1	4	5	6
02	4	4	6	3	2	5	1
03	6	10	8	4	7	6	1
04	8	7	6	5	3	9	4
05	7	3	4	5	4	3	12
06	5	5	6	7	8	1	6

(a) Find out an allocation of operators to the old machines to achieve a minimum operation time.

(b) Reset the problem with the new machine and find out the allocation of the operators to each machine and comment on whether it is advantageous to replace an old machine to achieve a reduction in operating time only.

(c) How will the operators be reallocated to the machines after replacement?

Solution:

Operation	M$_1$	M$_2$	M$_3$	M$_4$	M$_5$	M$_6$	New
01	2	3	2	1	4	5	6
02	4	4	6	3	2	5	1
03	6	10	8	4	7	6	1
04	8	7	6	5	3	9	4
05	7	3	4	5	4	3	12
06	5	5	6	7	8	1	6

a)

2	3	2	1	4	5
4	4	6	3	2	5
6	10	8	4	7	6
8	7	6	5	3	9
7	3	4	5	4	3
5	5	6	7	8	1

Row Operation

1	2	1	0	3	4
2	2	4	1	0	3
2	6	4	0	3	2
5	4	3	2	0	6
4	0	1	2	1	0
4	4	5	6	7	0

Column Operation

0	2	0	0	3	4
1	2	3	1	0	3
1	6	3	0	3	2
4	4	2	2	0	6
3	0	0	2	1	0
3	4	4	6	7	0

Improved matrix

0	2	0	1	4	5
0	1	2	1	0	3
0	5	2	0	3	2
3	3	1	2	0	6
3	0	0	3	2	1
2	3	3	6	7	0

01	→	M_3	-	2
02	→	M_1	-	4
03	→	M_4	-	4
04	→	M_5	-	3
05	→	M_2	-	3
06	→	M_6	-	1

17 Hours Minimum Operation Time

b & c)

2	3	2	1	4	5	6
4	4	6	3	2	5	1
6	10	8	4	7	6	1
8	7	6	5	3	9	4
7	3	4	5	4	3	12
5	5	6	7	8	1	6
0	0	0	0	0	0	0

1	2	1	0	3	4	5
2	2	4	1	0	3	0
2	6	4	0	3	2	0
5	4	3	2	0	6	1
4	0	1	2	1	0	9
4	4	5	6	7	0	5
0	0	0	0	0	0	0

Improved Matrix

0	1	0	0	3	4	5
2	2	4	2	1	4	0
4	8	6	3	6	5	0
4	3	2	2	0	6	1
4	0	1	3	2	1	10
3	3	4	6	7	0	5
0	0	0	1	1	1	1

01	→	M_1	-	2
02	→	M_4	-	3
03	→	New	-	1
04	→	M_5	-	3
05	→	M_2	-	3
06	→	M_6	-	1
07	→	M_3	-	0
				13 Hours Minimum time

In Place of M_3 new machine is to be replaced.

0	2	0	0	4	5	6
1	2	3	1	1	4	0
3	8	5	2	6	5	0
3	3	1	1	0	6	1
3	0	0	2	2	1	10
2	3	3	5	7	0	5
0	1	0	1	2	2	2

0	2	0	0	5	6	7
0	1	2	0	1	4	0
2	7	4	1	6	5	0
2	2	0	0	0	6	1
3	0	0	2	3	2	11
1	2	2	4	7	0	5
0	1	0	1	3	3	3

Problem No.24.

Six salesmen are to be allocated to six sales regions so that the cost of allocation of the job will be minimum. Each salesman is capable of doing the job at different cost in each region.

The cost matrix is given below:

		Region					
		I	II	III	IV	V	VI
	A	15	35	0	25	10	45
	B	40	5	45	20	15	20
Salesmen	C	25	60	10	65	25	10
	D	25	20	35	10	25	60
	E	30	70	40	5	40	50
	F	10	25	30	40	50	15

(Figures are in Rupees)

(a) Find the allocation to give minimum cost what is the cost?
(b) Now suppose the above table gives earning of each salesman at each region. How can you find an allocation so that the earning will be maximum? Determine the solution with optimum earning.
(c) There are restrictions for commercial reasons that A cannot be posted to region V and E cannot be posted to region II. Write down the cost matrix suitably after imposing the restrictions.

Solution:

15	35	0	25	10	45
40	5	45	20	15	20
25	60	10	65	25	10
25	20	35	10	25	60
30	70	40	5	40	50
10	25	30	40	50	15

Row Operation

15	35	0	25	10	45
35	0	40	15	10	15
15	50	0	55	15	0
15	10	25	0	15	50
25	65	35	0	35	45
0	15	20	30	40	5

Column Operation

15	35	0	25	10	45
35	0	40	15	0	15
15	50	0	55	5	0
15	10	25	0	5	50
25	65	35	0	25	45
0	15	20	30	30	5

Improved Matrix

20	35	0	30	0	45
40	0	40	20	0	15
20	50	0	60	5	0
15	5	20	0	0	45
25	60	30	0	20	40
0	10	15	30	30	0

A	→	III	-	0
B	→	II	-	5
C	→	VI	-	10
D	→	V	-	25
E	→	IV	-	5
F	→	I	-	10
				Rs. 55 Minimum Cost

b)

Loss Matrix

55	35	70	45	60	25
30	65	25	50	55	50
45	10	60	5	45	60
45	50	35	60	45	10
40	0	30	65	30	20
60	45	40	30	20	55

Row Operation

30	10	45	20	35	0
5	40	0	25	30	25
40	5	55	0	40	55
35	40	25	50	35	0
40	0	30	65	30	20
40	25	20	10	0	35

Column Operation

25	10	45	20	35	0
0	40	0	25	30	25
35	5	55	0	40	55
30	40	25	50	35	0
35	0	30	65	30	20
35	25	20	10	0	35

Improved Matrix

5	10	25	20	35	0
0	60	0	15	50	45
15	5	35	0	40	55
10	40	5	50	35	0
15	0	10	65	30	20
15	25	0	10	0	35

0	10	20	20	30	0
0	65	0	50	50	50
10	5	30	0	35	55
5	40	0	50	30	0
10	0	5	65	25	20
15	30	0	15	0	40

A	→	I	-	15
B	→	III	-	45
C	→	IV	-	65
D	→	VI	-	60
E	→	II	-	70
F	→	I	-	50
			Rs. 305	Maximum

c) The cost matrix after imposing the given restriction is

Region

		I	II	III	IV	V	VI
	A	15	35	0	25	α	45
	B	40	5	45	20	15	10
Sales man	C	25	60	10	65	25	10
	D	25	20	35	10	25	60
	E	30	α	40	5	40	50
	F	10	25	30	40	50	15

Problem No.25.

A company has four zones open and four salesmen available for assignment. The zones are not equally rich in their sales potentials. It is estimated that a typical salesman operating in each zone would bring in the following annual sales:

Zone: A: 1,26,000: Zone B:1,05,000; Zone C: 84,000; Zone D: 63,000.

The four salesmen are also considered to differ in ability. It is estimated that working under the same condition their yearly sales would be proportionately as follows:

Salesman P:7; Salesman Q: 5; Salesman R:5; Salesman S:4. If the criterion is maximum expected total sales, the intuitive answer is to assign the best salesman to the richest zone, the next best to the second richest zone and so on. Verify this by the method of assignment.

Solution:

Sales Man	A	B	C	D
P	42	35	28	21
Q	30	25	20	15
R	30	25	20	15
S	24	20	16	12

Loss Matrix

0	7	14	21
12	17	22	27
12	17	22	27

Row Operation

0	7	14	21
0	5	10	15
0	5	10	15
0	4	8	12

Column Operation

0	3	6	9
0	1	2	3
0	1	2	3
0	0	0	0

0	2	4	7
0	0	0	1
0	0	0	1
2	1	0	0

0	2	5	8
0	0	1	2
0	0	1	2
1	0	0	0

P	→	A	-	42
Q	→	B	-	25
R	→	C	-	20
S	→	D	-	12
				99

x 3000 = Rs. 2,97,000 Maximum sales

Problem No.26.

Four jobs can be processed on four different machines, one job on one machine. Resulting profits vary with assignments. They are given below:

		Machines			
	I	42	35	28	21
	II	30	25	20	15
Jobs	III	30	25	20	15
	IV	24	20	16	12

Find the optimum assignment of jobs to machines and the corresponding profit.

Solution:

Profit Matrix

0	7	14	21
12	17	22	27
12	17	22	27
18	12	26	30

Row Operation

0	7	14	21
0	5	10	15
0	5	10	15
0	4	8	12

Column Operation

```
0   3   6   9
0   1   2   3
0   1   2   3
0   0   0   0
```

Improved Matrix

```
0   2   5   8
0   0   1   2
0   0   1   2
1   0   0   0
```

Further Improved

```
0   2   4   7
0   0   0   1
0   0   0   1
2   1   0   0
```

I	-	1	-	42
II	-	2	-	25
III	-	3	-	20
IV	-	4	-	12
				99

Maximum Profit Rs. 99

Problem No.27.

A salesman has to visit five cities A,B,C,D and E. The inter-city distances are tabulated below. Note the distance between two cities need not be same both ways.

From / To	A	B	C	D	E
A	-	12	24	25	15
B	6	--	16	18	7
C	10	11	--	18	12
D	14	17	22	--	16
E	12	13	23	25	--

Note further that the distances are in km.

Required:

If the salesman starts from city A and has to come back to city A, which route would you advise him to take that total distance traveled by him is minimised?

Solution:

Profit Matrix

-	12	24	25	15
6	-	16	18	7
10	11	-	18	12
14	17	22	-	16
12	13	23	25	-

Row Operation

-	0	12	13	3
0	1	10	12	1
0	1	-	8	2
0	3	8	-	2
0	1	11	13	-

Column Operation

-	0	4	5	2
0	-	2	4	0
0	1	-	0	1
0	3	0	-	1
0	1	3	5	-

A → B → E → D → C → A

12 + 7 + 25 + 22 + 10 = 76 Kms

Optimum Distance 76 Kms.

(c) TRANSPORTATION

INTRODUCTION:

The basic transportation problem was originally developed by F.L. Hitchcock (1941) in his study entitled "the distribution of a product from several sources to numerous locations". In 1947, T.C. Koopmans independently published a study on "optimum utilization of the transportation system".

Transportation models deals with the transportation of a product manufactured at different plants or factories (supply origins) to a number of different warehouses (demand destinations). The objective is to satisfy the destination requirements within the plants capacity constraints at the minimum transportation cost. Transportation models thus typically arise in situations involving physical movement of goods from plants to warehouses, warehouses to wholesalers, wholesalers to retailers and retailers to customers. Solution of the transportation models requires the determination of how many units should be transported from each supply origin to each demands destination in order to satisfy all the destination demands while minimizing the total associated cost of transportation.

Feasible Solution:

A set of non-negative values x_{ij}, i=1, 2, ……, m; j = 1, 2, …., n that satisfies no. of rows to no. of columns is called a feasible solution to the transportation problem.

Basic Feasible Solution:

An initial feasible solution with an allocation of (m + n − 1) number of variables, x_{ij}, i=1, 2, ……, m; j = 1, 2, …., n, is called a basic feasible solution.

Optimum Solution:

A feasible solution (not necessarily basic) is said to be optimum if it minimizes the total transportation cost.

Balanced or Unbalanced Transportation Problems:

A transportation problem can be balanced or unbalanced. It is said to be balanced if the total demand of all the warehouses equals the amount produced in all the factories. If in reality, capacity is greater than requirement, then a dummy warehouse may be used to create desired equality. If capacity is less than requirement, then a dummy factory may be introduced. The transportation cost in both the dummy cases is assumed to be zero.

Where the number of rows and columns are not equal, it is called unbalanced transportation problem.

Loops in Transportation Table:

In a transportation table, an ordered set of four or more cells is said to form a loop if any two adjacent cells in the ordered set lie either in the same row or in the same column. Moreover every loop has an even number of cells. It may be noted that a feasible solution to a T.P is basic if and only if the corresponding cells in the transportation table do not contain a loop.

Degeneracy of a Transportation Problem:

When the quantities are allocated to cost cells within the matrix and if such allocations are less than m + n -1 allocations (where 'm' stands for no. of rows and 'n' stands for no. of columns), such a situation is said to be Degeneracy of a Transportation Problem.

METHODS OF SOLVING TRANSPORTATION PROBLEM:

The following are the methods of solving transportation problem:
1.   The north-west corner rule

2.   Lowest cost entry method
3.   Vogel's approximation method

1.   North West Corner Method (NWCM):
The simplest of the procedures used to generate an initial feasible solution is NWCM. It is so called because we begin with the north west or upper left corner cell of our transportation table. Various steps of this method can be summarized as under:
Step 1:
Select the north west (upper left-hand) corner cell of the transportation table and allocate as many units as possible equal to the minimum between available supply and demand requirement, i.e., min (s_1, d_1).
Step 2:
Adjust the supply and demand numbers in the respective rows and columns   allocation.
Step 3:
(a) If the supply for the first row is exhausted, then move down to the first cell in the second row and first column and go to step 2.
(b) If the demand for the first column is satisfied, then move horizontally to the next cell in the second column and first row and go to step 2.
Step 4:
If for any cell, supply equals demand, then the next allocation can be made in cell either in the next row or column.
Step 5:
Continue the procedure until the total available quantity is fully allocated to the cells required.

2.   Least Cost Method (LCM):
The allocation according to this method is very useful as it takes into consideration the lowest cost and therefore, reduces the computation as well as the amount of time necessary to arrive at the optimum solution. Various steps of this method can be summarized as under:
Step 1:
a)   Select the cell with the lowest transportation cost among all the rows or columns of the transportation table.
b)   If the minimum cost is not unique, then select arbitrarily any cell with this minimum cost.
Step 2:
Allocate as many units as possible to the cell determined in step 1 and eliminate that row (column) in which either supply is exhausted or demand is satisfied.
Step 3:
Repeat steps 1 and 2 for the reduced table until the entire supply at different factories is exhausted to satisfy the demand at different warehouses.

3.   Vogel's Approximation Method (VAM):
This method is preferred over the other two methods because the initial basic feasible solution obtained is either optimum or very close to the optimum solution. Therefore, the amount of time required to arrive at the optimum solution is greatly reduced. Various steps of this method are summarized as under:
Step 1:
Compute a penalty for each row and column in the transportation table. The penalty for a given row and column is merely the difference between the smallest cost and the next smallest cost in that particular row or column.

Step 2:

Identify the row or column with the largest penalty. In this identified row or column, choose the cell which has the smallest cost and allocate the maximum possible quantity to the lowest cost cell in that row or column so as to exhaust either the supply at a particular source or satisfy demand at a warehouse.

If a tie occurs in the penalties, select that row/column which has minimum cost. If there is a tie in the minimum cost also, select that row/column which will have maximum possible assignments. It will considerably reduce computational work.

Step 3:

Reduce the row supply or the column demand by the amount assigned to the cell.

Step 4:

If the row supply is now zero, eliminate the row, if the column demand is now zero, eliminate the column, if both the row supply and the column demand are zero, eliminate both the row and column.

Step 5:

Recompute the row and column difference for the reduced transportation table, omitting rows or columns crossed out in the preceding step.

Step 6:

Repeat the above procedure until the entire supply at factories are exhausted to satisfy demand at different warehouses.

<div align="center">**PROBLEMS AND SOLUTIONS**</div>
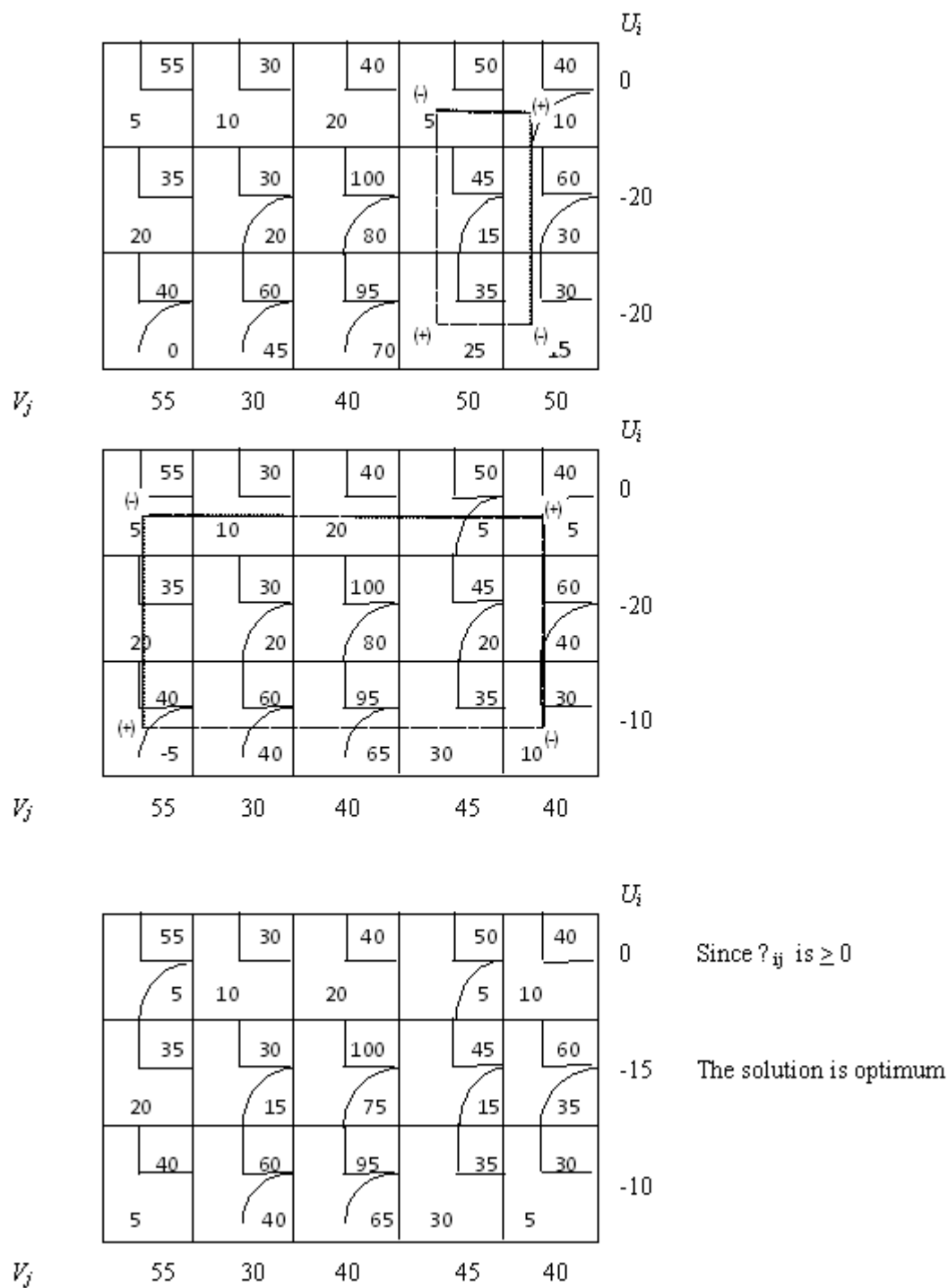
Problem No.28.

A manufacturer has distribution centres X, Y, and Z. These centres have 40,20 and 40 units of his product. His retail outlets at A, B, C, D and E require 25,10,20,30 and 15 units respectively. The transport cost in (Rupees/Unit) between each centre and each outlet is given in the following table:

Distribution Centre	Retail outlets				
	A	B	C	D	E
X	55	30	40	50	40
Y	35	30	100	45	60
Z	40	60	95	35	30

We have to find out the optimum distribution cost.

Solution:

First tableau (U_i values: 0, -20, -20):

					U_i
55	30	40	50	40	0
5	10	20	(-) 5	(+) 10	
35	30	100	45	60	-20
20	20	80	15	30	
40	60	95	35	30	-20
0	45	70	(+) 25	(-) 5	

V_j: 55, 30, 40, 50, 50

Second tableau (U_i values: 0, -20, -10):

					U_i
55	30	40	50	40	0
(-) 5	10	20	5	(+) 5	
35	30	100	45	60	-20
20	20	80	20	40	
40	60	95	35	30	-10
(+) -5	40	65	30	10 (-)	

V_j: 55, 30, 40, 45, 40

Third tableau (U_i values: 0, -15, -10):

					U_i	
55	30	40	50	40	0	Since $?_{ij}$ is ≥ 0
5	10	20	5	10		
35	30	100	45	60	-15	The solution is optimum
20	15	75	15	35		
40	60	95	35	30	-10	
5	40	65	30	5		

V_j: 55, 30, 40, 45, 40

		Qty		Minimum Cost
X →→	B ——	10 x 30 =		300
→→	C ——	20 x 40 =		800
→→	E ——	10 x 40 =		400
Y →→	A ——	20 x 35 =		700
Z →→	A ——	5 x 40 =		200
→→	D ——	30 x 35=	1050	
→→	E ——	5 x 30 =		150
		100		**Rs. 3600**

Problem No.29.

The cost conscious company requires for the next month 300, 260 and 180 tonnes of stone chips for its three constructions C1,C2 and C3 respectively. Stone chips are produced by the company at three mineral fields taken on short lease by the company. All the available boulders must be crushed into chips. Any excess chips over the demands at sites C1, C2 and C3 will be sold ex-fields.

The fields are M1, M2 and M3 which will yield 250,320 and 280 tones of stone chips respectively.

Transportation costs from mineral fields to construction sites vary according to distances, which are given below in monetary unit (MU).

	To	C1	C2	C3
	M1	8	7	6
From	M2	5	4	9
	M3	7	5	5

(i) Determine the optimal economic transportation plan for the company and the overall transportation cost in MU.

(ii) What are the quantities to be sold from M1, M2 and M3 respectively?

Solution:

Hence, there are m + n – 1 allocations. Hence Optimality test is to be performed.

Since Δ ij ≥0 Solution is optimum.

			Qty	Minimum Cost
M_1	→	C_3	140 x 6 =	840
	→	C_4	110 x 0 =	0
M_2	→	C_1	300 x 5 =	1500
	→	C_2	20 x 4 =	80
M_3	→	C_2	240 x 5 =	1200
	→	C_3	40 x 5 =	200
			850	**Rs. 3820**

Problem No.30.

Ladies fashion shop wishes to purchase the following quantity of summer dresses:

Dress size	I	II	III	IV
Quantity	100	200	450	150

Three manufacturers are willing to supply dresses.

The quantities given below are the maximum that they are able to supply of any given combination of orders for dresses:

Manufacturers	A	B	C
Total quantity	150	450	250

The shop expects the profit per dress to vary with the manufacturer as given below:

Size

	I	II	III	IV
A	£2.5	£4.0	£5.0	£2.0
B	£3.0	£3.5	£5.5	£1.5
C	£2.0	£4.5	£4.5	£2.5

Required:

(a) Use the transportation technique to solve the problem of how the orders should be placed with the manufacturers by the fashion shop is order to maximise profit.

(b) Explain how you know there is no further improvement possible.

Solution:
Profit Matrix

Profit Matrix is converted into Loss Matrix.

	I	II	III	IV		
A	3 100	1.5	.5 €	3.5 50	150/50/0	1/1.5/.5*
B	2.5	2	0 450	4	450/0 2*	
C	3.5	1 200	1	3 50	250/50/0	0/2*/.5
D	5.5	5.5	5.5	5.5 50	50/0	0/0/0

100 0	200 0	450 0	150 100 0
.5 .5 .5	.5 .5	1	.5 .5 .5

There are 1 less than m + n – 1 allocations. Hence € (Epsilon) is introduced in least cost unallocated cell.

	I	II	III	IV		
A	3 100	1.5	.5 €	3.5 50	150/50/0	1/1.5/.5*
B	2.5	2	0 450	4	450/0 2*	
C	3.5	1 200	1	3 50	250/50/0	0/2*/.5
D	5.5	5.5	5.5	5.5 50	50/0	0/0/0

100 0	200 0	450 0	150 100 0
.5 .5 .5	.5 .5	1	.5 .5 .5

Since Δ_{ij} is ≥ 0, the solution is optimum

			Qty		Maximum Profit
A	→	I	— 100 x 2.5 =		250
	→	IV	— 50 x 2 =		100
B	→	III	— 450 x 5.5 =		2475
C	→	II	— 200 x 4.5 =		900
C	→	IV	— 50 x 2.5 =		125
Dummy IV			— 50 x 0 =		0
			900		**Rs. 3850**

Problem No.31.

Departmental store wishes to purchase the following quantities of Sprees:

Types of sprees	A	B	C	D	E
Quantity	150	100	75	250	200

Tenders are submitted by 4 different manufacturers who undertake to supply not more than the quantities mentioned below (all types of sprees combined):

Manufacturer	W	X	Y	Z
Total quantity	300	250	150	200

The store estimates that its profit/spree will vary with the manufacturer as shown in the following matrix.

Sprees					
Manufacturers	**A**	**B**	**C**	**D**	**E**
W	275	350	425	225	150
X	300	325	450	175	100
Y	250	350	475	200	125
Z	325	275	400	250	175

How should the orders be placed?

Solution:

Profit matrix

	A	B	C	D	E	F	
W	275	350	425	225	150	0	300
X	300	325	450	175	100	0	250
Y	250	350	475	200	125	0	150
Z	325	275	400	250	175	0	200
	150	100	75	250	200	125	

Loss Matrix

	A	B	C	D	E	F	
	200	125	50	250	325	475	300/275/225/25
		25		50	200	25	
	175	150	25	300	375	475	250/100/0
	150					100	25/25/125/75/5
	225	125	0	275	350	475	150/75/0
		75	75				125* 100*
	150	200	75	225	300	475	
				200			200/0

75/50/50/75/75/75*

150	100	75	250	200	125
0	25	0	50	0	100
	0		0		0
25	0	25	25	25	0
25	0		25	25	0
25	25		25	25	0
25			25	25	0
			25	25	0
			50	50	0

m + n − 1 allocation s are there, optimality test can be performed.

As $\Delta_{ij} \geq 0$, maximum profit is as follows.

				Qty	Maximum Profit
W	→	B	—	25 x 350 =	8750
		D	—	50 x 225 =	11250
		E	—	200 x 150=	30000
		F	—	25 x 0 =	0
X	→	A	—	150 x 300 =	45000
		F	—	100 x 0 =	0
Y	→	B	—	75 x 350 =	26250
		C	—	75 x 475 =	35625
Z	→	D	—	200 x 250=	50000

Max. Profit.   **Rs. 2,06,875**

Problem No.32.

The products of three plants F1,F2 and F3 are to be transported to 5 warehouses W1,W2,W3,W4 and W5. The capacities of plants, demand of warehouses and the cost of transportation from one plant to various warehouses are indicated in the following table:

	W1	W2	W3	W4	W5	Plant Capacity
F1	74	56	54	62	68	400
F2	58	64	62	58	54	500
F3	66	70	52	60	60	600
Warehouse Demand	200	280	240	360	320	1500/1400

(a) Find out a distribution plan of products from plants to the warehouses at a minimum cost. What is the minimum cost?
(b) Is there any surplus capacity of the plants? If so, in which plant should we associate that surplus capacity?
(c) Is there any alternate solution for the optimum solution achieved in

Solution:

						Supply
74	56	54	62	68	0	400/300/20/0 54/2/6/6/6/6
	280		20		100	
58	64	62	58	54	0	500/300/0 *54/4/4/4/4
200				300		
66	70	52	60	60	0	600/360/340/0 52/8/0/0/0/6
		240	340	20		

200	280	240	360	320	100	
0	0	0	340	20		0
			0	0		

8	8	2	2	6	0
8	8	2	2	6	
8	*8		2	6	
8*			2	6	
			2	6*	
			2	8*	

	W₁	W₂	W₃	W₄	W₅	Dummy	Uᵢ
	74	56	54	62	68	0	
F₁	8	280	0	20	6	100	0
	58	64	62	58	54	0	
F₂	200	16	18	4	300	8	-8
	66	70	52	60	60	0	
F₃	2	16	240	340	20	2	-2
Vⱼ	66	56	54	62	62	0	

Since m + n − 1 allocation, optimality test can be performed.

Since Δᵢⱼ is ≥ 0, the solution is optimal.

	Qty		Minimum Cost
F_1	W_2 — 280 x 56 =	15680	
	W_4 — 20 x 62 =	1240	
	Dummy 100 x 0 =	0	
F_2	W_1 — 200 x 58 =	11600	
	W_5 — 300 x 54 =	16200	
F_3	W_3 — 240 x 52 =	12480	
	W_4 — 340 x 60 =	20400	
	W_5 — 20 x 60 =	1200	
	1500	**Rs. 78800**	

Alternative Solution:

	74	56	54	62	68	0
		280		20		100
	58	64	62	58	54	0
	200				300	
	66	70	52	60	60	0
			220	360	20	

F_1		W_2	280 x 56 =	15680	
	W_4	20 x 54 =	1080		
	Dummy 100 x 0 =	0			
F2	W_1	200 x 58 =	11600		
	W_5	300 x 54 =	16200		
F3	W_3	220 x 52 =	11440		
	W_4	360 x 60 =	21600		
	W_5	20 x 60 =	1200		
	1500		**Rs. 78800**		

Problem No.33.

A Company has 4 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 table below in the first two rows. The transportation costs from the factories to the sales depots S_1, S_2 and S_3 are also given. The last two columns in the table below give the sales price and total requirements at each depot and the production capacity of each factory is given in the last row.

	F$_1$	F$_2$	F$_3$	F$_4$	Sales Price/Unit (Rs)	Requirement
Production Cost/Unit (Rs.)	15	18	14	13		
Raw Materials Cost/Unit (Rs.)	10	9	12	9		
Transportation Cost/Unit (Rs.)						
S$_1$	3	9	5	4	34	80
S$_2$	1	7	4	5	32	120
S$_3$	5	8	3	6	31	150
Production capacity	10	150	50	100		

Determine the optimal solution and the associated profit as per Vogel's Approximation Method (VAM)

Solution:

Loss Matrix

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As Δ_{ij} is ≥ 0, the solution is optimum.

			Qty		Maximum Profit
S_1	→	F_4	— 80 x 8	=	640
S_2		F_1	10 x 6	=	60
		F_2	90 x(-2)=	(-)	180
		F_4	20 x 5	=	100
S_3		F_2	60 x -4	= (-)	240
		F_3	50 x 2	=	100
		Dumy	60 x 0	=	0
			350		**Rs. 480**

Problem No.34.

The Bombay Transport Company has trucks available at four different sites in the following numbers:

Site A	5 Trucks
Site B	10 Trucks
Site C	7 Trucks
Site D	3 Trucks

Customers – W, X and Y require trucks as shown below.

Customer W	5 Trucks
Customer X	8 Trucks
Customer Y	10 Trucks

Variable Costs of getting trucks to the Customers are given below:

From A to W	Rs. 7, to X	Rs. 3, to Y	Rs. 6
From B to W	Rs. 4, to X	Rs. 6 to Y	Rs. 8
From C to W	Rs. 5, to X	Rs. 8 to Y	Rs. 4
From D to W	Rs. 8 to X	Rs. 4 to Y	Rs. 3

Solve the above transportation problem.

Solution:

	7		3		6		0		5/0	3	3*	-	-	-
		5												
	4		6		8		0		10/8/3/0	4*	2	2*	2	2
5		3				2								
	5		8		4		0		7/0	4	1	1	4	-
				7										
	8		4		3		0		3/0	3	1	1	1	1
						3								

5	8	10	2	
0	3/0	3/0	0	
1	1	1	0	
1	1	1	-	
1	2	1		
-	2	1	-	
-	2	5	⊣	

	W	X	Y	Z	Ui
A	7 / 6	3	6 / 4	0 / 3	-3
B	4	6	8	0	0
	5	3	3	2	
C	5 / 2	8 / 3	4 / 7	0 / 1	-1
D	8 / 6	4	3 / 3	0 / 1	-2

As Δ_{ij} is ≥ 0, the solution is optimum.

Allocation

				Minimum Cost
A	→X	→5 x 3	=	15
B	→W	→5 x 4	=	20
	X	→3 x 6	=	18
	Z	→2 x 0	=	0
C	→Y	→7 x 4	=	28
D	→Y	→3 x 3	=	9
		25		**Rs. 90**

Problem No.35.

The products of two plants A and B are to be transported to 3 warehouses W1, W2 and W3. The cost of transportation of each unit from plants to the warehouses are indicated below:

Warehouses				
Plants	(W1)	(W2)	(W3)	Capacities
A	25	17	25	300
B	15	10	18	500
Demand	300	300	500	800/1100

Find the optimum distribution and the optimum cost.

Solution:

	W1	W2	W3				
A	25 · 100	17 · 200	25	300/0	8	8	8
B	15 · 300	10 · 200	18	500/200/0	5	5	8
C	0	0	0 · 300	300/0	0	-	-
	300 / 0	300 / 100 / 0	500 / 200 / 0				
	15	10	18*				
	10*	7	7				
	-	7	7				

There are (m + n) - 1 allocations optimality is to be performed.

25 ⟋ 3	17 · 100	25 · 200	0
15 · 300	10 · 200	18 ⟋ 0	-7
0 ⟋ 3	0 ⟋ 8	0 · 300	-25
22	17	25	

As $\Delta_{ij} \geq 0$, the solution is optimum. Therefore the minimum cost is as follows:

		Quantity	Minimum Cost
A	W2	100 x 17	1700
	W3	200 x 25	5000
B	W1	300 x 15	4500
	W2	200 x 10	2000
	DummyW3	300 x 0	0
		1100	**Rs. 13200**

Optimum cost: Rs. 13,200

Problem No.36.

Priyanshu enterprise has three factories at locations A, B and C which supply three warehouses located at D,E and F. Monthly factory capacities are 10,80 and 15 units respectively. Monthly warehouse requirements are 75,20 and 50 units respectively. Unit shipping costs (in Rs.) are given in the following table:

	To	D	E	F
	A	5	1	7
From	B	6	4	6
	C	3	2	5

The penalty costs for not satisfying demand at the warehouses D,E and F are Rs.5, Rs.3 and Rs.2 per unit respectively. Determine the optimum distribution for Priyanshu, using any of the known algorithms.

Solution:

Since there are m+n-1 allocations optimality test can be performed.

Since $\Delta ij \geq 0$, the solution is optimum.

		Quantity	Minimum Cost
A	E	10 x 1	10
	D	60 x 6	360
B	E	10 x 4	40
	F	10 x 6	60
C	D	15 x 3	45
Dummy	F	40 x 2	**80**
		145	**Rs. 595**

(including Penalty cost of Rs. 80)

Problem No.37

A company has 3 plants located at different places but producing an identical product. The cost of production, distribution cost of each plant to the 3 different warehouses, the sale price at each warehouse and the individual capacities for both the plant and warehouse are given below:

Plants	F1	F2	F3
Raw material	15	18	14
Other expenses	10	9	12

Distribution cost to warehouse				Sales Price in (Rs.)	Warehouse Capacity (No)
W1	3	9	5	34	80
W2	1	7	4	32	110
W3	5	8	3	31	150
Capacity of Plant (No.)	150	100	130		

(a) Establish a suitable table giving net profit/loss for a unit produced at different plants and distributed at different locations.

(b) Introduce a suitable dummy warehouse / plant so as to match the capacities of plants and warehouses.

(c) Find distribution pattern so as to maximise profit / minimise loss.

(d) Interpret zero value of square evaluation of an empty cell and find alternative solutions.

Solution:

Profit matrix

6	-2	3	80
6	-2	2	110
1	-4	2	150
0	0	0	40
150	100	130	380

Loss Matrix:

			80/40/0	3/3/5
			110/0	4*
			150/20/0	1/1/6*
			40/0	0/0/0

```
150      100      130
 40        0        0
  0
  0        2        1
 5*        2        1
           2        1
```


As there are m+n-1 allocations, optimality test can be performed. Since $\Delta_{ij} \geq 0$, the solution is optimum.

		Quantity	Maximum Profit
F1	W1	40 x 6	240
	W2	40 x -2	-80
F2	W1	110 x 6	660
F3	W2	20 x -4	-80
	W3	130 x 2	260
F4 Dummy	W2	40 x 0	0
		380	**Rs. 1000**

 Profit Rs. 1,000/-

Problem No.38

A company manufacturing television sets has four plants with a capacity of 125, 250, 175 and 100 units respectively. The company supplies T.V. sets to its four show rooms which have demand of 100,400,90 and 60 units respectively. Due to the differences in the raw material cost and the transportation cost, the profit per unit (in Rs.) differ which are given in the following table:

Showroom

		I	II	III	IV
	I	90	100	120	110
Plants	II	100	105	130	117
	III	111	109	110	120
	IV	130	125	108	113

By using Vogel's approximation method, plan the production programme so as to maximise the profit. Also determine the maximum total profit.

Solution: **Profit matrix**

Show Room

		I	II	III	IV	
	I	90	100	120	110	125
Plants	II	100	105	130	117	250
	III	111	109	110	120	175
	IV	130	125	108	113	100
		100	400	90	60	650

Loss Matrix:

40 / 40	30 / 40	10	20	125/0	10/10/10
0 / 110	8	4	13 / 60	250/160/100/0	13/13*/12*
5	10 / 20	4 / 130	10	175/0	9/10/11
6 / 40	6	6	17	100/0	5

100	400	130	60
0	225	0	0
	125		
	0		
19*	16	10	3
	4	10	3
	4		3

As there are m+n-1=7 but there are 6 allocations only. Therefore a notional allocation called € (epsilon) is to be placed in the least cost unallocated cell.

				U
40 / 15 / 125	30	10 / 5	20 / 2	5
30 / 10 / 100	25	0 / 90 / 2 / 60	13	0
19 / 3 / 175	10 / 130	20 / 16	10 / 1	-4
0 / 100	5 / €	22 / 2	17 / 10	-20
V				
20	25	0	13	

As $\Delta_{ij} = C_{ij} - (U_{ij} + V_{ij}) \geq 0$, the solution is optimum and therefore maximum profit is as follows:

		Quantity	Maximum Profit
I	II	125 x 100	12500
	II	100 x 105	10500
II	III	90 x 130	11700
	IV	60 x 117	7020
III	II	175 x 109	19075
IV	I	130 x 100	13000
Maximum profit			**Rs. 73795**

Problem No.39

A firm manufacturing single product has three plants at locations X,Y and Z. The three plants have produced 60, 35 and 40 Units respectively during this week. The firm has made commitments to sell 22, 45, 20, 18 and 30 Units of the product to customers A, B, C, D and E respectively. The net per unit cost of transporting from the three plants to the five customers is given in the table below.

Customers

		A	B	C	D	E
Plant	X	4	1	3	4	4
Location	Y	2	3	2	2	3
	Z	3	5	2	4	4

Use Vogel's approximation method to determine the cost shifting the product from plant locations to the customers. Does your solution provide a least cost transportation schedule?

Solution:

4	1	3	4	4		60/15/0	2/1/1/0/0
	45			15			
2	3	2	2	3		35/17/0	0/0/0/1
17			18				
3	5	2	4	4		40/20/15/0	1/1/1*/1/1*
5		20		15			

22	45	20	18	30
5	0	0	0	0
0				

1	2*	0	2	1
1		0	2*	1
1*		0		1
1				0

There are m + n -1 allocations. Therefore non-degenerate

Since Δ$_{ij}$ ≥ 0, the optimality test is satisfied.

Minimum Cost is as follows:

		Quantity	Minimum Cost
X	B	45 x 1	45
	E	15 x 4	60
Y	A	17 x 2	34
	D	18 x 2	36
Z	A	5 x 3	15
	C	20 x 2	40
	E	15 x 4	60
		135	**Rs. 290**

Problem No.40

A manufacturing company has three plants at locations X,Y and Z which supply to the distributors located at A, B, C, D and E. Monthly capacities are 80, 50 and 90 units respectively. Monthly requirements of distributors are 40,40,50,40 and 80 units respectively. Unit transportation costs are given below in Rupees.

	To	A	B	C	D	E
	X	5	8	6	6	3
From	Y	4	7	7	6	6
	Z	8	4	6	6	3

Determine an optimum distribution for the company in order to minimise the total transportation cost.

Solution:

As Δ$_{ij}$≥0 , the solution is optimum. Hence the schedule and cost is as follows:

		Quantity	Minimum Cost
X	E	80 x 3	240
Y	A	40 x 4	160
	D	10 x 6	60
Z	B	40 x 4	160
	C	50 x 6	300
Dummy	D	30 x 0	0
		250	**Rs. 920**

Minimum Cost Rs. 920/-

Problem No.41

Anand Batteries have plants at X, Y and Z. Its products 'Torch Batteries' is sent in trucks to the warehouses situated at A, B, C and D for final delivery. The shipment, production runs and storage capacities are given on the basis of truckloads/week. The costing for transportation is also on the basis of truckloads.
The plants have their working capacities and the warehouses are of different sizes depending on market demand. The following tables show:
(i) The capacity details of the plants and the warehouses, and (ii) the transportation cost/truckload

Table-1:	Warehouse	Capacity Truckloads	Factory	Production Truckloads
	A	16	X	48
	B	20	Y	32
	C	40	Z	40
	D	44	-	—
	Total	120		120

Table 2: Transportation cost per truckload in units of Rs.100

	A	B	C	D
X	6	11	3.5	6
Y	2	6	5	4
Z	1.5	11	4.5	3

You are required to workout as to how the supplies from the plant be allocated to the warehouses to minimise total transportation cost. Determine the minimum total transportation cost.

Transport cost matrix

Warehouses	A	B	C	D	Capacity/Production
Factory X	6	11	3.5	6	48
Y	2	6	5	4	32
Z	1.5	11	4.5	3	40
Demand	16	20	40	44	120

Solution:

	A	B	C	D		
X	6	11	3.5 \quad 40	6 \quad 8	48/8/0	2.5/2.5/0/0
Y	2 \quad 12	6 \quad 20	5	4	32/12/0	2/2/2*
Z	1.5 \quad 4	11	4.5	3 \quad 36	40/36/0	1.5/1.5/0.5/1.5

16	20	40	44
4	0	0	8
0			0
0.5	5*	1	1
0.5		1	1
0.5			1
4.5*			3

U_i

				U_i
6 / 1.5	11 / 2.5	40 / 3.5	8 / 6	0
2 / 12	6 / 20	5 / 4	4 / 0.5	-2.5
1.5 / 4	11 / 5.5	4.5 / 4	36 / 3	-3

V_j : 4.5   8.5   3.5   6

As $\Delta_{ij} \geq 0$, the solution is optimum

		Quantity	Minimum Cost '000
X	C	40 x 3.5	140
	D	8 x 6	48
Y	A	12 x 2	24
	B	20 x 6	120
Z	A	4 x 1.5	6
	D	36 x 3	108
Minimum Cost			**Rs.446**

Minimum Cost Rs. 4,46,000

(d) SIMULATION

In the earlier chapters, we have observed that mathematical models to describe and analyse the characteristics of a given system. Such models are useful for determining optimal solutions. Especially the techniques of LPP, Transportation, and assignment are used for such optimization. However, all the business situations can not be solved with the above techniques only. There may be some complex situations, where number of assumptions is also necessary. It may be quite often possible to simulate the given system and study the behavior.

To simulate means to imitate. In general, simulation involves developing a model of real phenomenon and then performing experiments on the model evolved. It is to be noted that it is a descriptive and not optimizing technique. In simulation, a given system is copied and the variables and constants associated with it are manipulated in that artificial environment to examine the behavior of the system. For ex: aerodynamic testing, scaled down models of airplanes and placing term in wind tunnels etc.

Thus, a businessman also in a complex situation a given system is taken and simulates for obtaining the required results.

It consists of four phases:

1) Definition of the problem and statement of objectives.
2) Construction of an appropriate model
3) Experimentation with the model constructed.
4) Evaluation of the results of simulation.

PROBLEMS AND SOLUTIONS

Problem No.42

State the major two reasons for using simulation to solve a problem

A confectioner sells confectionery items. Past data of demand per week in hundred kilograms with frequency is given below:

Demand/Week	0	5	10	15	20	25
Frequency	2	11	8	21	5	3

Using the following sequence of random numbers, generate the demand for the next 10 weeks. Also find out the average demand per week

Random numbers	35	52	13	90	23	73	34	57
	35	83	94	56	67	66	60	

Solution:

Random No. Range Table for demand				
Demand per week	Frequency	Probability	Cumulative Probability	Range
0	2	.04	.04	0-3
5	11	.22	.26	4-25
10	8	.16	.42	26-41
15	21	.42	.84	42-83
20	5	.10	.94	84-93
25	3	.06	1.00	94-99
	∑f = 50	1.00		

Simulated Values for next 10 weeks		
Weeks	R. Nos.	Demand
1	35	10
2	52	15
3	13	5
4	90	20
5	23	5
6	73	15
7	34	10
8	57	15
9	35	10
10	83	15
		120

Average weekly demand $= \dfrac{120}{10} = 12$

Problem No.43

The manager of a book store has to decide the number of copies of a particular tax law book to order. A book costs Rs. 60 and is sold for Rs. 80. Since some of the tax laws change year after year, any copies unsold while the edition is current must be sold for Rs. 30. From past records, the distribution of demand for this book has been obtained as follows:

Demand (No of copies)	15	16	17	18	19	20	21	22
Proportion	0.05	0.08	0.20	0.45	0.10	0.07	0.03	0.02

Using the following sequence of random numbers, generate the demand for 20 time periods(years). Calculate the average profit obtainable under each of the courses of action open to the manager. What is the optimal policy?

14	02	93	99	18	71	37	30	12	10
88	13	00	57	69	32	18	08	92	73

Solution:

Random No. Range Table			
Demand	**Probability**	**Cumulative Probability**	**Random Range**
15	.05	.05	0-4
16	.08	.13	5-12
17	.20	.33	13-32
18	.45	.78	33-77
19	.10	.88	78-87
20	.07	.95	88-94
21	.03	.98	95-97
22	.02	1.00	98-99
	1.00		

Calculation of demand and profit for next 20 years					
Year	**Random Numbers**	**Expected demand**	**No. of books unsold if stock is**		
			16	**17**	**18**
1	14	17	-	-	1
2	02	15	1	2	3
3	93	20	-	-	-
4	99	22	-	-	-
5	18	17	-	-	1
6	71	18	-	-	-
7	37	18	-	-	-
8	30	17	-	-	1
9	12	16	-	1	2

10	10	16	-	1	2
11	88	20	-	-	-
12	13	17	-	-	1
13	00	15	1	2	3
14	57	18	-	-	-
15	69	18	-	-	-
16	32	17	-	-	1
17	18	17	-	-	1
18	08	16	-	1	2
19	92	20	-	-	-
20	73	18	-	-	-
Total			**2**	**7**	**18**

Statement Showing Computation of Profit			
No. of Books order	**No. of Books sold**	**Profit**	**Average Profit**
15	15 x 20 = 300	Rs. 6000	Rs. 300
16	16 x 20 – 2 = 318	Rs. 6300 (318 x 20) – 2 x 30	Rs. 315
17	(17 x 20) – 7 = 333	Rs. 6450 (333 x 20) -7 x 30	Rs. 322.5
18	(18 x 20) – 18	Rs. 6300 (342 x 20) – 18 x 30	Rs. 315

Since profit is more at 17 books order, it is the best quantity and ordering is more optimum.

Problem No.44

A Small retailer has studied the weekly receipts and payments over the past 200 weeks and has developed the following set of information:

Weekly Receipts (Rs)	Probability	Weekly Payments (Rs)	Probability
3000	0.20	4000	0.30
5000	0.30	6000	0.40
7000	0.40	8000	0.20
12000	0.10	10000	0.10

Using the following set of random numbers, simulate the weekly pattern of receipts and payments for the 12 weeks of the next quarter, assuming further that the beginning bank balance is Rs 8000. What is the estimated balance at the end of the 12 weekly period? What is the highest weekly balance during the quarter? What is the average weekly balance for the quarter?

Random Numbers

For Receipts	03	91	38	55	17	46	32	43	69	72	24	22
For payments	61	96	30	32	03	88	48	28	88	18	71	99

According to the given information, the random number interval is assigned to both the receipts and the payments.

Solution:

Range of random numbers							
Receipt (Rs.)	Probability	Cumulative probability	Range	Payments (Rs.)	Probability	Cumulative probability	Range
3000	0.20	0.20	0-19	4000	0.30	0.30	0-29
5000	0.30	0.50	20-49	6000	0.40	0.70	30-69
7000	0.40	0.90	50-89	8000	0.20	0.90	70-89
12000	0.10	1.00	90-99	10000	0.10	1.00	90-99

Simulation of Data for a period of 12 weeks					
Week	Random No. for receipt	Expected Receipt (Rs.)	Random No. for payment	Expected Payment (Rs.)	Week end Balance (Rs.)
Opening Balance					8000
1	03	3000	61	6000	5000 (8000 + 3000 − 6000)
2	91	12000	96	10000	7000
3	38	5000	30	6000	6000
4	55	7000	32	6000	7000
5	17	3000	03	4000	6000
6	46	5000	88	8000	3000
7	32	5000	48	6000	2000
8	43	5000	28	4000	3000
9	69	7000	88	8000	2000
10	72	7000	18	4000	5000
11	24	5000	71	8000	2000
12	22	5000	99	10000	(3000)

Estimated balance at the end of 12th week = Rs. (3,000)
Highest balance   = Rs. 7,000
Average balance during the quarter = 45,000/12 = Rs. 3,750

Problem No.45

Patients arriving at a village dispensary are treated by a doctor on a first-come-first-served basis. The inter-arrival time of the patients is known to be uniformly distributed between 0 and 80 minutes, while their service time is known to be uniformly distributed between 15 and 40 minutes. It is desired to simulate the system and determine the average time a patient has to be in the queue for getting service and the proportion of time the doctor would be idle.

Carry out the simulation using the following sequences of random numbers. The numbers have been selected between 00 and 80 to estimate inter-arrival times and between 15 and 40 to estimate the service times required by the patients.

Series 1	07	21	12	80	08	03	32	65	43	74
Series 2	23	37	16	28	30	18	25	34	19	21

Solution:

Simulation of data at a village dispensary							
No. of patients	Inter arrival time Random No. (minutes)	Entry time in to queue (hrs)	Service Time Random No. (minutes)	Service Start time (hrs)	End time (hrs)	Waiting time of patient (minutes)	Idle time of doctor (minutes)
1	07	8.07	23	8.07	8.30	-	07
2	21	8.28	37	8.30	9.07	2	-
3	12	8.40	16	9.07	9.23	27	-
4	80	10.00	28	10.00	10.28	-	37
5	08	10.08	30	10.28	10.58	20	-
6	03	10.11	18	10.58	11.16	47	-
7	32	10.43	25	11.16	11.41	33	-
8	65	11.48	34	11.48	12.22	-	07
9	43	12.31	19	12.31	12.50	-	09
10	74	01.45	21	01.45	02.06	-	55
Total (in minutes)						129	115

Average waiting time of patient   =   129/10 = 12.9 minutes
Average waiting time of doctor   =   115/10 = 11.5 minutes

It has been assumed that starting time be 8.00 A.M.

   Problem No.46

An automobile production line turns out about 100 cars a day, but deviations occur owing to many causes. The production is more accurately described by the probability distribution given below

Production/Day	Prob.	Production/Day	Prob.
95	0.03	101	0.15
96	0.05	102	0.10
97	0.07	103	0.07
98	0.10	104	0.05
99	0.15	105	0.03
100	0.20		
		Total	1.00

Finished cars are transported across the bay, at the end of each day, by ferry. If the ferry has space for only 101 cars, what will be the average number of cars waiting to be shipped, and what will be the average number of empty space on the boat?

Solution:

Simulation of data of an Automobile Production line			
Production/day	Probability	Cumulative Probability	Random No. Range
95	0.03	0.03	0-2
96	0.05	0.08	3-7
97	0.07	0.15	8-14
98	0.10	0.25	15-24
99	0.15	0.40	25-39
100	0.20	0.60	40-59
101	0.15	0.75	60-74
102	0.10	0.85	75-84
103	0.07	0.92	85-91
104	0.05	0.97	92-96
105	0.03	1.00	97-99
	1.00		

Stimulated data				
Day	Random No.	Production	No.of cars waiting to be shipped	No. of empty space on the boat
1	20	98	-	3
2	63	101	-	-
3	46	100	-	1
4	16	98	-	3
5	45	100	-	1
6	41	100	-	1
7	44	100	-	1
8	66	101	-	-
9	87	103	2	-
10	26	99	-	2
11	78	102	1	-
12	40	100	-	1
13	29	99	-	2
14	92	104	3	-
15	21	98	-	3
Total			6	18

Average no. of cars waiting to be shipped   = 6/15 = 0.40

Average no. of empty space on the boat   = 18/15 = 1.2

Problem No.47

A book store wishes to carry 'Ramayana' in stock. Demand is probabilistic and replenishment of stock takes 2 days (i.e. if an order is placed on 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 in calculated on the basis of stock at the end of each day.

The manager of the bookstore wishes to compare two options for his inventory decision.

A. Order 5 books when the inventory at the beginning of the day plus order outstanding is less than 8 books.

B. Order 8 books when the inventory at the beginning of the day plus order outstanding is less than 8.

Currently (beginning 1st day) the store has a stock of 8 books plus 6 books ordered two days ago and expected to arrive next day.

Using Monte-Carlo Simulation for 10 cycles, recommend, which option the manager, should choose.

The two digit random numbers are given below:

89	34	70	63	61	81	39	16	13	73

Solution:

Demand	Probability	Cumulative Probability	Range
0	0.05	0.05	0-4
1	0.10	0.15	5-14
2	0.30	0.45	15-44
3	0.45	0.90	45-89
4	0.10	1.00	90-99

Option - A

Day	R No.	Demand	Option	Stock order	Closing Stock	Order Placed
1	89	3	8	-	5	-
2	34	2	5	6	9	-
3	70	3	9	-	6	0
4	63	3	6	-	3	5
5	61	3	3	0	0	-
6	81	3	0	5	2	5
7	39	2	2	-	0	5
8	16	2	0	5	3	-
9	13	1	3	5	7	-
10	73	3	7	-	4	5
					39+5=44	

Ordering cost 4 x 10	Rs. 40
Ordering cost 0.5 x 44	Rs. 22
Total Cost	Rs. 62

Option B

Day	R No.	Demand	Option	Orders received	Closing Stock	No. of Orders
1	89	3	8	-	5	-
2	34	2	5	6	9	-
3	70	3	9	-	6	-
4	63	3	6	-	3	8
5	61	3	3	-	0	-
6	81	3	0	8	5	-
7	39	2	5	-	3	8
8	16	2	3	-	1	-
9	13	1	1	8	8	-
10	73	3	8	-	5	-
					45	

Ordering cost 2 x 10	Rs. 20.0
Ordering cost 0.5 x 45	Rs. 22.5
Total Cost	Rs. 42.5

Option 'B' is better because it has low Inventory costs.

Problem No.48

After observing heavy congestion of customers over a period of time in a petrol station, Mr. Petro has decided to set up a petrol pump facility on his own in a nearby site. He has compiled statistics relating to the potential customer arrival pattern an service pattern as given below. He has also decided to evaluate the operations by using the simulation technique.

Arrivals		Services	
Inter-arrival time (minutes)	Probability	Inter-arrival time (minutes)	Probability
2	0.22	4	0.28
4	0.30	6	0.40
6	0.24	8	0.22
8	0.14	10	0.10
10	0.10		

Assume:

i)   The clock starts at 8:00 hours

ii)   Only one pump is set up.

iii)   The following12 Random Numbers are to be used to depict the customer arrival pattern:
        78, 26, 94, 08, 46, 63, 18, 35, 59, 12, 97 and 82.

iv)   The following 12 Random Numbers are to be used to depict the service pattern:
        44, 21, 73, 96, 63, 35, 57, 31, 84, 24, 05, 37

You are required to find out the

i)   probability of the pump being idle, and

ii)   Average time spent by a customer waiting in queue.

Solution:

		Inter-arrival time				Service time			
Minutes	Probability	Cumulative probability	Range	Minutes	Probability	Cumulative probability		Range	
2	.22	.22	00-21	4	.28	.28		00-27	
4	.30	.52	22-51	6	.40	.68		28-67	
6	.24	.76	52-75	8	.22	.90		68-89	
8	.14	.90	76-89	10	.10	1.00		90-99	
Sl. No.	Random No. for inter arrival	Inter arrival time	Entry time in queue	Service start time	Random no for service.	Service time	Service end time	Waiting time of customer	Idle time
1	78	8	8.08	8.08	44	6	8.14	-	8
2	26	4	8.12	8.14	21	4	8.18	2	-
3	94	10	8.22	8.22	73	8	8.30	-	4
4	08	2	8.24	8.30	96	10	8.40	6	-
5	46	4	8.28	8.40	63	6	8.46	12	-
6	63	6	8.34	8.46	35	6	8.52	12	-
7	18	2	8.36	8.52	57	6	8.58	16	-
8	35	4	8.40	8.58	31	6	9.04	18	-
9	59	6	8.46	9.04	84	8	9.12	18	-
10	12	2	8.48	9.12	24	4	9.16	34	-
11	97	10	8.58	9.16	05	4	9.20	18	-
12	82	8	9.06	9.20	37	6	9.26	14	-
Total Time								140	12

Average waiting time spent by the customer = 140/12 = 11.67 minutes
Probability of idle time of petrol station = 12/86 = 0.1395

Problem No.49

A bakery keeps stock of a popular brand of cakes. Previous experience shows the daily demand pattern for the item with associated probabilities, as given:

Daily demand (No.s)	0	10	20	30	40	50
Probability	0.01	0.20	0.15	0.50	0.12	0.02

Use the following sequence of random numbers to simulate the demand for next 10 days. Also find out the average demand per day

Random Numbers: 25, 39, 65, 76, 12, 05, 73, 89, 19, 49

Solution:

Random No. Range for demand

Daily demand	Probability	Cumulative Probability	Random No. Range
0	0.01	0.01	-
10	0.20	0.21	1-20
20	0.15	0.36	21.35
30	0.50	0.86	35-85
40	0.12	0.98	89.97
50	0.02	1.00	97-99

Simulated demand for next 10 days

Day	Random No.	Demand
1	25	20
2	39	30
3	65	30
4	76	30
4	10	10
6	05	10
7	73	30
8	89	40
9	19	10
10	49	30

Average Demand per day = 240/10 = 24 Units

Problem No.50

The Tit-Fit Scientific Laboratories is engaged in producing different types of high class equipment for use in science laboratories. The company has two different assembly lines to produce its most popular product 'Pressure'. The processing time for each of the assembly lines is regarded as a random variable and is described by the following distributions.

Process Time (minutes)	Assembly A1	Assembly A2
10	0.10	0.20
11	0.15	0.40
12	0.40	0.20
13	0.25	0.15
14	0.10	0.05

Using the following random numbers, generate data on the process times for 15 units of the item and compute the expected process time for the product. For the purpose, read the numbers vertically taking the first two digits for the processing time on assembly A1 and the last two digits for processing time on assembly A_2.

4134	8343	3602	7505	7428
7476	1183	9445	0089	3424
4943	1915	5415	0880	9309

In the first stage, we assign random number intervals to the processing times on each of the assemblies.

Solution: **Computation of Random Interval for Processing Time**

Process time Minutes	A1			A2		
	P_i	$\sum P_i$	Range	P_i	$\sum P_i$	Range
10	0.10	0.10	0-9	0.20	0.20	0-19
11	0.15	0.25	10-24	0.10	0.60	20-59
12	0.40	0.65	25-64	0.20	0.80	60-79
13	0.25	0.90	65-89	0.15	.095	80-94
14	0.10	1.00	90-99	0.05	1.00	95-99

Simulated date for 15 units

	Random No.	Process Time	Random No.	Process Time	Total
1	41	12	34	11	23
2	74	13	76	12	25
3	49	12	43	11	23
4	83	13	43	11	24
5	11	11	83	13	24
6	11	11	83	13	24
7	36	12	02	10	22
8	94	14	45	11	25
9	54	12	15	10	22
10	75	13	05	10	23
11	00	10	89	13	23
12	08	10	80	13	23
13	74	13	28	11	24
14	34	12	24	11	23
15	93	14	09	10	24
		182		**167**	**349**

Average Process time for

A1 = 182/15 = 12.13 Minutes

A2 = 167/15 = 11.13 Minutes

For product = 349/15 = 23.27 Minutes

Expected process time for the product = 23.27 minutes (12 .13 + 11.13)

   Problem No.51

A businessman is considering taking over a certain new business. Based on past information and his own knowledge of the business, he works out the probability distribution of the monthly costs and sales revenues, as given here:

Cost (in Rs.)	Probability	Sales Revenue (Rs.)	Probability
17000	0.10	19000	0.10
18000	0.10	20000	0.10
19000	0.40	21000	0.20
20000	0.20	22000	0.40
21000	0.20	23000	0.15
		24000	0.05

Use the following sequences of random numbers to be used for estimating costs and revenues. Obtain the probability distribution of the monthly net revenue.

Sequence 1	82	84	28	82	36	92	73	91	63	29
	27	26	92	63	83	02	10	39	10	10
Sequence 2	39	72	38	29	71	83	19	72	92	59
	49	39	72	94	04	92	72	18	09	00

b. Repeat the analysis in (a) by using the following random number streams:

Sequence 1	20	63	46	16	45	41	44	66	87	26
	78	40	29	92	21	36	57	03	28	08
Sequence 2	23	57	99	84	51	29	41	11	66	30
	41	80	62	74	64	26	41	40	97	15

Solution:

Cost (Rs.)	Probability	Cumulative Probability	Random Range	Cost (Rs.)	Probability	Cumulative Probability	Random Range
17000	0.1	0.1	00-09	19000	0.1	0.1	00.09
18000	0.1	0.2	10-19	20000	0.1	0.2	10-19
19000	0.4	0.6	20-59	21000	0.2	0.4	20-39
20000	0.2	0.8	60-79	22000	0.4	0.8	40-79
21000	0.2	1.0	80-99	23000	0.15	0.95	80-94
				24000	0.05	1.00	95-99

Month	Random No. for Cost	Cost (Rs.)	Random No. for Sales	Cost (Rs.)	Monthly Net Revenue (Rs.)
1	82	21000	39	21000	-
2	84	21000	72	22000	1000
3	28	19000	38	21000	2000
4	82	21000	29	21000	-
5	36	19000	71	22000	3000
6	92	21000	83	23000	2000
7	73	20000	19	20000	-
8	91	21000	72	22000	1000
9	63	20000	92	23000	3000
10	29	19000	59	22000	3000
11	27	19000	49	22000	3000
12	26	19000	39	21000	2000
13	92	21000	72	22000	1000
14	63	20000	94	23000	3000
15	83	21000	04	19000	(2000)
16	02	17000	92	23000	6000
17	10	18000	72	22000	4000
18	39	19000	18	20000	1000
19	10	18000	09	19000	1000
20	10	18000	00	19000	1000
					35000

Average = 35000/20=Rs.1750

(e) REPLACEMENT

<u>INTRODUCTION:</u>

Replacement theory is concerned with the problem of replacement of machines, electricity bulbs, men etc. due to their deteriorating efficiency, failure or breakdown. Replacement is usually carried out under the following situations:

   (i)   When existing items have outlived their effective lives and it may not be economical to continue with them anyone.
   (ii)   Items which might have been destroyed either by accident or otherwise.

The above replacement situations may be categorized into the following four categories.

   (a) Replacement of items that deteriorates with time, e.g., machine tools, vehicles, equipment, buildings etc.
   (b) Replacement of items which do not deteriorate but fail completely after certain amount of use, e.g., electric bulbs, T.V parts etc.
   (c) Replacement of an equipment (or item) that becomes out of date due to new developments e.g., ordinary weaving looms by automatic looms, mechanized accounting system by computer system, etc.
   (d) The existing working staff in an organization gradually diminishes due to death, retirement, retrenchment and other reasons. The replacements are thus needed.

METHODOLOGY OF SOLVING REPLACEMENT PROBLEMS:

   (i)   Identify the items to be replaced and also their failure mechanism. There can be two type of failures viz. gradual and sudden. Items such as machines, equipment etc follow gradual failure mechanism and they deteriorate with time.   Such type of failures account for increased expenditure in the form of operating costs, decrease in the productivity of the equipment and decrease in the value of the equipment i.e., the resale or salvage value. Items which follow sudden failure mechanism may fail anytime, thus precipitating cost of failure. The cost of failure in some cases may be quite high as compared to the value of the item itself. Sometime sudden failure of an item may cause loss of production and may also account for damaged or faulty products. In some cases failures may involve safety risks to personnel as well. To avoid the cost of sudden failure, the concern should try to predict when such failures are likely to occur and try to replace the item before it actually fails.
   (ii)   Collect the data relating to the depreciation cost and the maintenance cost over a time period from the available sources for the items which follow gradual failure mechanism. In the case of items following sudden failure mechanism collect the data for failure rates cost of replacement for failed items and cost of preventive replacement.
   (iii) On using, the above data, suitable model in OR (as discussed in the following sections) may be evolved for determining the exact time of replacing the involved items.

<u>Replacement of Items that Deteriorates with Time (without change in money value):</u>

For finding the optimum replacement period of the items pertaining to this class, we will consider basically two categories of costs. In one category, we have maintenance and operating cost which tend to increase as the equipment ages. In the other category, we have depreciation cost which diminishes with the age of the equipment. Further we disregard the time value of money. The optimum replacement of the equipment is calculated according to the following rules:

I. If the scrap value of the equipment is zero i.e., the depreciation cost is not given, then replace the equipment when the maintenance cost becomes greater than the current average cost.

II. If we are given the resale value or the depreciation cost, the maintenance cost and the cost of the equipment, then the optimum replacement period is determined by the minimum value of the average cost of date.

Replacement of Equipment that Deteriorates with Time (Money value also changes)
For finding the replacement period of items of this class, we first of all tabulate the net costs flows of the item. We then covert these costs to their present value by discounting at the relevant rate. We use these discounted costs to establish the total cost (in present value terms) that has accumulated from the start of the operation to the end of each successive time interval. We also accumulate the values of discounting factor from the start of the operation to the end of each successive time interval. We then compute the weighted average of each successive time interval by dividing the total cost with the cumulative value of the discounted factor.

Replacement if items that fail completely:
In real life; we always come across some practical situations where the failure of a certain item occurs all of a sudden instead of gradual deterioration e.g., electric light bulb, T.V parts etc., which result in complete break down of a system. The break down implies loss in production, idle inventory, immediate replacement of the item may not be available, idle labour and many other losses, so that the failure of the item puts the organization to a heavy loss. Using the probability distribution of the failure time of the item, following two types of replacement policies have been developed.
1. Individual Replacement Policy:
    Under this policy, an item is immediately replaced after its failure.
2. Group replacement:
    Under this policy decision is taken as to when all the item must be replaced irrespective of the fact that items have failed or have not failed, with the provision that if any item fails before the optimum time, it may be replaced individually. Such policy generally requires two fold consideration, namely:
    (i)   The rate of individual replacement during the period, and
    (ii) The total cost incurred for individual and group replacements during the selected interval.

The period for which the total cost incurred is minimum will be the optimum period for replacement. Thus for the formation of group replacement policy one should know the probability of failure, loss incurred due to these failures, cost of individual replacements and cost of group replacements. The rule for calculating time of group replacement and the total cost involved is given below:
(a) One should replace the group of items at the end of the tth period if the cost of individual replacement for t^{th} period is greater than the average cost per period through the end of tth period.
(b) One should not replace the group of items at the end of the tth period if the cost of individual replacement at the end of $(t-1)^{th}$ period is less than the average cost per period through the end of the tth period.

PROBLEMS AND SOLUTIONS

Problem No.52

A machine owner finds from his past experience that cost per year of maintenance of a machine whose purchase price is Rs.6,000/- are as given below:

Year:	1	2	3	4	5	6	7	8
Maintenance Cost (Rs.):	1,000	1,200	1,400	1,800	2,300	2,800	3,400	4,000
Resale price (Rs.):	3,000	1,500	750	375	200	200	200	200

At what age is replacement due?

Solution:

Statement showing computation of average cost per year and determination of optimal period.

Year	Net Capital Cost (Cost – Scrap)	Maintenance Cost	Cumulative Maintenance cost	Total Cost (2 + 4)	Average Cost (5 / 1)
	Rs.	Rs.	Rs.	Rs.	Rs.
(1)	(2)	(3)	(4)	(5)	(6)
1	3000	1000	1000	4000	4000
2	4500	1200	2200	6700	3350
3	5250	1400	3600	8850	2950
4	5625	1800	5400	11025	2756.25
5	588	2300	7700	13500	**2700***
6	5800	2800	10500	16300	2716.67
7	5800	3400	13900	19700	2814.29
8	5800	4000	17900	23700	2962.50

Hence, optimal replacement period is at the end of 5th year (5 years)

Problem No.53

The data on the operating costs per year and resale prices of equipment A whose purchase price is Rs.10,000 are given here:

Year:	1	2	3	4	5	6	7
Operating Cost (Rs.):	1500	1900	2300	2900	3600	4500	5500
Resale Value (Rs.):	5000	2500	1250	600	400	400	400

a) What is the optimum period for replacement?
b) When equipment A is 2 years old, equipment B, which is a new model for the same usage, is available. The optimum period for replacement is 4 years with an average cost of Rs.3600. Should we change equipment A with that of B? If so, when?

Solution:

(a) **Statement showing computation of average cost per year and determination of optimal period.**

Year	Net Capital Cost (Cost – Scrap)	Operating Cost	Cumulative Operating cost	Total Cost (2 + 4)	Average Cost (5 / 1)
	Rs.	Rs.	Rs.	Rs.	Rs.
(1)	(2)	(3)	(4)	(5)	(6)
1	5000	1500	1500	6500	6500
2	7500	1900	3400	10900	5450
3	8750	2300	5700	14450	4816.67
4	9400	2900	8600	18000	4500
5	9600	3600	12200	21800	**4360***
6	9600	4500	16700	26300	4383.33
7	9600	5500	22200	31800	4542.86

Hence, Replacement period is 5 years.

(b)

Year	Operating Cost	Replacement Cost	Total
	Rs.	Rs.	Rs.
3	2300	1250 (=2500-1250)	3550
4	2900	650 (=1250-600)	3550
5	3600	200 (=600-400)	3800

Since average cost of 'B' is less than Average cost of 'A' Replacement period is 4 years i.e. 2 years from the third year of A's use.

Problem No.54

A firm has a machine whose purchase price is Rs.20,000. Its maintenance cost and resale price at the end of different years are as given here:

Year:	1	2	3	4	5	6
Maintenance Cost:	1500	1700	2000	2500	3500	5500
Resale Price:	17000	15300	14000	12000	8000	3000

Obtain the economic life of the machine and the minimum average cost.

Solution:

Statement showing computation of average cost per year and determination of optimal period.

Year	Net Capital Cost (Cost – Scrap)	Maintenance Cost	Cumulative Maintenance cost	Total Cost (2 + 4)	Average Cost (5 / 1)
	Rs.	Rs.	Rs.	Rs.	Rs.
(1)	(2)	(3)	(4)	(5)	(6)
1	3000	1500	1500	4500	4500
2	4700	1700	3200	7900	3950
3	6000	2000	5200	11200	3733*
4	8000	2500	7700	15700	3925
5	12000	3500	11200	23200	4640
6	17000	5500	16700	33700	5617

Economic life of Machine is 3 years. Therefore at the 3rd year it can be replaced.

Problem No.55

A large computer installation contains 2,000 components of identical nature which are subject to failure as per probability distribution that follows:

Month End:	1	2	3	4	5
% Failure to date:	10	25	50	80	100

Components which fail have to be replaced for efficient functioning of the system. If they are replaced as and when failures occur, the cost of replacement per unit is Rs.3. Alternatively, if all components are replaced in one lot at periodical intervals and individually replace only such failures as occur between group replacement, the cost of component replaced is Re 1.

a) Assess which policy of replacement would be economical.
b) If group replacement is economical at current costs, then assess at what cost of individual replacement would group replacement be uneconomical.
c) How high can the cost per unit in-group replacement be to make a preference for individual replacement policy?

Solution:

(a) **Computation of failures & Mean life**

Month	Probability	P_1X_1
1	0.10	0.10
2	0.15	0.30
3	0.25	0.75
4	0.30	1.20
5	0.20	1.00
		3.35

Average No. of Replacements = 2000/3.35 = 597

Cost of Individual Replacement = 597 x 3 = 1791

Computation of expected No. of Replacements:

Month		
0	$N_0 = N_0P_0 = 2000$	0
1	$N_1 = N_0P_1 = 2000 \times 0.1$	200
2	$N_2 = N_0P_2 + N_1P_1 = 2000 \times 0.15 + 200 \times 0.1$	320
3	$N_3 = N_0P_3 + N_1P_2 + N_2P_1 = 2000 \times 0.25 + 200 \times 0.15$ + 320 x 0.1	562
4	$N_4 = N_0P_4 + N_1P_3 + N_2P_2 + N_3P_1 = 2000 \times 0.3 + 200 \times 0.25 + 320 \times 0.15 +$ 562 x 0.1	754.2
5	$N_5 = N_0P_5 + N_1P_4 + N_2P_3 + N_3P_2 + N_4P_1 = 2000 \times 0.2 +$ 200 x 0.3 + 320 x 0.25 + 562 x 0.15 + 754.2 x 0.1	699.72

Computation of Average cost

Month	Individual Replacement	Cost		Total Cost	Average Cost
		IR	GR		
		Rs.	Rs.	Rs.	Rs.
1	200	600	2000	2600	2600
2	520	1560	2000	3560	1780
3	1082	3246	2000	5246	**1748.67***
4	1836.2	5508.6	2000	7508.6	1877.15
5	2535.92	7607.76	2000	9607.76	1921.55

Since the average cost is lowest in 3rd month, the optimal interval i.e. replacement is 3 months. Also the average cost is less than Rs. 1791 of individual replacement, **the group replacement policy is better.**

(b)   Let 'K' be the cost of Individual Replacement

Month	Average Cost of Group Replacement	Average cost of IR	'K' Value (Rs.)
1	1 (2000 + 200 K)	597 K	5.04
2	0.5 (2000 + 520 K)	597 K	2.97
3	0.33 (2000 + 1082 K)	597 K	**2.82**
4	0.25 (2000 + 1836.2 K)	597 K	3.62
5	0.20 (2000 + 2535.92 K)	597 K	4.45

If group replacement is anything smaller than 2.82, then Group Replacement would be uneconomical.

(c)

Let 'a' be the unit cost of Group Replacement Policy

Month			'a' Value (Rs.)
1	1 (2000 a + 600)	1791	0.60
2	0.5 (2000 a + 1560)	1791	1.01
3	0.33 (2000 a + 3246)	1791	**1.06**
4	0.25 (2000 a + 5508.6)	1791	0.83
5	0.20 (2000 a + 7607.76)	1791	0.67

When unit cost is more than Rs. 1.06 then Individual Replacement policy would be better.

Problem No.56

An electro-mechanical equipment has a purchase price of Rs.7,000. Its running costs per year and resale values are given here:

Year:	1	2	3	4	5	6	7	8
Running Costs (Rs.)	2,000	2,100	2,300	2,600	3,000	3,500	4,100	4,600
Resale Value (Rs.)	4,000	3,000	2,200	1,600	1,400	700	700	700

At which year is the replacement due?

Solution:

Computation of Average Cost

Year	Net Capital Cost (Cost – Scrap)	Maintenance Cost	Cumulative Maintenance cost	Total Cost (2 + 4)	Average Cost (5 / 1)
	Rs.	Rs.	Rs.	Rs.	Rs.
(1)	(2)	(3)	(4)	(5)	(6)
1	3000	2000	2000	5000	5000
2	4000	2100	4100	8100	4050
3	4800	2300	6400	11200	3733
4	5400	2600	9000	14400	3600
5	5600	3000	12000	17600	**3520***
6	6300	3500	15500	21800	3633
7	6300	4100	19600	25900	3700
8	6300	4600	24200	30600	3825

Replacement is due 5 years.

Problem No.57

Goodlite Company has installed 200 electric bulbs of a certain brand. The company follows the policy of replacing the bulbs as and when they fail. Each replacement costs Rs. 2. The probability distribution of the life of the bulbs is as given here:

Life of Bulb (Weeks):	1	2	3	4	5
% of Bulbs	0.10	0.30	0.45	0.10	0.05

Determine the cost/week of the replacement policy in the long run.

Solution:

Computation of average no. of replacements and cost per week

Week	Probability	Total Product
1	0.10	0.10
2	0.30	0.60
3	0.45	1.35
4	0.10	0.40
5	0.05	0.25
		2.70

Average no. of Replacements = 200/2.7 = 74

Therefore, cost per week = 74 x 2 = Rs. 148.

Computation of expected no. of Replacements

Week		
0	$N_0 = N_0 P_0 = 200$	0
1	$N_1 = N_0 P_1 = 200 \times 0.1$	20
2	$N_2 = N_0 P_2 + N_1 P_1 = 200 \times 0.3 + 20 \times 0.1$	62
3	$N_3 = N_0 P_3 + N_1 P_2 + N_2 P_1 = 200 \times 0.45 + 20 \times 0.30 + 62 \times 0.1$	102.2
4	$N_4 = N_0 P_4 + N_1 P_3 + N_2 P_2 + N_3 P_1 = 200 \times 0.1 + 20 \times 0.45 + 62 \times 0.3 + 102.2 \times 0.1$	57.82
5	$N_5 = N_0 P_5 + N_1 P_4 + N_2 P_3 + N_3 P_2 + N_4 P_1 = 200 \times 0.5 + 20 \times 0.1 + 62 \times 0.45 + 102.2 \times 0.30 + 57.82 \times 0.1$	76.342

Computation of Average cost of Group Replacement

Week	Individual Replacements	Cost of Individual Replacements	Cumulative Individual Replacement Cost	Average Cost
		Rs.	Rs.	Rs.
1	20	40	40	40
2	62	124	164	82
3	102.2	204	368	122.67
4	58	116	484	**121.00***
5	76	152	636	127.2

Replacement is once in four weeks.

5
ENTERPRISE PERFORMANCE MEASUREMENT SYSTEM

1. **Write a short note on Balanced Score Card**.

Ans: The Balanced Score Card approach emphasizes the need to provide management with a set of information, which deals with all relevant areas of performance in an objective and unbiased fashion. The information provided may be both financial and non-financial. It covers areas such as profitability, customer satisfaction, internal efficiency and innovation. This approach looks at both internal and external matters concerning the organization.

A number of benefits have materialized from this approach. It is a more effective reporting process. There is greater clarity and focus and the issues to be tackled.

There will be improved understanding of the key issues and it helps the managers to focus resources and take action more effectively.

Balanced Score Card is a performance management and strategy development methodology that helps executives translate on organization's mission statement and overall business strategy into specific, qualifiable goals and monitors the organization's performance in terms of these goals. Balance Score Card also aligns budgets to strategy and helps in developing an enterprise performance management system.

It is a set of financial and non-financial measures relating to company's critical success factors. As a management tool it helps companies to assess overall performance, improve operational processes and enable management to develop better plans for improvements. It offers managers a balanced view of their organization upon which they can base real change.

Balanced Score Card has the following four perspectives:

a) Customer perspective: To achieve the company's vision and strategy, how should the company appear its customers

b) Internal business perspective: To satisfy the company's shareholders and customers and what business processes must the company excel

c) Learning and growth perspective: To achieve the vision, how will the company sustain its ability to change and improve

d) Financial perspective: To succeed financially how should the company appear to the company's share holders

2. **What are the Advantages of Balanced Score Card?**

Ans:

a) **Holistic approach:** It brings strategy and vision as the center of Management focus. It helps Companies to assess overall performance, improve operational processes and enable Management to develop better plans for improvement. It provides Management with a comprehensive picture of business operations.

b) **Overall Agenda:** It brings together in a single Management Report, various aspects like customer oriented, shortening response time, and improving quality etc. of competitive agenda.

c) **Objectivity:** It emphasizes the need to provide the user with a set of information, which address all relevant areas of performance in an objective and unbiased manner.

d) **Management by Objectives:** The methodology of BSC facilitates communication and understanding of business goals and strategies at all levels of the Firm. Thus it enables Management by Objective.

e) **Feedback and Learning:** It provides strategic feedback and learning. BSC guards against sub-ordination. It emphasizes an integrated combination of traditional and non-traditional performance measures.

f) **System Approach:** It helps Senior Managers to consider all the important performance measures together and allows them to see whether an improvement in one area has been achieved at the expense of another.

3.   What are the major components of Balanced Score Card?

Ans:

1.   A well designed Balanced Score Card combines financial measures of past performance with measures of the Firm's drivers of future performance.

2.   The specific objectives and measures of a Firm's BSC are derived from the Firm's vision and strategy.

3.   Generally, the BSC has the following perspectives from which a Company's activity can be evaluated.

a) **Customer perspective i.e., How customers see us?** In order to translate effective internal processes into organizational success, customers/clients must be happy with the service they receive. The Customer perspective considers the business through the eyes of the customers, measuring and reflecting upon Customer satisfaction.

b) **Internal business perspective i.e., in what processes must the Firm excel?** The Internal perspective focuses attention on the performance of the key internal processes, which drive the business. The nature of the processes is dependent on the nature of the organization.

c) **Innovation and learning perspective i.e. Can we continue to improve and create value?** The learning and Growth perspective is a measure of potential future performance – it directs attention to the basis of all future success – the organization's people and infrastructure. Adequate investment in these areas is critical to all long term success.

d) **Financial perspective i.e., How we look to our shareholders?** The Financial perspective measures the results that the organization delivers to its stakeholders.

Outline the process of creating a Balanced Score Card:

Step	Description
1	Identify the Firm's Vision. e.g. the vision of a Company may be to dominate the market
2	Identify the Organization's Strategies i.e., how an organization is planning to go there. E.g. strategy may be to focus on cost efficiency, high quality and fresh investment in new technology.
3	Define Critical Success Factors and perspectives i.e., what we have to do well in each perspective. (See Note Below)
4	Identify Measures, which will ensure that everything is going in the expected way
5	Evaluation of Balanced Score Card i.e., ensuring what we are measuring is right
6	Create Action Plans and Plan Reporting of the Balanced Score Card.
7	Follow up and Manage, i.e., which person should have Reports and how Reports should look like.

Note: Illustration of perspective and performance Measures –

1. **Customer Perspective:**

Goals	Performance Measures
Price	Competitive Price
Delivery	Number of on time deliver, lead time from receipt of order to delivery to customers
Quality	Own quality relative to industry standards, number of defects or defect level
Support	Response time, customer satisfaction surveys.

2. **Internal Business Perspective**:

Goals	Performance Measures
Efficiency of Manufacturing Process	Manufacturing Cycle Time
Sales Penetration	Annual Sales Vs. Plan Sales. Increase in number of customers in a unit of time
New Product introduction	Rate of new product introduction/quarter.

3. **Innovation and learning Perspective**:

Goals	Performance Measures
Technology Leadership	Product Performance compared to competitors, number of new products with parented technology
Cost Leadership	Manufacturing Overheads per quarter as a percentage of sales, rate of decrease in cost per quarter.
Market Leadership	Market Share in all major markets
Research and Development	Number of new products, number of patents

4. **Financial Perspective**:

Goals	Performance Measures
Sales	Revenue and Profit Growth
Cost of Sales	Extent to which it remained fixed or decreased each year
Profitability	Return on Capital Employed
Prosperity	Cash Flow

4.   What is Standard Costing? And what are the General Principles of Standard Costing?

Ans: **Standard Costing**: During the first stages of development of cost accounting, historical costing was the only method available for ascertaining and presenting costs. Historical cost have, however, the following limitations:

   a.   Historical cost is valued only for one accounting period, during which the particular manufacturing operation took place.

   b.   Data is obtained too late for price quotations and production planning.

   c.   Historical cost relating to one batch or lot of production is not a true guide for fixing price.

   d.   Past actual are affected by the level of working efficiencies.

   e.   Historical costing is comparatively expensive as it involves the maintenance of a large volume of records and forms.

The limitations and disadvantages attached to historical costing system led to further thinking on the subject and resulted in the emergence of standard costing which makes use of scientifically pre-determined standard costs under each element.

General Principles of Standard Costing:
Standard Costing is defined as the preparation and use of standard cost, their comparison with actual costs and the measurement and analysis of variances to their causes and points of incidence. Standard Cost is a predetermined cost unit that is calculated from the management's standards of efficient operation and the relevant necessary expenditure. Standard Costs are useful for the cost estimation and price quotation and for indicating the suitable cost allowances for products, process and operations but they are effective tools for cost control only when compared with the actual costs of operation. The techniques of standard costing may be summarized as follows:

a) Predetermination of technical data related to production. i.e., details of materials and labour operations required for each product, the quantum of inevitable losses, efficiencies expected level of activity, etc.
b) Predetermination of standard costs in full details under each element of cost, viz., labour, material and overhead.
c) Comparison of the actual performance and costs will the standards and working out the variances, i.e., the differences between the actual and the standards.
d) Analysis of the variances in order to determine the reasons for deviations of actual from the standards.
e) Presentation of information to the appropriate level of management to enable suitable action (remedial measures or revision of the standard) being taken.

5. **Distinguish Standard Costing from Budgetary Control.**

Ans: **Standard Costing and Budgetary Control**: Like budgetary control, standard costing assume that costs are controllable along definite lines of supervision and responsibility and it aims at managerial control by comparison of actual performances with suitable predetermined yardsticks. The basic principles of cost control, viz., setting up of targets or standards, measurement of performance, comparison of actual with the targets and analysis and reporting of variances are common to both standard costing and budgetary control systems. Both techniques are of importance in their respective fields a dare complementary to each other. Thus conceptually there is not much of a difference between standard costs and budgeted and the terms budgeted performance and standard performance mean, for many concerns one and the same thing.

Budgets are usually based on past costs adjusted for anticipated future changes but standard costs are of help in the preparation of production costs budgets. In fact, standards are often indispensable in the establishment of budgets. On the other hand, while setting standard overhead rates of standard costing purposes, the budgets framed for the overhead costs may be made use of with modifications, if necessary. Thus, standard costs and budgets are interrelated but not inter-dependent.

Despite the similarity in the basic principles of standard costing and budgetary control, the two systems vary in scope and in the matter of detailed techniques. The difference may be summarized as follows:

a) A system of budgetary control may be operated even if no standard costing system is in use in the concern.
b) While standard is a unit concept, budget is a total concept.

c) Budgets are the ceilings or limits of expenses above which the actual expenditure should not normally rise; if it does, the planned profits will be reduced. Standards are minimum targets to the attained by actual performance at specified efficiency.

d) Budgets are complete in as much as they are framed for all the activities and functions of a concern such as production, purchase, selling and distribution, research and development, capital utilization, etc. Standard Costing relates mainly to the function of production and the related manufacturing costs.

e) A more searching analysis of the variances from standards is necessary than in the case of variations from the budget.

f) Budgets are indices, adherence to which keeps a business out of difficulties. Standard are pointers to further possible improvements.

6. Distinguish between Standard Costs and Estimated Costs.

Ans: **Standard Costs and Estimated Costs**: The distinction between standard costs and estimated costs should be clearly understood. While both standard costs and estimated costs are predetermined costs, their objectives are different. The main differences between the two types of costs are:

a) Estimated costs are intended to determine what the costs 'will' be. Standard costs aim at what costs 'should' be.

b) Estimated costs are based on average of past actual figures adjusted for anticipated changes in future. Anticipated wastes, spoilage and inefficiencies, all of which tend to increase costs are included in estimated costs. Standard Costs are planned costs determined on a scientific basic and they are based upon certain assumed conditions of efficiency and other factors.

c) In estimated costing systems, stress is not so much on cost control, but costs are used for other purposes such as fixation of prices to be quoted in advance. Standard costs serve as effective tools for cost control.

7. What are the Advantages of Standard Costing?

Ans: **Advantages of Standard Costing**: The advantages derived from a system of standard costing are tabulated below:

a) Standard costing system established yard-sticks against which the efficiency of actual performances are measured.

b) The standards provide incentive and motivation to work with greater effort and vigilance for achieving the standard. This increase efficiency and productivity all round.

c) At the very stage of setting the standards, simplification and standardization of products, methods, and operations are effected and waste of time and materials is eliminated. This assists in managerial planning for efficient operation and benefits all the divisions of the concern.

d) Costing procedure is simplified. There is a reduction in paper work in accounting and less number of forms and records are required.

e) Cost are available with promptitude for various purposes like fixation of selling prices, pricing of inter-departmental transfers, ascertaining the value of closing stocks of work-in-progress and finished stock and determining idle capacity.

f)   Standard Costing is an exercise in planning - it can be very easily fitted into and used for budgetary planning.

g)   Standard Costing system facilities delegation of authority and fixation of responsibility for each department or individual. This also tones up the general organization of the concern.

h)   Variance analysis and reporting is based on the principles of management by exception. The top management may not be interested in details of actual performance but only in the variances from the standards, so that corrective measures may be taken in time.

i)   When constantly reviewed, the standards provide means for achieving cost reduction.

j)   Standard costs assist in performance analysis by providing ready means for preparation of information.

k)   Production and pricing policies may be formulated in advance before production starts. This helps in prompt decision making.

l)   Standard costing facilities the integration of accounts so that reconciliation between cost accounts and financial accounts may be eliminated.

m)   Standard costing optimizes the use of plant capacities, current assets and working capital.

8.   **What are the Limitations of Standard Costing?**
Ans: Limitations of Standard Costing:
1.   Establishment of standard costs is difficult in practice.
2.   In course of time-sometimes even in a short period the standards become rigid.
3.   Inaccurate, unreliable and out of date standards do more harm than benefit.
4.   Sometimes, standards create adverse psychological effects. If the standard is set at high level, its non achievement would result in frustration and build-up of resistance.
5.   Due to the play of random factors, variances cannot sometimes be properly explained, and it is difficult to distinguish between controllable and non-controllable expenses.
6.   Standard costing may not sometimes be suitable for some small concerns. Where production cannot be carefully scheduled, frequent changes in production conditions result in variances, detailed analysis of all of which would be meaningless, superfluous and costly.
7.   Standard costing may not sometimes be suitable and costly in the case of industries dealing with non-standardised products and for repair jobs which keep on changing in accordance with customer's specifications.
8.   Lack of interest in standard costing on the part of the management makes the system practically ineffective. This limitation, of course, applies equally in the case of any other system which the management does not accept whole heartedly.

9.   **What are the Causes and Remedies of Material Variances?**
Ans: **Causes and Remedies of Material Variances**: Material cost variance which denotes the difference between the standard cost of materials specified and the actual cost of materials used is a combination of two sub variances namely material price variance and material usage variance.

Material price variance is the result of actual price or the material being different (higher/lower) from the predetermined price. If the actual price is more it is an adverse variance and in the reverse case it is a favourable variance. The possible causes of such a variance rising can be summarised below:

   a) Variation in the market price of the materials.
   b) Variation in the trade discount or bulk purchase benefits due to change in lots or batch size limitation in storage/handling facilities.
   c) Forced purchase of other alternative materials or substitutes due to non-availability of the standard materials.
   d) Incorrect buying policy by not being able to take advantage of off season discount.
   e) Variation in other costs like freight, transportation, rail or air charges which are usually beyond the control of the purchases.
   f) Changes in different modes of taxes like excise duty, octroi duty, sales tax, etc.
   g) Changes in Export/Import policy resulting into variations in prices.

The foregoing list is not exhaustive but inclusive because there may be many more reasons of such a variance.

The other part of the sub-variance is the Material Usage Variance which arises due to the actual use of materials being different from the standard specified. If the quantity used is higher than the standard it is an adverse variance and in the reverse case it is favorable variance. The possible causes of such variance are summarised below:

   a) The losses allowed for storage/production process may be difficult from the predetermined standard either due to inefficient storage or inefficient supervision.
   b) The material may be of indifferent quality then originally envisages resulting into difference in yields.
   c) Inefficient material handling or incorrect weighment resulting more losses.
   d) Changing in the material mix either due to non-availability of the standard material or due to changes in specification.
   e) The machines or the tools may defective or sub-standard which may give rise to higher material utilization.
   f) Improper planning which may be the case for poor material handling or wrong production process ultimately resulting into more material usage than the present standard.

Here again the foregoing list is an inclusive list and not an exhaustive one and there may be more reasons for material usage variance to result.

10. What is Zero Base Budgeting?
Ans: **Zero Base Budgeting**: It differs from the convectional system of budgeting mainly in that start from scratch or zero and not on the basis of trends or historical levels of expenditure. In the customary budgeting system, the last year's figures are accepted as they are, or cut back or increases are granted. Zero base budgeting on the other hand, starts with the premises that the budget for next period is zero is long the demand for a function, process, project or activity is not justified for each rupee from the first rupee up. The assumptions are that without such a justification no spending will be allowed. The burden

of proof thus shifts to each manager to justify why the money should be spent at all and to indicate what would happen if the proposed activity is not carried out and no money is spent. In this way, he is required to carry out cost benefit in to analysis of each of the activities etc. under his control and for which he is responsible. Such analysis would reveal that some activities and loss essential or have less pay value or money than the others and that some activities may be eliminated or curtailed or made into productive and profitable ones. Thus zero base budgeting affords a choice amongst the alternative so that the activities would be selected in the order of their importance.

11. What are the advantages of Zero Base Budgeting?

Ans:

a) Out of date and inefficient operations are identified.

b) Allows managers to promptly respond to changes in the business environment.

c) Instead of accepting the current practice, it creates a challenging and questioning attitude.

d) Allocations of resources are made according to needs and the benefits derived.

e) Has a psychological impact on all levels of management which makes each manager to 'pave his way'.

12. What is Economic Value Added (EVA)?

Ans: In corporate finance, Economic Value Added or EVA is an estimate of a firm's economic profit - being the value created in excess of the required return of the company's shareholders - where EVA is the profit earned by the firm less the cost of financing the firm's capital. The idea is that shareholders gain when the return from the capital employed is greater than the cost of that capital; see Corporate finance: working capital management. This amount can be determined, among other ways, by making adjustments to general accounting, including deducting the opportunity cost of equity capital.

13. How do you calculate Economic Value Added (EVA)?

Ans: EVA is Net Operating Profit after Taxes (or <u>NOPAT</u>) less the money cost of capital. Any value obtained by employees of the company or by product users is not included in the calculations. The basic formula is:

Where:
$$r = \frac{NOPAT}{K}$$

- r is the Return on Invested Capital (ROIC);
- c is the Weighted Average Cost of Capital (WACC);
- K is capital employed;
- NOPAT is the Net Operating Profit after Tax, with adjustments and translations for the amortization of goodwill, the capitalization of brand advertising and others.

EVA Calculation
EVA = (r x Capital) – (c x Capital)
EVA = (NOPAT- c x Capital
EVA = operating profits – a capital charge
where: r = rate of return, and c = cost of capital, or the weighted average cost of capital.

NOPAT is profits derived from a company's operations after taxes but before financing costs and noncash-bookkeeping entries. It is the total pool of profits available to provide a cash return to those who provide capital to the firm.

Capital is the amount of cash invested in the business, net of depreciation. It can be calculated as the sum of interest-bearing debt and equity or as the sum of net assets less noninterest-bearing current liabilities. Capital charge is the cash flow required to compensate investors for the riskiness of the business given the amount of capital invested. The cost of capital is the minimum rate of return on capital required to compensate debt and equity investors for bearing risk.

Another perspective on EVA can be gained by looking at a firm's Return on Net Assets (RONA). RONA is a ratio that is calculated by dividing a firm's NOPAT by the amount of capital it employs (RONA = NOPAT/Capital) after making the necessary adjustments of the data reported by a conventional financial accounting system.
EVA = (Net Investments)(RONA – Required minimum return)
If RONA is above the threshold rate, EVA is positive.

14. What is Segment Performance?
Ans: Segment is a subdivision or unit of an organisation. It is for example, in Tata Group Tata Motors represents a segment, similarly Tata Steel etc. The performance of each individual subdivision is measured by different parameters, especially by economic value added and reported to top management and stake holders as per relevant Accounting Standards either financial or costing. This measurement of performance and reporting helps the management in taking appropriate decisions in the competitive world.

Objective and Bit Questions:

15. _____ is a new approach to strategic Management which was developed by Robert Kaplan and David Norton.
16. Balanced Score Card (BSC) is a performance Management. and _____ methodology that helps executives translate an organization's mission statement and overall business strategy into specific quantifiable goals.
17. Indeed BSC is a way to translate _____ into _____
18. Four perspectives of BSC includes _____, _____, _____, _____.
19. "To achieve our vision, how should we appear to our companies share holders"? Is _____ perspective.
20. 'To achieve our vision, how should we appear to our customer"?, is_____ perspective.
21. "To achieve our vision, how will we sustain our ability to change and improve?" is _____ perspective.
22. "To satisfy our share holders and customers, what business processes must we excel at?" is _____perspective.
23. In addition to strategic Management process, two kinds of business processes may be identified, such as _____, _____.
24. _____Perspective includes employee training and corporate cultural attitudes related to both individual and corporate self improvement.
25. The BSC includes both _____ and _____ parameters.
26. BSC = _____ + _____ + _____.

Answers to Objective and Bit Questions:

15. Balance Score Card (BSC)
16. Strategy Deployment
17. Strategy, Action
18. Customer perspective, business process perspective, learning and growth perspective, financial perspective.
19. Financial perspective
20. Customer perspective
21. Learning and growth perspective
22. Internal Business perspective
23. Business oriented process, b) Support processes
24. Learning and growth perspective
25. Financial, Non-financial
26. Strategy + Operations + Change (S+O+C)

VARIANCE ANALYSIS AND STANDARD COSTING
PROBLEMS AND SOLUTIONS

Problem No.1.

S.V.Ltd. Manufacturers by mixing three raw materials. For every batch of 100Kg. of BXE, 125 Kg. of raw Materials are used. In April, 1988, 60 batches were prepared to produce an output of 5,600 Kg. of BXE. The standard and actual particulars for April, 1988 are as under:-

Raw material	Mix %	Price per kg	Mix %	Price per kg	Quantity of raw materials purchased kg
A	50	20	60	21	5,000
B	30	10	20	8	2,000
C	20	5	20	6	1,200

Calculate all variances.

Solution:

		Standard data			actual data		
		Q	P	V	Q	P	V
	A	3750	20	75000	4500	21	94500
	B	2250	10	22500	1500	8	12000
	C	1500	5	7500	1500	6	9000
		60x125=7500		105000	7500		115500
(-)standard loss		60x25=1500			1900		
		6000		105000	5600		115500

		(1)	(2)	(3)	(4)
		SQSP	RSQSP	AQSP	AQAP
	A	3500x20		4500x20	
	B	2100x10		1500x10	
	C	1400x5		1500x5	
	A	70000		90000	
	B	21000		15000	
	C	7000		75000	
	Total	Rs. 98000	Rs. 105000	Rs. 112500	Rs. 115500

SQ FOR A=5600/6000x3750, B=5600/6000x2250, C=5600/6000x1500

(1) SQSP = Standard Cost of Standard Material = Rs. 98,000
(2) RSQSP= Revised Standard Cost of Material = Rs. 1,05,000
(3) AQSP= Standard Cost of Actual Material = Rs. 1,12,500
(4) AQAP= Actual Cost of Material = Rs. 1,15,500

a   Material yield variance = 1-2 = Rs.7000(A)

     Material mix variance = 2-3 = Rs. 7500(A)

c   Material usage variance =1-3 = Rs. 14,500(A)

d   Material price variance = 3-4 = Rs. 3,000 (A)

e   Material cost variance= 1-4 = Rs.17500(A)

Problem No.2.

A brass foundry making castings which are transferred to the machine shop of the company at standards in regard to material stocks which are kept at standard price are as follows:-

       Standard Mixture 70% Copper : 30% Zinc

       Standard Price Copper Rs.2,400 per ton

       Zinc Rs. 650 per ton

       Standard loss in melting   5% of input

Figures in respect of a costing period are as follows:

Commencing stocks	Copper	100 tons	
	Zinc	60 tons	
Finishing stocks	Copper	110 tons	
	Zinc	50 tons	
Purchases	Copper	300 tons	Cost Rs.7,32,500
	Zinc	100 tons	Cost Rs.62,500
Metal melted	400 tons		
Casting produced	375 tons		

Present figures showing: Material Price, Mixture and yield Variance.

Solution:

	Copper		Zinc	
	Q	V	Q	V
Opening stock	100	240000	60	39000
(+)purchases	300	732500	100	62500
	400	972500	160	101500
(-)closing stock	110	264000	50	32500
	290	708500	110	69000

	Q	P	V	Q	P	V
Copper	280	2400	672000	290		708500
Zinc	120	650	78000	110		69020
	400		750000	400		777500
(-)standard loss @ 5%	20			25		
	380		750000	375		777500

	(1)	(2)	(3)	(4)
	SQSP	RSQSP	AQSP	AQAP
copper	276.315x2400		29x2400	
zinc	118.42x650		110x650	
copper	663157		696000	
zinc	76975		71500	
total	740132	750000	767500	777500

(1) SQSP = Standard Cost of Standard Material = Rs. 7,40,132
(2) RSQSP= Revised Standard Cost of Material = Rs. 7,50,000
(3) AQSP= Standard Cost of Actual Material = Rs. 7,67,500
(4) AQAP= Actual Cost of Material = Rs. 7,77,500
a) Material yield variance = 1-2 = Rs.9,868(A)
b) Material mix variance = 2-3 = Rs. 17,500(A)
c) Material usage variance =1-3 = Rs. 23,368(A)
d) Material price variance = 3-4 = Rs. 10,000 (A)
e) Material cost variance= 1-4 = Rs.37,368(A)

Problem No.3.

A company manufacturing a special type of fencing tile 12"X 8" X 1\2" used
a system of standard costing. The standard mix of the compound used for making the tiles is:

1,200 kg. of material A @ Rs.0.30 per kg.

500 kg. of Material B @ Rs.0.60 per kg.

800 kg. of Material C @ Rs.0.70 per kg.

The compound should produce 12,000 square feet of tiles of 1/2" thickness.   During a period in which 1,00,000 tiles of the standard size were produced, the material usage was:-

Kg			Rs
7,000	Material A @ Rs.0.32 per kg.		2,240
3,000	Material B @ Rs.0.65 per kg.		1,950
5,000	Material C @ Rs.0.75 per kg.		3,750
15,000			7,940

Present the cost figures for the period showing Material price, Mixture, Sub-usage Variance.

Solution:

Area of tile =12x8/12x12=2/3 sq ft

No of tiles that can be laid in 12000 sq ft is 12000/(2/3) = 18000

	Standard data			actual data		
	Q	P	V	Q	P	V
A	6666.67	0.3	2000	7000		2240
B	2777.77	0.6	16666.67	3000		1950
C	4444.44	0.7	3111.11	5000		3750
	13888.89		6778	15000		7940

Q for A =18000/100000x1200=6666.67

Q for B=18000/100000500=2777.77

Q for C=18000/100000x800=4444.44

	(1)	(2)	(3)	(4)
	SQSP	RSQSP	AQSP	AQAP
A		7200x0.3	7000x0.3	
B		3000x0.6	3000x0.6	
C		4800x0.7	5000x0.7	
A		2160	2100	
B		1800	1800	
C		3360	3500	
	Rs. 6778	Rs.7320	Rs.7400	Rs.7920

RSQ for A= (15000/13888.89) x 666667

(1) SQSP = Standard Cost of Standard Material = Rs. 6,778

(2) RSQSP= Revised Standard Cost of Material = Rs. 7,320

(3) AQSP= Standard Cost of Actual Material = Rs. 7,400

(4) AQAP= Actual Cost of Material = Rs. 7,920

a) Material sub usage variance= 1-2 = Rs. 542(A)

b) Material mix variance= 2-3 = Rs. 80(A)

c) Material usage variance= 1-3 = Rs. 622(A)

d) Material price variance = 3-4 = Rs. 540(A)

e) Material cost variance= 1-4 = Rs. 1162(A)

Problem No.4.

The Standard labour complement and the actual labour complement engaged in a week for a job are:

	Skilled Workers	Semi-Skilled Workers	Unskilled Workers
a) Standard No. of workers in the gang	32	12	6
b) Standard wage rate per hour Rs.	3	2	1
c) Actual No. of workers employed in the gang during the week	28	18	4
d) Actual wage rate per hour	Rs.4	Rs. 3	Rs. 2

During the 40 hour working week the gang produced 1,800 standard labour hours of work. CALCULATE:

1) Labour efficiency variance   2) Mix variance   3) Rate of wages variance 4) Labour cost variance

Solution:

	Standard data			Actual data		
	H	R	V	H	R	V
Skilled	1280	3	3840	1120	4	4480
semi skilled	480	2	960	720	3	2160
Unskilled	240	1	240	160	2	320
	2000		5040	2000		6960

	(1)	(2)	(3)	(4)
	SRSH	SRRSH	SRAH	ARAH
Skilled	3 x 1152		3 x 1120	
Semi skilled	2 x 432		2 x 720	
Unskilled	1 x 216		1 x 160	
	Rs. 4536	Rs. 5040	Rs. 4960	Rs. 6960

SH for skilled workers = (1800/2000) x 1280 = 1152

(1) SRSH = Standard cost of standard labour = Rs. 4536

(2) SRRSH= Revised standard cost of labour = Rs. 5040

(3) SRAH = Standard cost of actual labour = Rs. 4960

(4) ARAH =Actual cost labour = Rs. 6960

a   Labour sub efficiency variance = 1-2 = Rs. 504(A)

Labour mix variance = 2-3 = Rs. 80(F)

c   Labour efficiency variance = 1-3 = Rs. 424(A)

d   Labour rate variance = 3-4 = Rs. 200(A)

e   Labour cost variance = 1-4 = Rs. 2424(A)

Problem No.5.

Item	Budget	Actual
No.of working days	20	22
Output per man hour	1.0 Units	0.9 Units
Overhead cost	Rs.1,60,000	1,68,000
Man-hours per day	8,000	8,400

CALCULATE OVERHEAD VARIANCES.

Solution:

(1)	(2)	(3)	(4)	(5)
SRSH	SRAH	SRRBH	SRBH	ARAH
1 x 266320	1 x 184800	1 x 176000		
Rs. 166320	Rs. 184800	Rs. 176000	Rs. 160000	Rs. 168000

- SR = budgeted FOH/budgeted hours = 160000/160000 = 1
- RBH = (22/20) x 160000 = 176000
- AH = 22 x 8400 = 184800
- AQ = 184800 x 0.9 = 166320
- SH = 166320/1 = 166320

(1) SRSH = Standard Cost of Standard Fixed Overheads = Rs. 1,66,320

(2) SRAH = Standard Cost of Actual Fixed Overheads (or)

Fixed Overheads absorbed or recovered = Rs. 1,84,800

(3) SRRBH = Revised budgeted Fixed overheads = Rs. 1,76,000

(4) SRBH = Budgeted Fixed overheads = Rs. 1,60,000

(5) ARAH = Actual Fixed Overheads = Rs. 1,68,000

a) FOH efficiency variance = 1-2 = Rs. 18480(A)

b) FOH capacity variance = 2-3 = Rs. 8800(F)

c) FOH calendar variance = 3-4 = Rs. 16000(F)

d) FOH volume variance = 1-4 = Rs. 6320(F)

e) FOH budget variance = 4-5 = Rs. 8000(A)

f) FOH cost variance = 1-5 = Rs. 1680(A)

Problem No.6.

In a company operating on a standard costing system for a given four week period budgeted for sales of 10,000 units @ Rs.50 per unit, actual sales were 9,000 units at Rs.51.25 per unit.   Costs relating to that period were as follows:

	STANDARDS (Rs.)	ACTUALS (Rs.)
Materials	Rs.2,50,000	2,57,400
Wages	75,000	70,875
Fixed Overhead	20,000	18,810
Variable Overhead	10,000	9,250
Semi-variable overhead	2,700	2,430
Standard hours 50,000		
Actual hours 40,500		

1) The Standard material content of each unit is estimated at 25 kg. at Rs.1 per kg. actual figures were 26 kg. at Rs.1.10 per kg.

2) Semi-variable Overhead consists of FIVE - NINTHS fixed expenses and FOUR - NINTHS variable.

3) The Standard wages per unit are 5 hours at Rs.1.50 per Unit actual wages were 4.5 hours at Rs.1.75.

4) There were no opening stocks and the whole production for the period was sold.

5) The four week period was normal period.

YOU ARE REQUIRED:

a) To compute the variances in Sales, Materials, Labour and Over heads due to all possible causes; and

b) with the help of such a computation draw a statement reconciling the actual profit for the period with the standard profits.

Solution:

Working notes:

	Budget	Actual
	Rs.	Rs.
Fixed overhead	20000	18810
Share in semi variable OHs	1500	1350
	21500	20160
Variable OHs	10000	9250
Share in semi variable OHs(4/9)	1200	1080
	11200	10330

Variances:

⇒Sales

(1)	(2)	(3)
AQAP	AQSP	SQSP
51.25 x 9000	50 x 9000	50 x 10000
Rs. 461250	Rs. 450000	Rs. 500000

AQAP = actual value of sales = 461250
AQSP = actual sales at standard prices = 450000
SQSP = standard value of sales = 500000

a   Sales volume variance = (2) – (3) = 50000(A)
       Sales price variance = (1) – (2) = 11250(F)
c   Sales value variance = (1) – (3) = 38750(A)

⇒ Material

(1)	(2)	(3)
SQSP	AQSP	AQAP
1 x 225000	1 x 234000	1.1 x 234000
225000	234000	257400

AQ = 9000 x 26 = Rs. 234000

SQ = 9000 x 25 = Rs. 225000

1) SQSP= Standard cost of standard material = Rs. 225000
2) AQSP = Standard cost of actual material = Rs. 234000
3) AQAP = Actual cost of material = Rs. 257400

(a) Material usage variance = (1) – (2) = Rs. 9000(A)
(b) Material price variance = (2) – (3) = Rs. 23400(A)
(c) Material cost variance = (1) – (3) = Rs. 32400(A)

⇒ Labour

(1)	(2)	(3)
SRSH	SRAH	ARAH
1.5 x 45000	1.5 x 40500	1.75 x 40500
Rs. 67500	Rs. 60750	Rs. 70875

SH = 9000 x 5 = 45000

1) SRSH = standard cost of standard labour = Rs. 67500
2) SRAH = standard cost of actual labour = Rs. 60750
3) ARAH = actual cost of labour = Rs. 70875

(a) Labour efficiency variance = (1) – (2) = Rs. 6750(F)
(b) Labour rate variance = (2) – (3) = Rs. 10125(A)
(c) Labour cost variance = (1) – (3) = Rs. 3375(A)

⇒ Variable OHs

(1)	(2)	(3)
SRSH	SRAH	ARAH
0.224 x 45000	0.224 x 40500	10330
Rs. 10080	Rs. 9072	Rs. 10330

SR = 11200/50000 = Rs. 0.224
1) SRSH = standard cost of standard variable OHs = Rs. 10080
2) SRAH = standard cost of actual variable OHs = Rs. 9072
3) ARAH = actual cost of variable OHs = Rs. 10330
   (a) Variable OHs efficiency variance = (1) – (2) = Rs. 1008(F)
   (b) Variable OHs budget variance =(2) – (3) = Rs. 1258(A)
   (c) Variable OH cost variance = (1) - (3) = Rs. 250(A)

⇒Fixed OHs

(1)	(2)	(3)	(3)
SRSH	SRAH	SRBH	ARAH
0.43 x 45000	0.43 x 40500	0.43 x 50000	
Rs. 19350	Rs. 17415	Rs. 21500	Rs. 20160

SR = 21500/50000 = 0.43
1) SRSH = Standard cost of standard fixed OHs = Rs. 19350
2) SRAH = standard cost of actual fixed OHs = Rs. 17415
3) SRBH = budgeted fixed OHs = Rs. 20160
4) ARAH = actual fixed OHs = Rs. 20160
   (a) Fixed OHs efficiency variance = (1) – (2) = Rs. 1935(F)
   (b) Fixed OHs capacity variance = (2) –(3) = Rs. 4085(A)
   (c) Fixed OHs volume variance = (1) – (3) = Rs. 2150(A)
   (d) Fixed OHs budget variance = (3) – (4) = Rs. 1340(F)
   (e) Fixed OH cost variance = (1) – (4) = Rs. 810(A)

Statement showing reconciliation of actual & standard profits:

	Rs.	Rs.
Budgeted sales		500000
(+)sales price variance	11250	
(-) sales volume variance	(50000)	(38750)
Actual sales		461250
(-) standard cost of sales		
Material {250000 x (9/10)}	225000	
Wages {75000 x (9/10)}	67500	
Fixed OHs {21500 x(9/10)}	19350	
Variable OHs {11200 x (9/10)}	10080	321930
Standard profit		139320

Add favorable variances		
labour efficiency variance	6750	
Variable OH efficiency	1008	
Fixed OH efficiency	1935	
Fixed OH budget	1340	11033
		150353
Less adverse variances		
material usage variance	9000	
Material price variance	23400	
Labour rate variance	10125	
Variable OH budget	1258	
Fixed OH capacity variance	4085	47868
Actual profit		**102485**

Problem No.7.

One kilogram of product 'K' requires two chemicals A and B.The following were the details of product 'K' for the month of June,1987:

a) Standard mix Chemical 'A' 50% and Chemical 'B' 50%

b) Standard price per kilogram of Chemical 'A' Rs.12 and Chemical 'B' Rs.15

c) Actual input of Chemical 'B' 70 kilograms.

d) Actual price per kilogram of Chemical 'A' Rs.15

e) Standard normal loss 10% of total input.

f) Materials Cost variance total Rs.650 adverse.

g) Materials Yield variance total Rs.135 adverse.

You are required to calculate:

1. Materials mix variance total

2. Materials usage Variance total

3. Materials price variance total

4. Actual loss of actual input

5. Actual input of chemical 'A'

6. Actual price per kilogram of Chemical 'B'

Solution:

Let,   actual output of chemical A be a kgs

Actual price per Kg of chemical B be Rs b

Standard input be 100Kgs

Actual output be 90Kgs

	Standard			Actual		
	Q	P	V	Q	P	V
A	50	12	600	a	15	15a
B	50	15	750	70	b	70b
	100		1350	70 + a		15a + 70b
(-) normal loss	10	--	--	a − 20	--	--
	90		1350	90		15a + 70b

	(1)	(2)	(3)	(4)
	SQSP	RSQSP	AQSP	AQAP
A		12 x (70+a/100) x 50	12 x a	
B		15 x (70+a/100)/50	15 x 70	
	1350	945 + 13.5a	1050 + 12a	15a + 70b

Given material cost variance = (1) − (4) = Rs. -650

$$= 15a + 70b = Rs. 2000$$

Material yield variance = (1) − (2) = Rs. -135

$$\Rightarrow a = 40$$

$$\Rightarrow b = 20$$

1) SQSP = Rs. 1350
2) RSQSP = 945 + (13.5 x 40) = Rs. 1485
3) AQSP = 1050 + (12 x 40) = Rs. 1530
4) AQAP = (15 x 40) + (70 x 20) = Rs. 2000
   - (a) Material mix variance = Rs. 45(A)
   - (b) Material usage variance = Rs. 180(A)
   - (c) Material price variance = Rs. 470(A)
   - (d) Actual loss of actual input = Rs. 20
   - (e) Actual input of chemical A = 40Kgs
   - (f) Actual price per Kgs of chemical B = Rs. 20

Problem No.8.

Compute the missing data indicated by the Question marks from the following.

	Product 'R'	Product 'S'
Sales quantity		
Std.(units)	?	400
Actual (Units)	500	?
Price (Unit)		
Standard	Rs.12	Rs.15
Actual	Rs.15	Rs.20
Sales price variance	?	?
Sales volume variance	Rs. 1,200 F	?
Sales value variance	?	?

Sales mix variance for both the products together was Rs.450 F,'F' denotes Favourable.

Solution:

Let the standard units of product R be r

        Actual units of product S be s

	Standard			Actual		
	Q	P	V	Q	P	V
R	R	12	12r	500	15	7500
S	400	15	6000	s	20	20s
	400 + r		6000 + 12r	500 + s		7500 + 20s

Given sales volume variance for R = Rs. 1200(F)

        $\Rightarrow$ AQSP −SQSP = Rs. 1200

        r = Rs. 400

Sales mix variance = AQSP - RSQSP = Rs. 450(F)

	AQSP	RSQSP
R	12 x 500	12 x {(500+s)/(400+r)} x 400
S	15 x s	12 x {(500+s)/(400+r)} x 400
	6000 + 15s	6750 + 13.5s

Then s = 800

- Standard units of product R, r = Rs. 400
- Actual units of product S, s = Rs. 800
- Sales price variance for R = AQ(AP - SP) = Rs. 1500(F)

                            S = 4000(F)

- Sales volume variance for S = SP(AQ – SQ) = Rs. 6000(F)
- Sales value variance for R = AQAP – SQSP = Rs. 2700(F)

                          For S = Rs. 10000(F)

Problem No.9.

The assistant management accountant of your company has been preparing the profit and loss account for the week ended 31st October. Unfortunately, he has had a traffic accident and is now in a hospital, so as senior cost analyst you have been asked to complete this statement. The uncompleted statement and relevant data are shown below.

Week ended 31st October

	Rs.	Rs.
Sales		50,000
Standard Cost:		
Direct materials		
Direct wages		
Overhead	—	—
Standard profit		

Variances	Fav./(adv.)	Fav./(adv.)	
	Rs.	Rs.	
Direct materials: Price	(400)		
Usage	(300)		
Total:		(700)	
Direct Labour:			
Rate			
Efficiency			
Total		---	
Overhead expenditure			
Volume			
Total	___		
Total variance		—-	
Actual Profit		—-	

Standard Data

The standard price of direct material used is Rs.600 per tone. From each tone of material it is expected that 2,400 units will be produced. A forty hour week is operated. Standard labour rate per hour is Rs.4. There are 60 employees working as direct labour.

The standard performance is that each employee should produce one unit of product in 3 minutes. There are 4 working weeks in October. The budgeted fixed overhead for October is Rs.76,800.

Actual data

Materials used during the week were 20 tones at Rs.620 per tone. During the week 4 employees were paid of Rs.4.2 p.h and 6 were paid Rs.3.8 p.h and Remaining were paid at Standard Rate Overheads incurred was Rs. 18000.

You are required to complete the P & L Statement for the week ended 31st October

Solution:

Actual cost of material 620 x 20   Rs 12400/-

(-) direct material: price variance   400

         Usage variance   300   (700)

                             11700

For Rs 600/- production = 2400 units

For Rs 11700/- production = (2400/600) x 11700 = 46800 units

Labour variances

(1)	(2)	(3)
SRSH	SRAH	ARAH
4 X 2340	4 x (40 x 60)	[(4 x 4.20) + (6 x 3.80) + (50 x 4)] 40
Rs. 9360	Rs. 9600	Rs. 9584

Labour rate variance (2) – (3): 16(F)

Labour efficiency variance: (1) – (2): 240(A)

Overhead variances:

(1)	(2)	(3)	(4)
SRSH	SRAH	SRBH	ARAH
8 x 2340	8 x 2400		
Rs. 18720	Rs. 19200	Rs. 19200	Rs. 18000

OHs expenditure variance: (3) – (4): 1200(F)

OHs volume variance: (1) – (3): 480(A)

P&L statement for the week ended 31st October:

		Rs	Rs
Sales			50000
Standard cost			
direct material		11700	
direct wages		9360	
overheads		18720	39780
Standard profit			10220
Variances	F/(A)	F/(A)	
direct material: price			
usage	(400)		
total	(300)		
		(700)	
Direct labour:			
rate	16		
efficiency	(240)		
Total		(224)	
Overheads:			
Expenditure	1200		
Volume	(480)		
Total		720	
Total variance			(204)
Actual profit			**10016**

Problem No.10.

Standard Cost card of a product is as under:

Direct Materials: Rs.

A. 2Kg. @Rs.3 per kg.	6.00
B. 1Kg. @Rs.4 Per Kg.	4.00
Direct wages 5 Hours @ Rs.4 per hour	20.00
Variable overheads 5 hours @Rs.1 per hour	5.00
Fixed overheads 5 hours @Rs.2 per hour	10.00
Total:	45.00
Standard profit	5.00
Standard selling price	**50.00**

Budgeted out put are 8,000 units per month. In October 1989, the company produced 6,000 units.

The actual sales value was Rs.3,05,000. Direct material consumed was Material A 14,850Kg valued at Rs.43,065 and material B 7,260 kg valued at Rs.29750. The total direct labour hours worked was 32,000 and the wages paid there fore amounted to Rs.1,27,500. The direct labour hours actually booked on production was 31,800. Overheads recorded were: Fixed Rs.80,600 and variable Rs.30,000. Closing work in progress 600 units in respect of which materials A and B were fully issued and labour and overheads were 50%complete. Analyse the variance and present an operating statement showing the reconciliation between budgeted and actual profit for the month in the following format:

Operating Statement   Rs.

Budgeted Profit

Sales Margin Variances

                        Price

                        Volume

                        Total

Cost Variances

                        Direct Material

                        Price

                        Yield

                        Mix

Direct Wages

                        Rate

                        Efficiency

                        Idle time

Variable overheads

                        Expenses

                        Efficiency

Fixed Overheads

                        Expenses

                        Efficiency

                        Idle time

                        Capacity

Total cost variance

Actual Profit

Solution:

Sales margin or profit variances:

(1)	(2)	(3)
AQAR	AQSR	SQSR
6000 x (50.83 – 45)	6000 x 5	8000 x 5
Rs. 35000	Rs. 30000	Rs. 40000

  a)   Profit variance due to selling price = (1) – (2) = Rs. 5000(A)

  b)   Profit variance due to sales volume = (2) – (3) = Rs. 10000(A)

  c)   Profit value variance =   (1) – (3) = Rs. 5000(A)

Material variances:

	Standard			Actual		
	Q	P	V	Q	P	V
A	13200	3	39600	14850		43065
B	6600	4	26400	7260		29750
	19800		66000	22110		72815

		SQSP	RSQSP	AQSP	AQAP
A			14740 x 3	14850 x 3	
B			7370 x 4	7260 x 4	
		66000	73700	73590	72815
	(6000/6600) x	Rs. **60000**	Rs. **67000**	Rs. **66900**	Rs. **66195**

a) Material yield variance:(1) – (2) = Rs. 7000(A)
b) Material mix variance : (2) – (3) = Rs. 100(F)
c) Material price variance : (3) –(4) = Rs. 705(F)

Labour variances:

		(1)	(2)	(3)
		SRSH	SRAH	ARAH
		4 x 31500	4 x 32000	
		126000	128000	127500
	(6000/6300) x	Rs. 120000	Rs. 121905	Rs. 121429

a) Labour idle time variance : 200 x 4 = 800 (A)
b) Labour rate variance: (2) – (3) = 476(F)
c) Labour efficiency variance: 1905 – 800 = 1105 (A)

Variable overheads variances:

		(1)	(2)	(3)
		SRSH	SRAH	ARAH
		1 x 31500	1 x 31800	
		31500	31800	30000
	(6000/6300) x	Rs. 30000	Rs. 30286	Rs. 28571

a) VOH efficiency variance: (1) – (2) = Rs. 286 (A)
b) VOH budget variance : (2) – (3) = Rs. 1715(F)

Fixed overhead variance:

		(1)	(2)	(3)	(4)
		SRSH	SRAH	SRBH	ARAH
		2 x 31500	2 x 32000		
		63000	64000	80000	80600
	(6000/6300) x	Rs. 60000	Rs. 60952	Rs. 80000	Rs. 76762

a) FOH idle capacity variance:200 x 2 = Rs. 400(A)
b) FOH efficiency variance :952 – 400 = Rs. 552 (A)
c) FOH capacity variance = Rs. 19048 (A)
d) FOH budget variance: Rs. 3238(F)

Operating statement showing reconciliation of budgeted and actual profit:

	Rs.	Rs.
Budgeted profit		40000
Sales margin variance due to:		
Price	5000(F)	
Volume	10000(A)	(5000)
		35000
Cost variances		
Direct material variances:		
Price	705(F)	
Mix	100(F)	
Yield	7000(A)	(6195)
Direct wages variances:		
Rate	476(F)	
Efficiency	1105(A)	
Idle time	800(A)	(1429)
Variable OHs variances:		
Expenditure	1715(F)	
Efficiency	286(A)	1429
Fixed OHs variances:		
Efficiency	552(A)	
Expenditure	3238(F)	
Idle time	400(A)	
Capacity	19048(A)	(16762)
Actual profit		**12043**

Problem No.11.

The summarised results of a company for the two years ended 31st December 1988 and 1987 are given below: -

	1988	1987
	Rs.lacs	Rs.lacs
Sales	770	600
Direct Materials	324	300
Direct Wages	137	120
Variable Overheads	69	60
Fixed Overheads	150	80
Profit	90	40

As a result of re-organisation of production methods and extensive advertisement campaign use, the company was able to secure an increase in the selling prices by 10% during the year 1988 as compared to the previous year. In the year 1987,the company consumed 1,20,000 Kgs. of raw materials and used 24,00,000 hours of direct labour. In the year 1988, the corresponding figures were 1,35,000 kgs. of raw materials and 26,00,000 hours of direct labour.

You are required to: -

Use information given for the year 1987 as the base year information to analyse the results of the year 1988 and to show in a form suitable to the management the amount each factor has contributed by way of price, usage and volume to the change in profit in 1988.

Solution:

1) Sales price variance = 770 – {770 x (100/110)} = Rs. 70(F)
2) Sales volume variance = {770 x (100/110)} - 600 = Rs. 100(F)
   % increase in volume = (100/600) x 100 = Rs. 16.66667%
3) Sales Value variance = 770 – 600 = Rs. 170(F)
4) Material cost variance = 300 – 324 = Rs. 24 (F)
5) Material volume variance = 300 x (1/6) = Rs. 50(A)
   Material price = (30000000)/120000 = Rs 250/-
   Material expected to be used = (120000/600) x 700 = 140000 Kgs
6) Material usage variance = 5000 x 250 = Rs. 12.5 (F)
7) Material price variance = 50 – 24 – 12.5 = Rs. 13.5 (F)
8) Labour cost variance = Rs. 17 (A)
9) Labour volume variance = 120/6 = Rs. 20(A)
   Labour rate = (12000000)/(2400000) = Rs 5/-
   Labour hours expected to be used = (2400000/600) x 700 = 2800000
10) Labour efficiency variance = 2 x 5 = Rs. 10 (F)
11) Labour rate variance = 20 – 17 -10 = Rs. 7 (A)
12) VOH cost variance = Rs. 9(A)
13) VOH volume variance = 60/6 = Rs. 10(A)
14) VOH efficiency variance = 200000 x 2.5 = 5 Rs. (F)
15) VOH expenditure variance = 10 – 9 – 5 = Rs. 4(A)
16) FOH cost variance = Rs. 70(A)

Profit reconciliation statement:

		Rs in lakhs
Profit for 1987		40
(+)sales variance:		
Price	70	
Volume	100	
Material variance:		
Usage	12.50	
Price	13.50	
Labour variance-efficiency	10	
VOH efficiency variance	5	211
		251
(-) material volume variance	50	
Labour variance:		
Volume	20	
Rate	7	
VOH variances:		
Volume	10	
Expenditure	4	
FOH cost variance	70	161
Profit for 1988		90

Problem No.12.

A company using a detailed system of standard costing finds that the cost of investigation of variances is Rs.20,000. If After investigation an out of control situation is discovered, the cost of correction is Rs.30,000. If no investigation is made, the present value of extra cost involved is Rs.1,50,000. The probability of the process being in control is 0.82 and the probability of the process being out of control is 0.18. You are required to advise.

      (i)   Whether investigation of the variances should be undertaken or not;

      (ii)   The probability at which it is desirable to institute investigation into variances.

Solution:

i. Cost of investigation = 20000 + 0.18 x (30000) = 25400

    Cost of investigation is not conducted = 150000 x 0.18 = 27000

    Hence, it is worthwhile to undertake the investigation.

ii. Let X be the probability of process being in – control where it is desirable to institute investigation into variances.

- $20000 + 30000(1 - X) = 150000(1 - X)$
- $X = 83.33\%$

    Therefore, if the probability of the process being in – control is 83.33% of less it is better to investigate into variances, or else it is not necessary.

Problem No.13.

The following data have been obtained from the records of a machine shop for an average month:

	Budget
No.of working days	25
Working hours per day	8
No.of direct workers	16
Efficiency	One standard hour per clock hour
Down time	20%
Fixed	Rs.15,360
Variable	20,480

The actual data for the month of September 1985 are as under:

Overheads: Fixed	16,500
Variable	14,500
Net operator hours worked	1,920
Standard hours produced	2,112

There was a special holiday in September 1985. Required to present reports to Departmental Manager:

    (i)   Showing the three cost ratios you have chosen: ii) Setting out the analysis of variances.

Solution:

    (i)   Cost Ratios:

- Efficiency ratio = (SH/AH) x 100 = (2112/1920) x 100 = 110%
- Activity ratio = (SH/BH) x 100 = (2112/2560) x 100= 82.5%
- Capacity utilization ratio = (actual hours/budgeted hours) x 100

           = (1920/2560) x 100 = 75%

- Capacity usage ratio = (budgeted hours/maximum possible hours) x 100
  = (2560/3200) x 100 = 80%
- Idle capacity ratio = 100% - 80% = 20%
- Calendar ratio = (actual days/budgeted days) x 100
  = (24/25) x 100 = 96%

(ii) **Analysis of Variances**

Variable OHs:

(1)	(2)	(3)
SRSH	SRAH	ARAH
8 x 2112	8 x 1920	
Rs. 16896	Rs. 15360	Rs. 14500

- VOH efficiency variance = Rs. 1536(F)
- VOH budget variance = Rs. 860(F)
- VOH cost variance = Rs. 2396(F)

Fixed OHs:

(1)	(2)	(3)	(4)	(5)
SRSH	SRAH	SRRBH	SRBH	ARAH
6 x 2112	6 x 1920	6 x 2457.6		
Rs. 12672	Rs. 11520	Rs. 14746	Rs. 15360	Rs.16500

(1) SRSH = Standard Cost of Standard Fixed Overheads = Rs. 12,672

(2) SRAH = Standard Cost of Actual Fixed Overheads (or)
     Fixed Overheads absorbed or recovered = Rs. 11,520

(3) SRRBH = Revised budgeted Fixed overheads = Rs. 14,746

(4) SRBH = Budgeted Fixed overheads = Rs. 15,360

(5) ARAH = Actual Fixed Overheads = Rs. 16,500

   a) FOH efficiency variance = 1-2 = Rs. 1,152(F)
   b) FOH capacity variance = 2-3 = Rs. 3,226(A)
   c) FOH calendar variance = 3-4 = Rs. 614(A)
   d) FOH volume variance = 1-4 = Rs. 2,688(A)
   e) FOH budget variance = 4-5 = Rs. 1,140(A)
   f) FOH cost variance = 1-5 = Rs. 3,828(A)

Problem No.14.

The standard mix of product M5 is as follows: -

LES	MATERIAL	PRICE PER LB
50	A	5.00
20	B	4.00
30	C	10.00

The standard loss in production is 10% of input. There is no scrap value. Actual Production for a month was 7,240 1bs. of M5 from 80 mixes. Actual purchases and consumption of material during the month were:-

LES	MATERIAL	PRICE PER LB
4,160	A	5.50
1,680	B	3.75
2,560	C	9.50

Calculate variances.

Solution:

	Standard Data			Actual Data		
	Qty	Price	Value	Qty	Price	Value
A	4200	5	21000	4160	5050	22880
B	1680	4	6720	1680	3.42	6300
C	2520	10	25200	2560	9.50	24320
	8400		**52920**	**8400**		**53500**
Less: Loss @ 10%	840		-	1160		-
	7560		52920	7240	-	53500

	(1)	**(2)**	**(3)**	**(4)**
	SQSP	**RSQSP**	**AQSP**	**AQAP**
A	4022.22 X 5		4160 X 5	
B	1608.89 X 4		1680 X 4	
C	2413.33 X 10		2560 X 10	
A	20111		20800	
B	6436		6720	
C	24133		25600	
	Rs. 50680	Rs. 52920	Rs. 53120	Rs. 53500

SQ for

A = 4200/7560 x 7240

B = 1680/7560 x 7240

C = 2520/7560 x 7240

(1) SQSP = Standard Cost of Standard Material = Rs. 50,680

(2) RSQSP= Revised Standard Cost of Material = Rs. 52,920

(3) AQSP= Standard Cost of Actual Material = Rs. 53,120

(4) AQAP= Actual Cost of Material = Rs. 53,500

a) Mt yield variance (1-2) = Rs. 2240 (A)

b) Mt Mix variance (2-3) = Rs. 200 (A)

c) Mt Usage Variance (1-3) = Rs. 2440 (A)

d) Mt Price Variance (3-4) = Rs. 380 (A)

e) Mt Cost Variance (1-4) = Rs. 2820 (A)

Problem No.15.

Calculate variances from the following:

	STANDARD				ACTUAL		
INPUT	MATERIAL	RS./KG	TOTAL	INPUT	RS.KG	TOTAL	
400	A	@ 50	20,000	420	@ 45	18,900	
200	B	@20	4,000	240	@ 25	6,000	
100	C	@15	1,500	90	@15	1,350	
700			25,500	750		26,250	

	LABOUR HOURS			LABOUR HOURS		
	100 @ Rs. 2 Per hour	200		120 Hrs. @ Rs.2.50	300	
	200 Women @ Rs. 1.50	300	500	240 Women @ Rs. 1.60	384	684
25	Normal Loss			75 Actual Loss		
675			26,500	675		26,034

Solution:

Calculation of Material Variances:

	(1)	(2)	(3)	(4)
	SQSP	RSQSP	AQSP	AQAP
A		428.57 x 50	420 x 50	
B		214.29 x 20	240 x 20	
C		107.14 x 15	90 x 15	
A		21429		
B		4289		
C		1607		
	Rs. 25500	Rs. 27325	Rs. 27150	Rs. 26250

RSQ for

A = 400/700 x 750

B = 200/700 x 750

C = 100/700 x 750

    (1) SQSP = Standard Cost of Standard Material = Rs. 25,500

    (2) RSQSP= Revised Standard Cost of Material = Rs. 27,325

    (3) AQSP= Standard Cost of Actual Material = Rs. 27,150

    (4) AQAP= Actual Cost of Material = Rs. 26,250

    a) Material yield variance (1-2) = Rs. 1825 (A)

    b) Material mix variance (2-3) = Rs. 175 (A)

    c) Material usage Variance (1-3) = Rs. 1650 (A)

    d) Material price Variance (3-4) = Rs. 900 (A)

    e) Material cost Variance (1-4) = Rs. 750 (A)

Calculation of Labour Variances:

	(1)	(2)	(3)	(4)
	SRSH	**SRRSH**	**SRAH**	**ARAH**
Men		2 x 107.14	2 x 120	
Women		1.50 x 214.28	1.50 x 240	
Men		214.28	240	
Women		321.42	360	
	Rs. 500	Rs. 536	Rs. 600	Rs. 684

RSH for

Men = 100/700 x 750

Women = 200/700 x 750

(1) SRSH = Standard Cost of Standard Labour = Rs. 500

(2) SRRSH = Revised Standard Cost of Labour = Rs. 536

(3) SRAH = Standard Cost of Actual Labour = Rs. 600

(4) ARAH = Actual Cost of Labour = Rs. 684

a) Labour Yield Variance (1-2) = Rs. 36 (A)

b) Labour Mix variance (2-3) = Rs. 64 (A)

c) Labour efficiency Variance (1-3) = Rs. 100 (A)

d) Labour Rate Variance (3-4) = Rs. 84 (A)

e) Labour Cost Variance (1-4) = Rs. 184 (A)

Problem No.16.

The standard cost sheet per unit for the product produced by Modern Manufactures is worked out on this basis.

Direct materials 1.3 tons @ Rs.4 per ton

Direct labour 2.9 hours @ 2.3 per hour

Factory overhead 2.9 hours @ Rs.2 per hour

Normal capacity is 2,00,000 direct labour hours per month.

The factory overhead rate is arrived at on the basis of a fixed overhead of Rs.1,00,000 per month and a variable overhead of Rs.1.50 per direct labour hour.

In the month May,50,000 units of the product was started and completed. An investigation of the raw material inventory account reveals that 78,000 tons of raw material were transferred into and used by the factory during May. These goods cost Rs.4.20 per ton. 1,50,000 hours of direct labour were spent during May at cost of Rs.2.50 per hour. Factory overhead for the month amounted to Rs.3,40,000 of which 1,02,000 was fixed.

Compute and identify all variances under Material, Labour and Overhead as favourable or adverse. Also identify one or more departments in the Co. who might be held responsible for each variance.

Solution:

Calculation of Material Variance:

(1)	(2)	(3)
SQSP	AQSP	AQAP
65000 x 4	78000 x 4	78000 x 4.20
260000	312000	327600

SQ = 50000 x 1.3 = 65000 units

(1)   SQSP = Standard Cost of Standard Material = Rs. 2,60,000

(2)   AQSP = Standard Cost of Actual Material = Rs. 3,12,000

(3)   AQAP = Actual Cost of Material = Rs. 3,27,600

a)   Material usage variance (1-2) = Rs.52000 (A)

b)   Material Price Variance (2-3) = Rs.15600 (A)

c)   Material Cost Variance (1-3) = Rs.67600 (A)

Calculation of Labour Variances:

(1)	(2)	(3)
SRSH	SRAH	ARAH
2.3 X 145000	2.3 X 150000	2.50 X 150000
Rs.333500	Rs.345000	Rs.375000

SH = 50000 X 2.90 = 145000

50000 = Actual Production

(1)   SRSH = Standard Cost of Standard Labour = Rs. 3,33,500

(2)   SRAH = Standard Cost of Actual Labour = Rs. 3,45,000

(3)   ARAH = Actual Cost of Labour = Rs. 3,75,000

a)   Labour efficiency Variance (1-2) = Rs.11500 (A)

b)   Labour Rate Variance (2-3) = Rs.30000 (A)

c)   Labour Cost Variance (1-3) = Rs.41500 (A)

Calculation of Variable Overhead Variances:

(1)	(2)	(3)
SRSH	SRAH	ARAH
1.5 X 145000	1.5 X 150000	
Rs.217500	Rs.225000	Rs.238000 (340000-102000)

(1)   SRSH = Standard Cost of Standard Variable Overheads= Rs. 2,17,500

(2)   SRAH = Standard Cost of Actual Variable Overheads = Rs. 2,25,000

(3)   ARAH = Actual Cost of Variable Overheads = Rs. 2,38,000

a)   Variable Overhead efficiency Variance (1-2) = Rs.7500 (A)

b)   Variable Overhead Budget/exp. Variance (2-3) = Rs.13000 (A)

c)   Variable Overhead Cost Variance (1-3) = Rs.20500 (A)

Calculation of Fixed Overhead Variances:

(1)	(2)	(3)	(4)
SRSH	SRAH	SRBH	ARAH
0.5 X 145000	0.5 X 150000		
Rs.72500	Rs.75000	Rs.100000	Rs.102000

(1) SRSH = Standard Cost of Standard Fixed Overheads= Rs. 72,500
(2) SRAH = Standard Cost of Actual Fixed Overheads = Rs. 75,000
(3) SRBH = Budgeted Fixed Overheads = Rs. 1,00,000
(4) ARAH = Actual Cost of Fixed Overheads = Rs. 1,02,000

a) Fixed Overhead efficiency Variance (1-2) = Rs.2500 (A)
b) Fixed Overhead Capacity Variance (2-3) = Rs.25000 (A)
c) Fixed Overhead Volume Variance (1-3) = Rs.27500 (A)
d) Fixed Overhead Budget/Exp Variance (3-4) = Rs.2000 (A)
e) Fixed Overhead Cost Variance (1-4) = Rs.29500 (A)

Problem No.17.

Budgeted and actual sales for the month of December, 1989 of two products A and B of M/s. XY Ltd. were as follows:

PRODUCT	BUDGETED UNITS	SALES PRICE/UNIT	ACTUAL UNITS	SALES PRICE / UNIT (Rs.)
A	6,000	Rs.5	5,000	5.00
			1,500	4.75
B	10,000	Rs.2	7,500	2.00
			1,750	8.50

Budgeted costs for Products A and B were Rs.4.00 and Rs. 1.50 unit respectively. Work out from the above data the following variances.

Sales Volume Variance, Sales Value Variance, Sales Price Variance, Sales Sub Volume Variance, Sales Mix Variance

Solution:

		(1) AQAP	(2) AQSP	(3) RSQSP	(4) SQSP
A		5000 X 5.00	6500 X 5	5906.25 X 5	6000 X 5
		1500 X 4.75			
B		7500 X 2.00			
		1750 X 1.90	9250 X 2	9843.75 X 2	10000 X 2
A		25000	32500	29531.25	30000
		7125			
B		15000			
		3325	18500	19687.5	20000
		Rs.**50450**	Rs.**51000**	Rs.**49219**	Rs.**50000**

Revised Standard Quantity for

A = 6000/16000 x 15750 = 5906.25 units
B = 10000/16000 x 15750 = 9843.75 units

1) AQAP = Actual Sales = Rs.50,450
2) AQSP= Actual Quantity of Sales at Standard Price = Rs.51,000
3) RSQSP = Revised Budgeted or standard Sales = Rs.49,219
4) SQSP = Standard or Budgeted Sales = Rs.50,000
a) Sales Sub Volume or quantity variance = 3-4 = Rs.781 (A)
b) Sales Mix Variance = 2-3 = Rs.1781 (F)

c)   Sales Volume Variance = 2-4 = Rs.1000 (F)

d)   Sales Price Variance = 1-2 = Rs.550 (A)

e)   Sales Value Variance = 1-4 = Rs.450 (F)

Problem No.18.

	(Rs. In lakhs)	
	31-3-1988	31-3-1989
	Rs.	Rs.
Sales	120	129.6
Prime cost of sales	80	91.1
Variable Overheads	20	24.0
Fixed expenses	15	18.5
PROFIT	**5**	**(4.0)**

During 1988-89, average prices increased over these of the previous years

(1) 20% in case of sales   (2) 15% in case of prime cost   (3) 10% in case of Overheads.

Prepare a profit variance statement from the above data.

Solution:

Calculation of variances:

1)   Sales price Variance : 129.60 – (129.60 x 100/120) = Rs.21.60 (F)

2)   Sales Volume Variance : (129.60 x 100/120) = Rs. 12 (A)

3)   Sales Volume Variance : 129.60 –120 = Rs.9.60 (F)
      Decrease in volume = 120 – 12

                        100 - ?   = 10%

4)   Prime Cost price Variance : (91.10 x 100/115) – 91.10 = Rs.11.88 (A)

5)   Prime Cost Volume Variance = 80 x 10/100 = Rs.8 (F)

6)   Prime Cost Usage or efficiency Variance = (80 x 90/100) - (91.10 x 100/115)= Rs.7.22 (A)

7)   Prime Cost Variance : 80 – 90.1 = Rs.11.1 (A)

8)   Variable Overhead Price Variance = (24 x 100/110) - 24 = Rs.2.18 (A)

9)   Variable Overhead Volume Variance = 20 x 10/100 = Rs.2 (F)

10) Variable Overhead Efficiency Variance = (20 x 90/100) - (24 x 100/110) = Rs.3.82 (A)

11) Variable Overhead Cost Variance = 20-24 = Rs.4 (A)

12) Fixed Overhead Price Variance = (18.50 x 100/110) – 18.50 = Rs.1.68 (A)

13) Fixed Overhead Efficiency Variance = 15 - (18.50 x 100/110) = Rs.1.82 (A)

14) Fixed Overhead Cost Variance = 15 – 18.50 = Rs.3.5 (A)

Profit Variance Statement:

		Rs.
Budgeted Profit		5.00
Add: Sales Price Variance	21.60	
Prime Cost Variance	8.00	
Variable Overhead Variance	2.00	3100
		36.60
Less: Sales Volume Variance	12.00	

Price Cost Price Variance	11.88	
Price Cost usage Variance	7.22	
Variable Overhead Price Variance	2.18	
Variable Overhead Efficiency Variance	3.82	
Fixed Overhead Price Variance	1.68	
Fixed Overhead Efficiency Variance	1.82	40.60
Actual Loss		**4.00**

Problem No.19.

ABC Ltd; adopts a standard costing system. The standard output for a period is 20,000 units and the standard cost and profit per unit is as under:

	Rs.
Direct Material (3 units @ Rs.1.50)	4.50
Direct Labour (3 Hrs. @ Re.1.00)	3.00
Direct Expenses	0.50
Factory Overheads : Variable	0.25
Fixed	0.30
Administration Overheads	0.30
TOTAL COST	**8.85**
PROFIT	**1.15**
SELLING PRICE (FIXED BY GOVERNMENT)	**10.00**

The actual production and sales for a period was 14,400 units. There has been no price revision by the Government during the period.

The following are the variances worked out at the end of the period.

Direct Material		Favourable (Rs.)	Adverse(Rs.)
	Price		4,250
	Usage	1,050	
Direct labour			
	Rate		4,000
	Efficiency	3,200	
Factory Overheads			
	Variable – Expenditure	400	
	Fixed – Expenditure	400	
	Fixed – Volume		1,600
Administration Overheads			
	Expenditure		400
	Volume		1,600

You are required to:
a. Ascertain the details of actual costs and prepare a Profit and Loss Statement for the period showing the actual Profit/Loss. Show working clearly.
b. Reconcile the actual Profit with standard profit.

Solution:

a) **Statement Showing the actual profit and loss statement:**

Particulars	Amount	Amount
	Rs.	Rs.
Standard Material Cost (14400 x 4.50)	64800	
Add: Price Variance	4250	
Less: Usage Variance	(1050)	68000
Standard Labour Cost (14400 x 3)	43200	
Add: Rate Variance	4000	
Less: Efficiency Variance	(3200)	44000
Direct Expenses (14400 x 0.50)		7200
Factory Overhead:		
Variable (14400 x 0.25)	3600	
Less: Expenditure Variance	(400)	3200
Fixed (14400 x 0.30)	4320	
Add: Volume Variance	1680	
Less: Expenditure Variance	(400)	5600
Administration Overhead (14400 x 0.3)	4320	
Add: Volume Variance	1680	
Add: Exp. Variance	400	6400
Total Cost		134400
Profit (B/F)		9600
Sales		144000

b) **Statement showing reconciliation of standard profit with actual profit**

Particulars	Amount	Amount
	Rs.	Rs.
Standard Profit (14400 x 1.15)		16560
Add: Material usage variance	1050	
Labour efficiency Variance	3200	
Variable Overhead expenditure variance	400	
Fixed Overhead expenditure variance	400	5050
		21610
Less: Material price variance	4250	
Labour Rate Variance	4000	
Fixed Overhead volume variance	1680	
Administration Expenditure Variance	400	
Administration Volume Variance	1680	12010
Actual Profit		**9600**

Problem No.20.

You have been appointed as Management Accountant of S.M. Ltd. Given below is the Company's operating profit and loss Statement for the month of April, 1988.

	Standard and Variances Rs.	Actual Rs.
Budgeted Sales:	90,000	
Variances due to Volume of Orders	5,000	
Selling prices	2,000	97,000
Budgeted profit	19,000	
Profit Variance due to Sales Volume	1,200	
Selling price	2,000	22,200
Production cost Variances:		
Materials		
Price	750	
Usage	(300)	450
Labour		
Rate	(1,250)	
Efficiency	(500)	(1,750)
Overheads Expenditure: Fixed	500	
Variable	(1,250)	
Efficiency	1,000	
Capacity	500	750
Operating Profit		**21,650**

The costing department provides you with the following information about sales and cost for the month of May,1988,

Product	Standard Cost per unit Rs.	Budgeted Sales Number of Units	Budgeted Sales Value Rs	Actual Sales Number of Units	Actual Sales Value Rs
A	31	1,250	50,000	1,400	54,000
B	25	1,000	30,000	950	27,500
C	15	750	15,000	900	17,500

Materials:	Rs
Standard cost of materials actually used	26,150
Standard cost of materials allowed	26,650
Actual cost of materials used	27,150
Labour:	
Standard labour cost per hour	Re. 0.90
Actual clocked hours	22,000
Actual labour cost	Rs. 21,300
Budgeted hours	20,000
Standard hours produced	22,500

Overheads:

Budgeted rates of overheads recovery per direct labour hour:

Variable Re. 1.00 Fixed Re. 0.50

Actual Overhead Costs.

Variable Rs.21,500 Fixed Rs.12,000

Prepare an operating profit and loss statement for May, 1988 in the same form as for April,1988.

Solution:

	(1)	(2)	(3)
	AQAP	AQSP	SQSP
A	54000	56000	50000
B	27500	28500	30000
C	17500	18000	15000
	Rs.**99000**	Rs.**102500**	Rs.**95000**

(1) AQAP = Actual Sales = Rs. 99,000

(2) AQSP = Actual Quantity of Sales at standard prices = Rs.1,02,500

(3) SQSP = Standard or Budgeted Sales = Rs. 95,000

a) Sales volume Variance = 2 – 3 = Rs. 7500 (F)

b) Sales Price Variance = 1 – 2 = Rs. 3,500 (A)

Profit Variances:

	(1)	(2)	(3)
	AQAR	AQSR	SQSR
A	1440 X 7.5714	1400 X 9	1250 X 9
B	950 X 3.9473	950 X 5	1000 X 5
C	900 X 4.4444	900 X 5	750 X5
A	10600	12600	11250
B	3750	4750	5000
C	4000	4500	3750
	Rs.**17350**	Rs.**21850**	Rs.**20000**

SR= Standard Selling Price – Standard Cost per unit

AR = Actual Selling Price – Standard Cost per unit

SR: A= 9; B = 5; and C=5

AR:

A= (54000/1400) -31= Rs. 7.5714

B= (27500/950) -25= Rs.3.9473

B= (17500/900) -15= Rs.4.4444

1) AQAR = Actual Profit = Rs. 17.350

2) AQSR = Actual Sales at Standard Rate of Profit = Rs. 21,850

3) SQSR = Budgeted Profit = Rs. 20,000

a) Profit Variance Due to sales Volume = 2 – 3 = Rs. 1850 (F)

b) Profit Variance due to selling price = 1 – 2 = Rs.4500 (A)

Material Variance:

(1)	(2)	(3)
SQSP	AQSP	AQAP
26650	26150	27150

1) SQSP = Standard Cost of Standard Material = Rs. 26,650
2) AQSP = Standard Cost of Actual material = Rs. 26,150
3) AQAP = Actual Cost of Material = Rs. 27,150

a) Material usage Variance = 1-2 = Rs. 500 (F)
b) Material Price Variance = 2-3 = Rs. 1,000 (A)

Labour Variances:

(1)	(2)	(3)
SRSH	SRAH	ARAH
0.9 X 22500	0.9 X 22000	
20,250	19,800	21,300

1) SRSH = Standard Cost of Standard Labour = Rs. 20,250
2) SRAH = Standard Cost of Actual labour = Rs. 26,150
3) ARAH = Actual Cost of Labour = Rs. 21,300
a) Labour efficiency Variance = 1 – 2 = Rs. 450 (F)
b) Labour Rate Variance   = 2-3 = Rs. 1500 (A)

Variable Overhead Variances:

(1)	(2)	(3)
SRSH	SRAH	ARAH
1 x 22500	1 x 22000	
Rs.22500	Rs.22000	Rs.21500

SRSH = Standard Cost Standard Variable Overheads = Rs. 22,500
SRAH= Standard Cost of Actual Variable Overheads = Rs. 22,000
ARAH = Actual Variable Overheads = Rs. 21,500
a) Variable Overheads efficiency Variance = 1-2 = Rs. 500 (F)
b) Variable Overheads expenditure variance = 2-3 = Rs. 500 (A)

Fixed Overhead Variances:

(1)	(2)	(3)	(4)
SRSH	SRAH	SRBH	ARAH
0.5 X 22500	0.5 X 22000	0.5 X 20000	
Rs.11250	Rs.11000	Rs.10000	Rs.12000

1) SRSH = Standard Cost of Standard Fixed Overheads = Rs. 11,250
2) SRAH = Standard Cost of Actual Fixed Overheads = Rs. 11,000
3) SRBH = Budgeted Fixed Overheads = Rs. 10,000
4) ARAH = Actual Fixed Overheads = Rs. 12,000
a) Fixed Overheads efficiency Variance = 1-2 = Rs. 250 (F)
b) Fixed Overheads capacity variance = 2-3 = Rs. 1000 (F)
c) Fixed Overheads expenditure variance = 3-4 = Rs. 2000 (A)

Operating Profit and Loss Statement for the month of May, 2009:

	Standard Variances	Actual Variances
	Rs	Rs
Budgeted Sales	95000	
Variances due to Volume	7500	
Variances due to Selling prices	(3500)	99000
Budgeted Profit	20000	
Variance due to sales Volume	1850	
Variance due to Selling prices	(4500)	17350
Production Cost Variances:		
Material usage	500	
Material Price	(1500)	(1000)
Labour efficiency	450	
Labour Rate	(1500)	(1050)
Overheads:		
Expenditure: Variable	(500)	
Fixed	(2000)	
Efficiency	750	
Capacity	1000	(750)
Operating Profit		**14550**

Problem No.21.

The budgeted output of a single Product manufacturing company for 1984-85 was 5,000 units. The financial results in respect of the actual output of 4,800 unite achieved during the year were as under:-

	Rs
Direct Material	29,700
Direct wages	44,700
Variable Overheads	72,750
Fixed Overheads	39,000
Profit	36,600
Sales	2,22,750

The standard direct wage rate is Rs.4.50 per hour and the standard variable overhead rate is Rs.7.50 per hour.

The cost accounts recorded the following variances for the year.

Variances	Favourable (Rs)	Adverse (Rs)
Material Price	-	300
Material Usage	-	600
Wage Rate	750	-
Labour Efficiency	-	2,250
Variable Overhead Expense	3,000	-
Variable Overhead Efficiency	-	3,750
Fixed Overhead Efficiency	-	1,500
Selling Price	6,750	-

Required:

a)   Prepare a statement showing the original budget.

b)   Prepare the standard product cost sheet per unit.

c)   Prepare a statement showing the reconciliation of originally budgeted profit and the actual profit.

Solution:

Statement showing original budget and standard cost per unit:

Element	Actual (Rs.)	Variance (Rs.)	Standard Cost 4800 (Rs.)	Standard Cost Per unit (Rs.)	Original Budget 5000 units (Rs.)
Material	29700	300A	28800	6.00	30000
Direct Wags	44700	750	46200	9.00	45000
		2250A			
Value Overhead	75750	3000	72000	15.00	75000
		3750A			
Fixed Overhead	39000	1500A	37500	7.50	37500
	186150	3750F	181500	37.50	187500
Profit (b/f)	36600	8400A	34500	7.50	37500
		2100F			
Sales	222750	6750F	216000	45.00	225000

Statement showing reconciliation of budgeted profit with Actual profit

	(Rs.)
Budgeted Profit	37500
Add: All favourable variances	10500
	48000
Less All adverse variance	8400
	39600
Less: (5000-4800) 7.5 profit variances	1000
Less: (5000-4800) 7.5 profit variances	1500
Actual Profit	36600
(or)	
Standard Profit	34500
Add	10500
	45000
Less:	8400
Actual Profit	36600
Budgeted Profit	37500
Less: 8400 + 9000	17400
	20100
Add:	3750
Variable Cost	6000
Sales price variance	6750
	36600

Problem No.22.

You are appointed cost Accountant of Zed Ltd. Given below is the company's operating report for May 1988.

Standard and actual variance

	Rs.	Rs.
Sales-Budgeted	18,000	
Variances due to:		
Volume of orders	1,000	
Selling Price	400	19,400
Profit budgeted	3,800	
Variance due to:		
Sales volume	240	
Sales price	400	4,400
Production Cost Variances:		
Labour – Rate	(250)	
- Efficiency	(100)	
Material-Price	150	
-Usage	(60)	
Overhead Expenditure- Fixed	100	
- Variable	(250)	
- Efficiency	200	
- Capacity	100	
		150
Operating Profit		4,330

Your assistant provides the following information about sales and costs for June 1988:

Sales	Budgeted Units	Sales Value Rs.	Actual Units	Sales value Rs.
Product A	250	10,000	280	10,800
Product B	200	6,000	190	5,500
Product C	150	3,000	180	3,500
		19,000		19,800

Product	Standard Selling Price per unit	Standard Product Cost per unit
A	Rs.40	Rs.31
B	Rs.30	25
C	Rs.20	15

	Rs
Labour:	
Standard labour cost per hour	0.90
Budgeted hours	4,000
Actual clocked hours	4,400
Standard hours produced	4,500
Actual labour cost	4,260

Materials:	
Standard cost of material actually used	5,230
Standard cost of material allowed	5,330
Actual cost of material used	5,430
Overheads:	
Budgeted rates of overhead recovery per labour hour:	
Fixed	0.50
Variable	1.00
	1.50
Actual overhead costs: Fixed	2,000
Variable	4,300
	6,300

Required:

Prepare the operating Statement for June 1988 in the same form as May 1988.

Solution:

Sales Variances:

		(1)	(2)	(3)
		AQAP	AQSP	SQSP
A			280 X 40	
B			190 X 30	
C			180 X 20	
A			11200	
B			5700	
C			3600	
		Rs.19800	Rs.20500	Rs.19000

(1) AQAP = Actual Sales = Rs. 19,800

(2) AQSP = Actual Quantity of Sales at Standard Prices = Rs. 20,500

(3) SQSP = Standard or Budgeted Sales = Rs. 19,000

a) Sales volume variance 2-3 = 1500 (F)

b) Sales Price Variance 1-2 = 700 (A)

Profit / Sales Margin Variances:

		(1)	(2)	(3)
		AQAR	AQSR	SQSR
A		280 x 7.5714	280 x 9	250 x 9
B		190 x 3.9473	190 x 5	200 x 5
C		180 x 4.4444	180 x 5	150 x 5
A		2120	2520	2250
B		750	950	1000
C		800	900	750
		Rs.3670	Rs.4370	Rs.4000

(1) AQAR = Actual Profit = Rs. 3,670

(2) AQSR = Actual Sales at Standard rate of profit = Rs. 4,370

(3) SQSR = Standard or Budgeted Profit = Rs. 4,000

a) Sales margin / Profit variance due to volume (2-3) = Rs.370 (F)

b) Sales margin / Profit variance due to Selling Price (1-2) = Rs. 700 (A)

Material Variance:

	(1)	(2)	(3)
	SQSP	AQSP	AQAP
	Rs.5330	Rs.5230	Rs.5430

(1) SQSP = Standard Cost of Standard Material = Rs. 5,330
(2) AQSP = Standard Cost of Actual Material = Rs. 5,230
(3) AQAP = Actual Cost of Material = Rs. 5,430
a) Material usage variance 1-2 = Rs.100 (F)
b) Material Price variance 2-3 = Rs.200 (A)

Labour:

	(1)	(2)	(3)
	SRSH	SRAH	ARAH
	0.9 X 4500	0.9 X 4400	
	Rs.4050	Rs.3960	Rs.4260

(1) SRSH = Standard Cost of Standard Labour= Rs. 4,050
(2) SRAH = Standard Cost of Actual Labour = Rs. 3,960
(3) ARAH = Actual Cost of Labour = Rs. 4,260
a) Labour Efficiency Variance = 1-2 = Rs. 90 (F)
b) Labour Rate Variance = 2-3 = Rs. 300 (A)

Variable Overhead variances:

	(1)	(2)	(3)
	SRSH	SRAH	ARAH
	1 X 4500	1 X 4400	
	Rs.4500	Rs.4400	Rs.4300

(1) SRSH = Standard Cost of Standard Variable Overheads= Rs. 4,500
(2) SRAH = Standard Cost of Actual Variable Overheads = Rs. 4,400
(3) ARAH = Actual Cost of Variable Overheads = Rs. 4,300
   a) Variable Overhead Efficiency Variance (1-2) = Rs.100 (F)
   b) Variable Overhead Budgetary Variance (2-3) = Rs.100 (F)

Fixed Overhead Variance:

	(1)	(2)	(3)	(4)
	SRSH	SRAH	SRBH	ARAH
	0.5 X 4500	0.5 X 4400	0.5 X 4000	
	Rs.2250	Rs.2200	Rs.2000	Rs.2000

1) SRSH = Standard Cost of Standard Fixed Overheads = Rs. 2,250
2) SRAH = Standard Cost of Actual Fixed Overheads = Rs. 2,200
3) SRBH = Budgeted Fixed Overheads = Rs. 2,000
4) ARAH = Actual Fixed Overheads = Rs. 2,000

a) Fixed Overhead Efficiency Variance (1-2) = Rs.50 (F)
b) Fixed Overhead Capacity Variance (2-3) = Rs.200 (F)
c) Fixed Overhead Volume Variance (1-3) = Rs.250 (F)
d) Fixed Overhead Budget/Expenditure Variance (3-4) = Nil
e) Fixed Overhead Cost Variance (1-4) = Rs.250 (F)

Operating Statement for June 1988:

Budgeted Sales		19000	Rs.
Volume Variance	1500F		
Price Variance	700A	800	19800
Profit Budgeted		4000	
Profit Variances due to sales volume	370 F		
Profit Variances due to Sales price	700A	330A	3670
Production Cost Variance:			
Usage		100F	
Price		200A	(100)
Labour Variances:			
Rate		300A	
Efficiency		90F	(210)
Overhead Variances:			
Expenditure:			
Fixed		-	
Variable		100F	
Efficiency:			
Fixed		50F	
Variable		100F	
Capacity:			
Fixed		200F	450
Actual Operating Profit			**3810**

Problem No.23.

The profitability of a company for two years ended 31st March after eliminating the effects of inflation is as under:

	Years ended 31st March	
	1987	1988
	Rs. in lacs	Rs. in lacs
Sales	1,200	1,540
Direct Materials	600	648
Direct wages and variable overhead	360	412
Fixed overheads	160	300
Profit	80	180

Consequent upon the reorganisation of production methods and improvement in quality the company has been able to secure an increase in the selling prices by 10% during the year ended 31st March1988. The position of consumption of materials and utilisation of direct labour hours during the two years is as under:

	1987	1988
Direct Materials(Tones)	4,80,000	5,40,000
Direct Labour Hours	72,00,000	80,00,000

Required:
(i)   Keeping the year ended 31st March,1987 as the base year, analyse the result of the year ended 31st March, 1988 to show the amount which each factor has contributed to the change in the profit.
(ii)   Find the break-even sales for both the years.

(iii)   Calculate the percentage increase in selling price that would have been further necessary over the sales value for the year ended 31st March 1987 to earn a margin of safety of 40%

Solution:

Sales price variance = 1540 – (1540 x 100/110) = Rs.140 (F)

Sales Volume variance = (1540 x 100/110) – 1200 = Rs. 200 (F)

% increase in volume = 200/1200 x 100 = 16.67% or 1/6

Material cost variance = 648 – 600 = Rs.48 (A)

Material Volume variance = 600 x 1/6 = Rs.100 (A)

Standard Price = 60000000/480000 = Rs.125

The quantity of Material expected to be used = 1400/1200 x 480000 = 560000

1200 – 480000

1400 - ?

Material Usage variance = (560000 – 540000) 125 = Rs.2500000 (F)

Therefore , Material Cost Variance = Material Volume + Material Usage + Material Price Variance

-48 = -100 + 25 + Material Price

-48 + 100 – 25 = Material Price

Therefore Material Price = Rs.27 (F)

Wages and Variable Overhead Cost Variance = 360-412 = Rs.52 (A)

Wages and Variable Overhead Volume Variance = 360 x1/6 = Rs. 60 (A)

Standard Rate Or Rate in 1987 = 36000000/7200000 = Rs.5

Hours expected to be used in 1988 = 1400/1200 x 7200000 = 8400000

Wages or Variable Overhead efficiency variance = (8400000 – 8000000) 5 Rs.= 2000000 (F)

Wages or Variable Overhead Cost Variance = Volume + efficiency + labour Rate

-52 = -60 + 20 + labour Rate

-52 + 60 – 20 = labour Rate

12(a) = Labour Rate Variance

Fixed Overhead Cost Variance = 160-300 = Rs.140 (A)

Reconciliation of profit in 1987 with 1988:

Particulars	Amount	Amount
	Rs	Rs
Profit in 1987		80
Add: Sales price Variance	140	
Sales Volume Variance	200	
Material Usage Variance	25	
Material Price Variance	27	
Labour Efficiency Variance	20	412
		492
Less: Material Volume Variance	100	
Labour Overhead Volume Variance	60	
Labour Overhead Rate Variance	12	
Fixed Overhead Cost Variance	140	312
Actual Profit		180

b) Break-even Sales:

       1987 = 160 x 1200/240 = 800

       1988 = 300 x 1540/480 = 962.50

c) In order to maintain M/S of 40%, the Break-Even should be at 60%. Therefore, total sales required

60 – 962.50

100 - ?

= 100/60 x 962.50   Rs.= 1604.1666

                        Rs.= 1540.0000

                        Rs.=   64.1666

How:

1200 – 64.1666

100 - ?   = (5.35%)

6
QUALITY MANAGEMENT

1.   Write a note on the Total Quality Management (TQM).

Ans: Quality is considered a by-product of the manufacturing system i.e., each individual process has some variation that will lead to the production of some defective units. If the resulting defective rate is too high, compared to the established quality standards, quality inspectors will identify and send them for rework. The approach is expensive and does not guarantee the desired quality, because quality maintaining and ensuring itself cannot be inspected into a product. This approach assigns the responsibility for quality to quality control managers.

A more unlighted approach to quality emphasizes building quality into the product by studying and improving activities that affect quality, from marketing through design to manufacturing. This new approach is referred to as Total Quality Management (TQM). It is an active approach encompassing a company-wide operating philosophy and system for continuous improvement of quality. It demands cooperation from everyone in the company, from the top management down to workers.

The principles of TQM are as follows:
   a)   Customer Focus
   b)   Managerial Leadership
   c)   Belief in continuous improvement.

The current thinking of TQM is moving from Quality of product and service to Quality of people to embrace also Quality of environment. ISO 14000 standard supports this.

2.   Define the terms a) Quality Control b) Quality Assurance, and c) Quality Management. Define TQM. What are the core concepts of TQM?

Ans:
   1.   TQM seeks to increase customer satisfaction by finding the factors that limit current performance. The TQM approach highlights the need for a customer-oriented approach to management reporting, eliminating some or more of traditional reporting practices.
   2.   The emphasis of TQM is to design and build quality in the product, rather than allow defectives and then inspect and rectify them. The focus is on the causes rather than the symptoms of poor quality.
   3.   The three core concepts of TQM are –
      a)   Quality Control (QC): It is concerned with the past and deals with data obtained from previous production, which allow action to be taken to stop the production of defective units.
      b)   Quality Assurance (QA): It deals with the present and focuses to create and operate appropriate systems to prevent defects from occurring.
      c)   Quality Management (QM): It concerned with the future and manages people in a process of continuous improvement to the products and services offered by the firm.

3.   What are the various stages/steps to be taken in the implementation of TQM? How does TQM facilitate value addition in an organization?

Ans:

Stage	Description
1	Identification of customers/customer groups.
2	Identification of customer expectations

3	Identification of customer decision-making requirements and product utilities
4	Identification of perceived problems in decision making process and product utilities.
5	Comparison with other organizations and Benchmarking
6	Customer Feedback
7	Identification of improvement opportunities
8	Quality Improvement Process through – a) Determination of new strategies, b) Elimination of deficiencies, and c) Identifying solutions.

1. **Stage 1: Identification of customers / customer groups**: Through a team approach (a technique called Multi – Voting), the firm should identify major customer groups. This helps in generating priorities in the identification of customers and critical issues in the provision of decision – support information.

2. **Stage 2**: **Identifying customer expectations:** Once the major customer groups are identified, their expectations are listed. The question to be answered is – What does the customer expect from the Firm?

3. **Stage 3**: **Identifying customer decision-making requirements and product utilities:** By identifying the need to stay close to the customers and follow their suggestions, a decision – support system can be developed, incorporating both financial and non-financial information, which seeks to satisfy used requirements. Hence, the Firm finds out the answer to – What are the customer's decision-making requirements and product utilities? The answer is sought by listing out managerial perceptions and not by actual interaction with the customers.

4. **Stage 4**: **Identifying perceived problems in decision-making process and product utilities:** Using participative processes such as brainstorming and multi-voting, the firm seeks to list out its perception of problem areas and shortcomings in meeting customer requirements. This will list out areas of weakness where the greatest impact could be achieved through the implementation of improvements. The firm identifies the answer to the question – What problem areas do we perceive in the decision-making process?

5. **Stage 5**: **Comparison with other Firms and benchmarking:** Detailed and systematic internal deliberations allow the Firm to develop a clear idea of their own strengths and weaknesses and of the areas of most significant deficiency. Benchmarking exercise allows the Firm to see how other Companies are coping with similar problems and opportunities.

6. **Stage 6**: **Customer Feedback:** Stages 1 to 5 provide a information base developed without reference to the customer. This is rectified at Stage 6 with a survey of representative customers, which embraces their views on perceived problem areas. Interaction with the customers and obtaining their views helps the Firm in correcting its own perceptions and refining its process.

7. **Stage 7 & 8**: **Identification of improvement opportunities and implementation of Quality Improvement Process:** The outcomes of the customer survey, benchmarking and internal analysis, provides the inputs for stages 7 and 8. i.e., the identification of improvement opportunities and the implementation of a formal improvement process. This is done through a six-step process called PRAISE, for short.

4. What are the Various Quality Tools?
Ans:

Control Charts

Control charts as a means of maintaining a process in statistical control were pioneered by Dr. W.A. Shewhart, an engineer in the Bell Telephone Laboratories, USA with a view to eliminate abnormal variations in process output by distinguishing variations due to special causes from those due to common causes.

Understanding variation is at the heart of much quality work. If you can control variation then you can deliver consistent products and services. If you can reduce variation, then you can deliver higher quality and hence sell more, at higher prices.

There are two types of measurement which you can measure and plot on a Control Chart.

- Variables answer the question 'how much?' and are measured in quantitative units, for example weight, voltage or time.

- Attributes answer the question 'how many?' and are measured as a count, for example the number of defects in a batch of products

The Histogram is a common tool used for showing the distribution of a set of measures and often appears in a bell-shaped 'Normal' or 'Gaussian' graph, where the majority of measures are clustered around the centre. What the Histogram does *not* show, however, is the way in which those measurements changed over *time*.

5. Discuss the 6's Sigma Methodologies in brief?

Ans: Six Sigma has two key methodologies: DMAIC and DMADV, both inspired by W. Edwards Deming's Plan-Do-Check-Act Cycle: DMAIC is used to improve an existing business process, and DMADV is used to create new product or process designs for predictable, defect-free performance.

DMAIC

- ❖ Basic methodology consists of the following five (5) steps:
- ❖ *Define* the process improvement goals that are consistent with customer demands and enterprise strategy.
- ❖ *Measure* the current process and collect relevant data for future comparison.
- ❖ *Analyze* to verify relationship and causality of factors. Determine what the relationship is, and attempt to ensure that all factors have been considered.
- ❖ *Improve* or optimize the process based upon the analysis using techniques like Design of Experiments.
- ❖ *Control* to ensure that any variances are corrected before they result in defects. Set up pilot runs to establish process capability, transition to production and thereafter continuously measure the process and institute control mechanisms.

DMIADV

- ❖ Basic methodology consists of the following five steps:
- ❖ *Define* the goals of the design activity that are consistent with customer demands and enterprise strategy.
- ❖ *Measure* and identify CTQs (critical to qualities), product capabilities, production process capability, and risk assessments.
- ❖ *Analyze* to develop and design alternatives, create high-level design and evaluate design capability to select the best design.
- ❖ *Design* details, optimize the design, and plan for design verification. This phase may require simulations.
- ❖ *Verify* the design, set up pilot runs, implement production process and handover to process owners.

Some people have used DMAIC**R** (Realize). Others contend that focusing on the financial gains realized through Six Sigma is counter-productive and that said financial gains are simply byproducts of a good process improvement.

6. **What are the key roles required for successful implementation of Six Sigma?**

Ans: Six Sigma identifies several key roles for its successful implementation:

a) *Executive Leadership* includes CEO and other key top management team members. They are responsible for setting up a vision for Six Sigma implementation. They also empower the other role holders with the freedom and resources to explore new ideas for breakthrough improvements.

b) *Champions* are responsible for the Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from the upper management. Champions also act as mentors to Black Belts. At GE this level of certification is now called "Quality Leader".

c) *Master Black Belts*, identified by champions, act as in-house expert coaches for the organization on Six Sigma. They devote 100% of their time to Six Sigma. They assist champions and guide Black Belts and Green Belts. Apart from the usual rigour of statistics, their time is spent on ensuring integrated deployment of Six Sigma across various functions and departments.

d) *Experts* this level of skill is used primarily within Aerospace and Defense Business Sectors. Experts work across company boundaries, improving services, processes, and products for their suppliers, their entire campuses, and for their customers. Raytheon Incorporated was one of the first companies to introduce Experts to their organizations. At Raytheon, Experts work not only across multiple sites, but across business divisions, incorporating lessons learned throughout the company.

e) *Black Belts* operate under Master Black Belts to apply Six Sigma methodology to specific projects. They devote 100% of their time to Six Sigma. They primarily focus on Six Sigma project execution, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma.

f) *Green Belts* are the employees who take up Six Sigma implementation along with their other job responsibilities. They operate under the guidance of Black Belts and support them in achieving the overall results.

g) *Yellow Belts* are employees who have been trained in Six Sigma techniques as part of a corporate-wide initiative, but have not completed a Six Sigma project and are not expected to actively engage in quality improvement activities.

7. **Write a short note on Six Sigma process in Quality Control Process.**

Ans: **Six Sigma** is a set of practices originally developed by Motorola to systematically improve processes by eliminating defects. A defect is defined as non-conformity of a product or service to its specifications.

While the particulars of the methodology were originally formulated by Bill Smith at Motorola in 1986, Six Sigma was heavily inspired by six preceding decades of quality improvement methodologies such as quality control, TQM, and Zero Defects. Like its predecessors, Six Sigma asserts the following:

a) Continuous efforts to reduce variation in process outputs is key to business success

b) Manufacturing and business processes can be measured, analyzed, improved and controlled

c) Succeeding at achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management.

The term "Six Sigma" refers to the ability of highly capable processes to produce output within specification. In particular, processes that operate with six sigma quality produce at defect levels below 3.4 defects per (one) million opportunities (DPMO). Six Sigma's implicit goal is to improve all processes to that level of quality or better.

8.   Write a short notes on 5 S's concept in Quality Management.

Ans: <u>Five S – Concept:</u>

The Five S's are:

SEIRI   - Organization or re-organization.

SEITON   - Neatness

SEISO   - Cleaning

SEIKETSU   - Standardization

SHITSUKE   - Discipline

1.   **<u>SEIRI:</u>**

The literal meaning of the Japanese word `SEIRI' is to `straighten and contain'. It can be understood as discard unnecessary things i.e., get rid of waste and put things in such a way as to have quick access. This is how `straighten and contain' can be interpreted.

2.   **<u>SEITON:</u>**

While `SEIRI' helps us to decide what are the items needed, `SEITON' helps to decide the way things are to be placed so that our working is smooth. `SEITON' involves safety and productivity.

3.   **<u>SEISO:</u>**

The literal meaning of the word `SEISO' is clean up. It means take up the job of cleaning. Such cleaning is not restricted merely to the machines, table, kitchen cabinet etc., i.e., whichever we have taken up. It should be extended to the entire surroundings.

4.   **<u>SEIKETSU:</u>**

Seiri, Seiton and Seiso are easy to do once, but it is very difficult to maintain. To maintain, we have to standardize the system. Seiketsu is nothing but standardization. In five, 'S' means ensuring whatever cleanliness and orderliness have been achieved through Seiri, Seiton and Seiso, they are maintained. We should keep a strict control over the situation.

5.   **<u>SHITSUKE:</u>**

Shitsuke means discipline. Discipline is following a system, which calls for changing from our present unsystematic way of adherence to set procedures. Systems function in an orderly manner.

9.   What are the different types of Quality Costs? Briefly discuss the same.

Ans: <u>Different types of Quality Costs:</u>

Quality costs can be analyzed under two major categories.

a)   Costs of quality assurance incurred by the manufacturer.

b)   Costs of quality assurance at the user's end which are called "user quality costs".

<u>Internal Quality Costs</u>

There is a measure of all costs directly associated with the achievement of complete conformance to product quality requirements. These are not just the cost of quality management or inspection function. Specifically quality costs are the sum total of

a)   Prevention Costs - (Quality Engineering, Quality planning).

b)   Appraisal Costs - Cost of appraising product for conformance to requirements.

c)   Failure Costs - Costs incurred by failure to conform to requirements.

<u>User Quality Costs:</u>

In this approach an attempt is made to determine the costs incurred by the user when the purchased materials or equipment has problems. Such non – quality costs can be broadly grouped under seven categories as given below:

Category of user Quality Cost	Example	Categories of User Quality Costs
Cost of repairs	1A	Parts and material for failed items and any associated items which also must be replaced.
	1 B	Labour for replacing the failed items and Sociated items.
Cost of effectiveness loss	2 A	Idle direct labour before and during a shutdown and during startup of a process
	2 B	Extra defective product made before, during the immediately after process shutdown.
Cost of maintaining extra capacity because	3 A	Equipment parts and materials
of expected failure	3 B	Direct and indirect labour
Cost of damages	4 A	Injuries to personnel
caused by a failed item	4 B	Training new personnel when a replacement is required.
Lost income	5 A	Profit on production lost during downtime of failed item

10. What is a Quality Circle? What are the attributes of Quality Circle Concept?

Ans: **Quality Circle:**

Quality Circle is a small group of 6 to 12 employees doing similar work who voluntarily meet together on a regular basis to identify improvements in their respective work areas using proven techniques for analysing and solving work related problems coming in the way of achieving and sustaining excellence leading to mutual upliftment of employees as well as the organisation. It is "a way of capturing the creative and innovative power that lies within the work force".

Attributes of Quality Circle Concept:

The concept of Quality Circle is primarily based upon recognition of the value of the worker as a human being, as someone who willingly activates on his job, his wisdom, intelligence, experience, attitude and feelings. It is based upon the human resource management considered as one of the key factors in the improvement of product quality & productivity. Quality Circle concept has three major attributes:

a. Quality Circle is a form of participation management.
b. Quality Circle is a human resource development technique.
c. Quality Circle is a problem solving technique.

11. What are the objectives of Quality Circles?

Ans: <u>Objectives of Quality Circles:</u>

The objectives of Quality Circles are multi-faced.

a) **Change in Attitude.**

From "I don't care" to "I do care"

Continuous improvement in quality of work life through humanisation of work.

b) **Self Development**

Bring out 'Hidden Potential' of people

People get to learn additional skills.

c) **Development of Team Spirit**

Individual Vs Team – "I could not do but we did it"

Eliminate inter departmental conflicts.

d) **Improved Organisational Culture**

Positive working environment.

Total involvement of people at all levels.

Higher motivational level.

Participate Management process.

12. Write short note on "Zero Defects" and "Rights First Time" – Philip Crosby.

Ans: Philip Crosby prompted the phrases, "Zero Defects" does not mean mistakes never happen, rather than there is no allowable number of errors built into a product or process and that it is to be got right first time. He believes that management should take prime responsibility for quality and worker only follow their managers example.

His four absolute quality management:

a) Quality is conformance to requirements

b) Quality prevention is preferable to quality inspection

c) Zero defects is quality performance standard.

d) Quality is measured in monetary terms – the price of non- conformance.

Steps to quality improvement:

a) Committed to quality.

b) Creation of quality improvement teams representing all the departments.

c) Measure processes to determine current and potential quality issues.

d) Calculate cost of (poor) quality.

e) Raise quality awareness of all employees.

f) Take action to correct quality issues.

g) Monitor progress of quality improvement.

h) Train supervisions in quality improvement.

i) Hold "Zero Defects" days.

j) Encourage employees to create their own quality improvement goals.

k) Encourage employee communication with management about obstacles quality.

l) Recognize participants' effort.

m) Create quality councils.

n) Do it all over again – quality improvements does not end.

13. List out quality improvement steps conceptualized by Philip Crosby.

Ans: The following are the ten steps of Quality improvement, as per Philip Crosby:

a)   Management is committed to quality and this is clear to all.

b)   Create quality improvement teams, with representatives from all departments.

c)   Measure processes to determine current & potential quality issues.

d)   Calculate the cost of poor quality.

e)   Raise quality awareness of all employees.

f)   Take action to correct quality issues.

g)   Monitor progress of quality improvement-Establish a zero-defect committee.

h)   Train supervisors in Quality improvement.

i)   Encourage employees to create their own quality improvement goals.

j)   Recognize participants' efforts.

14. Write a note on Shewhart Cycle.

Ans: Shewhart Cycle or PDCA or Deming Cycle or Deming wheel or PDSA is explained as follows**:**
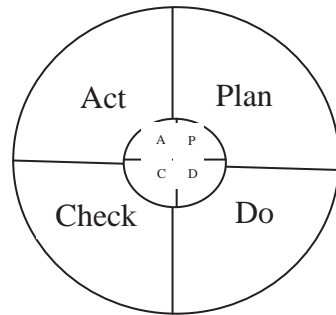
PLAN:

Establish the objectives and processes necessary to deliver results in accordance, with the specifications.

DO:

Implement the processes.

CHECK: Monitor and evaluate the processes and results as agent objectives and specifications and report the out come.

ACT:

Apply actions to the outcome for necessary improvement. That means reviewing all steps (plan, Do, Check, Act) and modifying the process to improve it before its next implementation.

Objective and Bit Questions:

15.   Joseph Juran is an internationally acclaimed _____ , strongly influencing Japanese manufacturing Practices.

16.   The quality Trigology: _____ , _____, _____.

17.   Kaoru Ishikawa led the concept and use of _____.

18.   Total quality control movement with focus on statistical quality control techniques such as _____ and _____.

19.   Philip Crosby is an American who promoted the phrases _____ and _____, to quality management.

20.   Control Chart's as a means of maintaining process in _____.

21.   The control chart's first trick is to add horizontal lines called _____.

22.   PDCA (Plan – Do- Check – Act) is an interactive four-step problem – solving process typically used in _____.

23.   PDCA also known as, ____, _____, _____ or _____

24.   PDCA was made popular by _____.

25.   The concept of PDCA comes out of the _____ method.

26.   In _____ programs, the PDSA cycle is called DMAIC (Define, Measure, Analyze, Improve, Control).

27.   Shewhart intended that experiments and _____ should be planned to deliver results in accordance with the specifications.

28.   _____ was not intended to cover aspects suchas creativity, innovation, invention.

29.   _____ is a people building philosophy, providing self motivation and happiness in improving environment without any compulsion or moneotry benefits.

30.   Kaizen is a Japanese term comprising KAI =_____ ZEN = _____.

31.   _____ is a Japanese strategy for continuous improvement.

32.   _____ is a set of practices originally developed by Motorola to systematically improve processes by eliminating defects.

33.   _____ was heavily inspired by six preceding decades of quality improvement methodologies such as quality control, TQM   and zero defects.

34.   _____ is used to improve an existing business process and DMADV is used to create new product or process designs for predictable, defeat free performance.

35.   In DMAIC, Analyze to verify relationship and _____.

36.   In DMAIC, Improve or optimize the process based upon the analysis using techniques like_____

37.   EFQM a _____ membership foundation.

Answer to Objective and Bit Questions:

15.   Quality guru

16.   Quality planning, quality control, Quality Improvement

17.   Quality circle

18.   Control charts and pare to charts,

19.   Right First Time, Zero defects

20.   Statistical Control

21.   Control Limits

22.   Quality Control

23.   Deming Cycle, Shewhart cycle, Deming wheel or plan – Do Study – Act

24.   Dr. W.E. Deming

25.   Scientific

26.   Six sigma

27.   Quality Control

28.   Planning (In PDCA)

29.   Quality Circle

30.   Change, better

31.   KAIZEN

32.   Six Sigma

33.   Six Sigma

34.   DMAIC

35.   Causality

36.   Design of Experiments

37.   Non profit.

PROBLEMS AND SOLUTIONS

Problem No.1.

Draw the control charts for $\bar{X}$ (mean) and R (Range) from the following data relating to 20 samples, each of size 5. Only the control line and the upper and lower control limits may be drawn in each chart.

Sample No.	$\bar{X}$	R	Sample No.	$\bar{X}$	R
1	38.2	15	11	32.6	31
2	33.8	1	12	22.8	12
3	24.4	22	13	21.6	29
4	36.6	24	14	28.8	22
5	27.4	18	15	28.8	16
6	30.6	33	16	24.4	19
7	31.2	21	17	30.4	20
8	27.0	29	18	25.4	34
9	24.0	29	19	37.8	19
10	29.4	18	20	31.4	17

(For sample of size 5-d_2 = 2.326, d_3 = 0.864)

Solution:

Given sample size   n = 5

No. of samples   k = 20

Sample No.	$\bar{X}$	R
1	38.2	15
2	33.8	1
3	24.4	22
4	36.6	24
5	27.4	18
6	30.6	33
7	31.2	21
8	27.0	29
9	24.0	29
10	29.4	18
11	32.6	31
12	22.8	12
13	21.6	29
14	28.8	22
15	28.8	16
16	24.4	19
17	30.4	20
18	25.4	34
19	37.8	19
20	31.4	17
Total	**586.6**	**429**

Therefore, $\overline{\overline{X}}$ = 586.6 / 20 = 29.33

$\overline{R}$ = 429/20 = 21.45

Control Limits for $\overline{\overline{X}}$ – Chart

Central Line (C.L) = $\overline{\overline{X}}$

= 29.33

Lower Control Limit (L.C.L) = $\overline{\overline{X}} - A_2 \overline{R}$

Where $A_2 = \dfrac{3}{d_2\sqrt{n}}$ = $\dfrac{3}{2.326\sqrt{5}}$

= $\dfrac{3}{2.326 \; x \; 2.2361}$

= $\dfrac{3}{5.2012}$

= 0.5768

Therefore L.C.L = 29.33 – 0.5768 (21.45)

= 29.33 – 12.3724

= 16.9576

Upper Control Limit U.C.L = $\overline{\overline{X}} + A_2 \overline{R}$

= 29.33 + 0.5768 (21.45)

= 29.33 + 12.3724

= 41.7024

Control Chart for mean ($\bar{x}$)
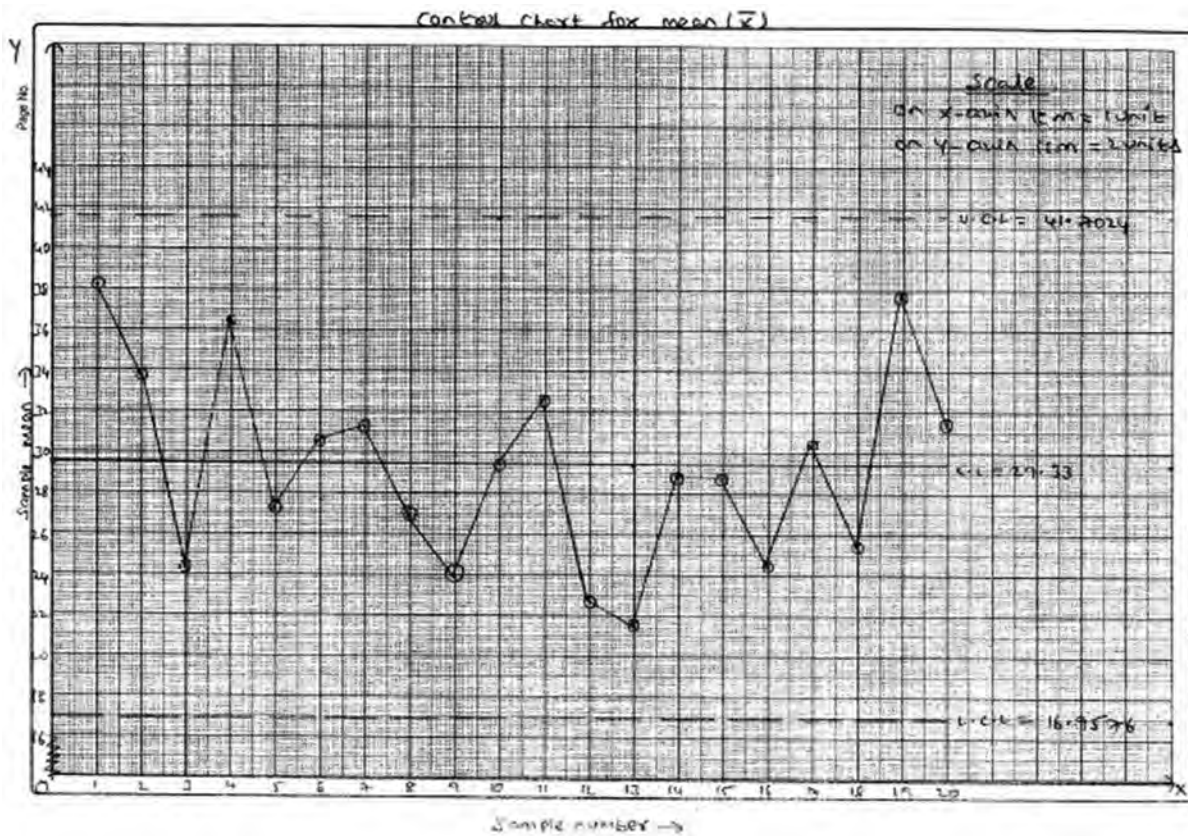
Control Limits for R-Chart:

Central Line (C.L) = $\bar{R}$

$$= 21.45$$

Lower Control Limit (L.C.L) = $D_3 \bar{R}$

$$\text{Where } D_3 = 1 - \frac{3d_3}{d_2}$$

$$= 1 - \frac{3\,(0.864)}{2.326}$$

$$= 1 - \frac{2.592}{2.326}$$

$$= 1 - 1.1143$$

$$= -0.1143$$

$$\cong 0 \text{ Since negative.}$$

Therefore L.C.L = 0 x 21.45 = 0

Upper Control Limit (U.C.L) = $D_4 \bar{R}$

Where $D_4 = 1 + \frac{3d_3}{d_2}$

$$= 1 + \frac{3(0.864)}{2.326}$$

$$= 1 + \frac{2.592}{2.326}$$

$$= 1 + 1.1143$$

$$= 2.1143$$

Therefore U.C.L $= 2.1143 (21.45) = 45.3517$
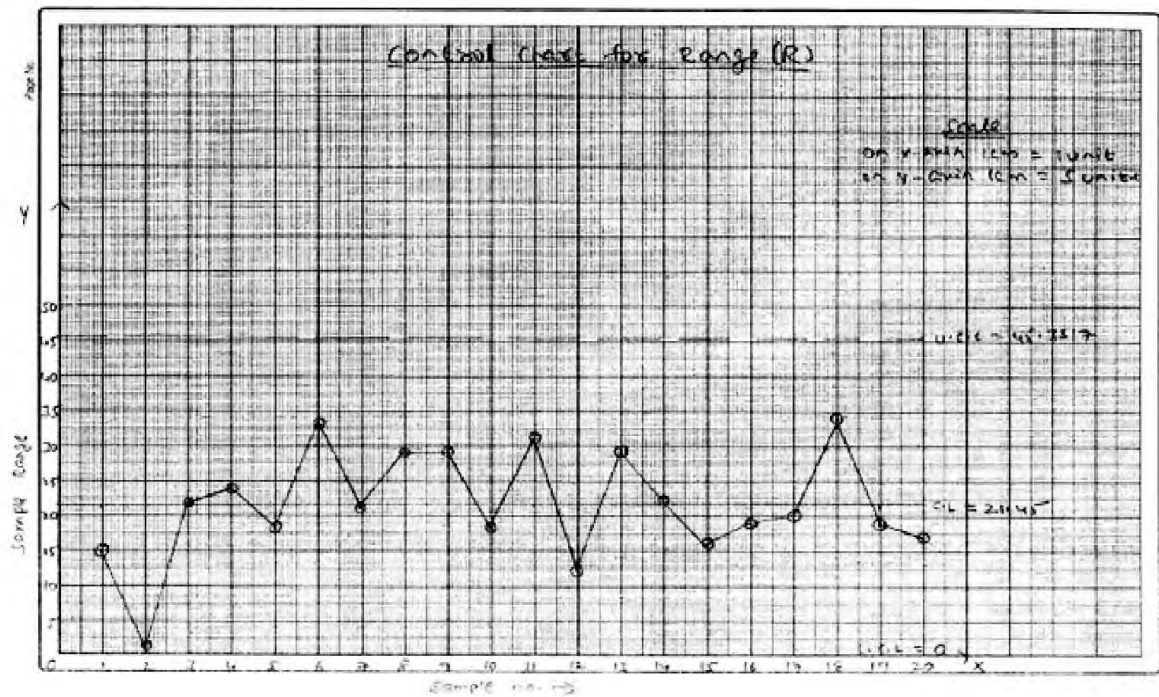
From the graph we observe that all the plotted points lies within the 3σ control limits. Hence the production process is in the state of statistical quality control.

Problem No.2.

The following table gives the average daily production figure for 20 months each of 25 working days. Given that the population standard deviation of daily production is 35 units, draw a control chart for the mean.

210	205	210	212	211	209	219	204	212	209
212	215	208	214	210	204	211	211	203	211

Solution:

Given σ = 35

Sample size n = 25

No. of samples k = 20

Sample No.	Sample Mean
1	210
2	205
3	210
4	212
5	211
6	209
7	219
8	204
9	212
10	209
11	212
12	215
13	208
14	214
15	210
16	204
17	211
18	211
19	203
20	211
Total	4200

Therefore, $\overline{\overline{X}}$ = 1 / 20 (4200) = 210

Central Line C.L = $\overline{\overline{X}}$ = 210

Lower Control Limit L.C.L = $\overline{\overline{X}}$ - A σ

Where A = $\frac{3}{\sqrt{n}} = \frac{3}{\sqrt{25}} = \frac{3}{5} = 0.6$

Therefore L.C.L   = 210 – 0.6 (35)
                     = 210 – 21
                     = 189

Upper Control Limit (U.C.L)   = $\overline{\overline{X}}$ + A σ
                                          = 210 + 0.6 (35)
                                          = 210 + 21
                                          = 231
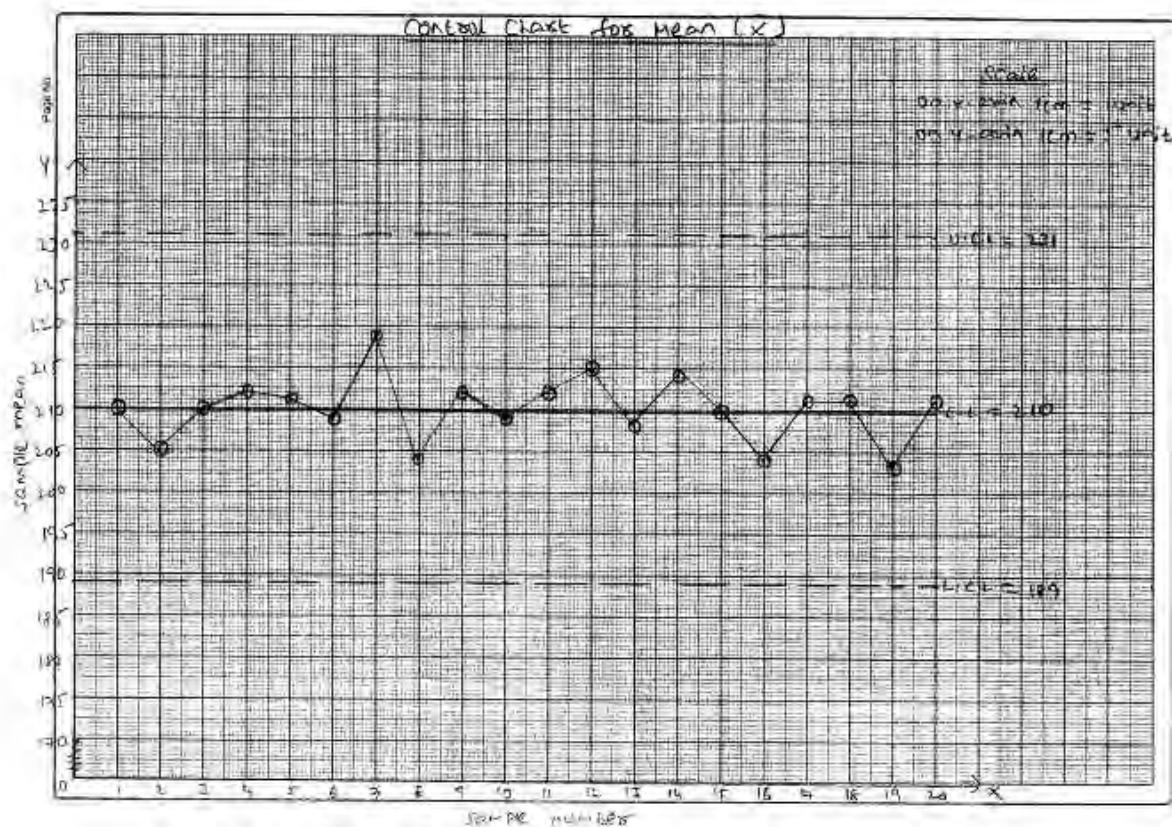
Since all the plotted points lies within the 3σ control limits, the process is in the state of statistical quality control.

Problem No.3.

15 Samples of size 4 each were taken and the observed values are given below:

Samples		Observed values		
1	32	20	33	6
2	42	36	52	50
3	25	15	52	63
4	22	33	34	23
5	29	30	27	31
6	30	34	26	16
7	34	31	28	34
8	11	21	20	16
9	11	22	28	31
10	36	30	35	26
11	34	16	37	26
12	27	36	51	53
13	26	35	32	37
14	25	36	37	24
15	10	28	14	13

Calculate UCL and LCL for X Chart and R chart. Also prepare the chart on graph paper. For a sample size 4 the control factors are —
$A_2 = 0.729$, $d_2 = 2.059$, $D_3 = 0$, $D_4 = 2.282$.

Solution:

Given Sample size n = 4

No. of samples k = 15

Sample No.	Sample Mean	Sample Range
1	91/4 = 22.75	33 - 6 = 27
2	180/4 = 45	52-36 = 16
3	155/4 = 38.75	63 − 15 = 48
4	112/4 = 28	34 − 22 = 12
5	117/4 = 29.25	31 − 27 = 4
6	106/4 = 26.5	34 − 16 = 18
7	127/4 = 31.75	34 − 28 = 6
8	68/4 = 17	21 − 11 = 10
9	92/4 = 23	31 − 11 = 20
10	127/4 = 31.75	36 − 26 = 10
11	113/4 = 28.25	37 − 16 = 21
12	167/4 = 41.75	53 − 27 = 26
13	130/4 = 32.5	37 − 26 = 11
14	122/4 = 30.5	37 − 24 = 13
15	65/4 = 16.25	28 − 10 = 18
Total	**443**	**260**

We have, $\overline{\overline{X}}$ = 443/15 = 29.5333

$\overline{\overline{R}}$ = 260 / 15 = 17.3333

Control Limits for $\overline{X} - Chart$

Central Line C.L = $\overline{\overline{x}}$ = 29.5333

Lower Control Limit (L.C.L) = $\overline{\overline{X}} - A_2 \overline{R}$
= 29.5333 – 0.729 (17.3333)
= 29.5333 – 12.6360
= 16.8973

Upper Control Limit (U.C.L) = $\overline{\overline{X}} + A_2 \overline{R}$
= 29.5333 + 0.729 (17.3333)
= 29.5333 + 12.6360
= 42.1693
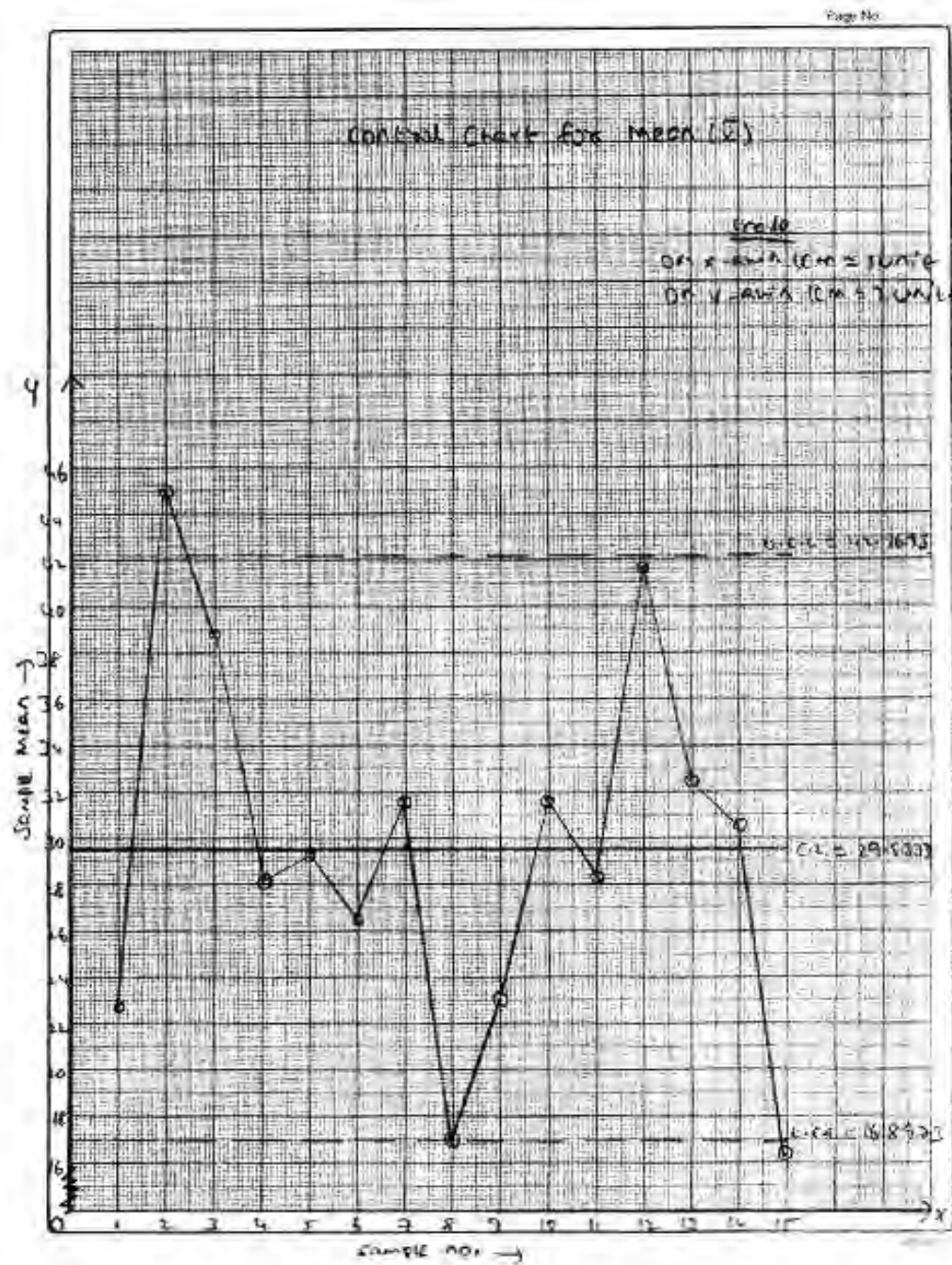
Control Limits for R – Chart

Central Line (C.L) = $\overline{R}$ = 17.3333

Lower Control Limit (L.C.L) = $D_3 \overline{R}$

$\qquad\qquad\qquad\qquad\qquad$ = 0 x 17.3333

$\qquad\qquad\qquad\qquad\qquad$ = 0

Upper Control Limit (U.C.L) $= D_4 \bar{R}$

                 $= 2.282 \,(17.3333)$

                 $= 39.5546$
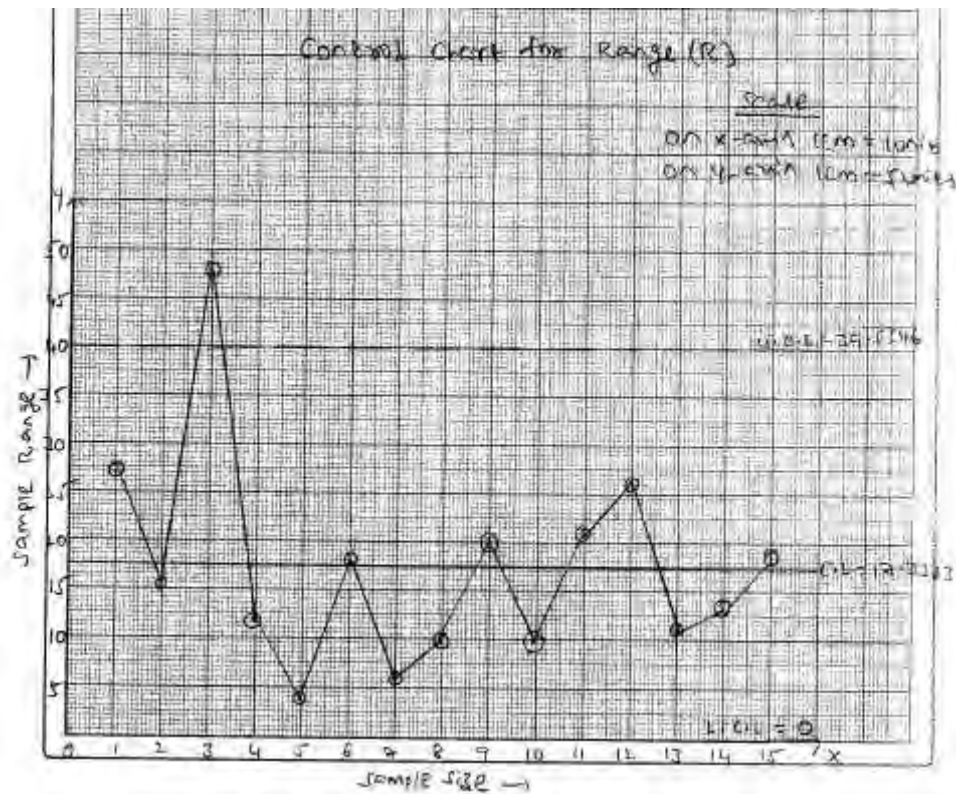
From $\bar{X}$ - chart we observe that the 15th samples lies below L.C.L and 2nd samples goes outside U.C.L. Hence the production process is not in control w.r.t. $\bar{X}$ – chart.

From R – Chart we observe that the 3rd sample lies above U.C.L. So the production process is not in control w.r.t to R – Chart.

Therefore, we infer that the entire production process is not in the state of Statistical Quality.

Problem No.4.

The following table gives the result of inspection of 20 samples of 100 items each taken in 20 working days.

Draw a P-chart. What conclusion do you draw from the chart about the process?

Sample number	No. of defectives	Sample number	No. of defectives
1	6	11	10
2	2	12	4
3	4	13	6
4	1	14	11
5	20	15	22
6	6	16	8
7	10	17	0
8	19	18	3
9	4	19	23
10	21	20	10

Solution:

Given sample size n = 100

Sample No.	d_i	$p_i = d_i/100$
1	6	0.06
2	2	0.02
3	4	0.04
4	1	0.01
5	20	0.2
6	6	0.06
7	10	0.1
8	19	0.19
9	4	0.04
10	21	0.21
11	10	0.1
12	4	0.04
13	6	0.06
14	11	0.11
15	22	0.22
16	8	0.08
17	0	0
18	3	0.03
19	23	0.23
20	10	0.1
Total	--	1.90

We have $\overline{P}$ = 1.9/20 = 0.095

⇨ $\overline{q}$ = 1 - $\overline{p}$ = 0.905

Therefore, the 3σ control limits for P – chart are

$$\bar{p} \pm 3\sqrt{\frac{\bar{p}\,\bar{q}}{n}}$$

Therefore Central Line C.L = $\bar{P}$ = 0.095

Lower Control Limit (L.C.L) = $\bar{p} - 3\sqrt{\frac{\bar{p}\,\bar{q}}{n}}$

$$= 0.095 - 3\sqrt{\frac{0.095\,(0.905)}{100}}$$

$$= 0.095 - 0.08797$$
$$= 0.00703$$

Upper Control Limit (U.C.L) = $\bar{p} \pm 3\sqrt{\frac{\bar{p}\,\bar{q}}{n}}$

$$= 0.095 + 3\sqrt{\frac{0.095\,(0.905)}{100}}$$

$$= 0.095 + 0.08797$$
$$= 0.18297$$
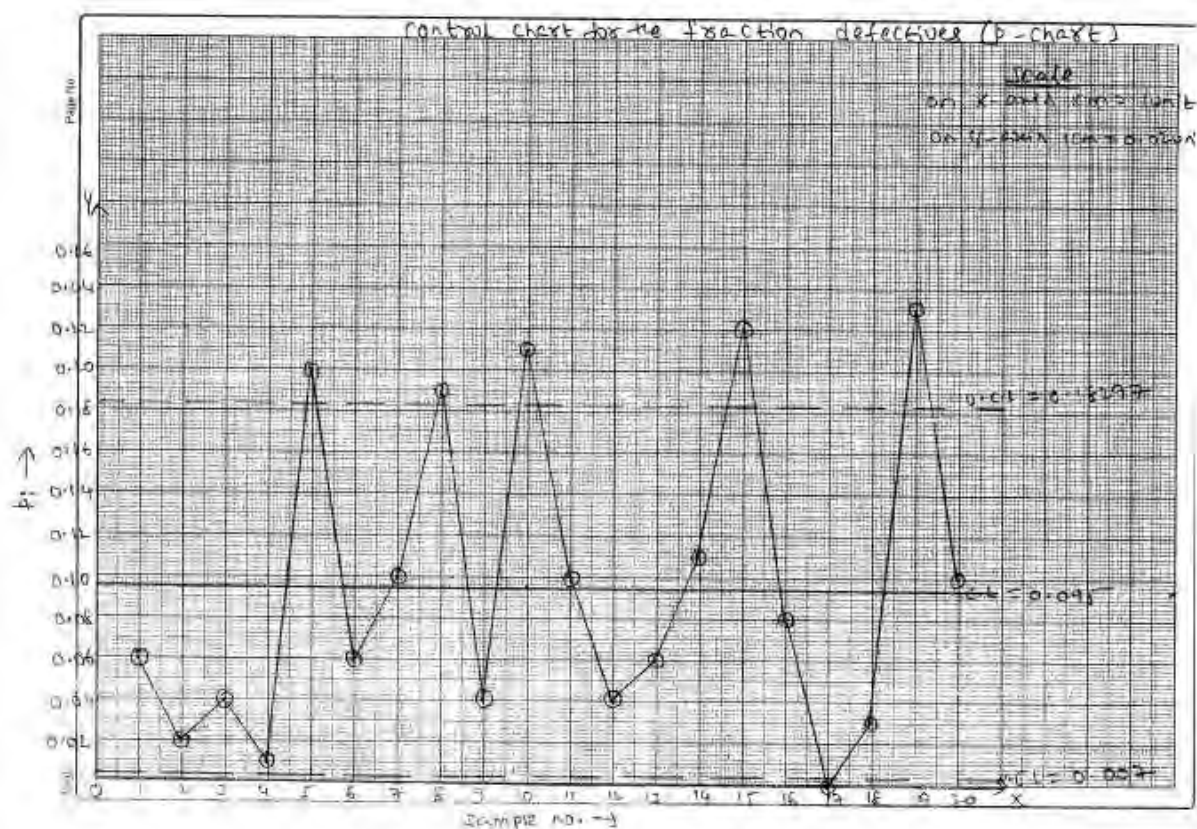
From P chart we observe that so many plotted points goes outside the 3σ control limits. Hence the production process is not in the state of statistical quality control.

Problem No.5.

The following table gives the result of inspection of 20 samples of 100 items each taken on 20 working days. Draw a P-chart. What conclusion would you draw from the chart?

Sample No.	1	2	3	4	5	6	7	8	9	10
No. of defectives	9	17	8	7	12	5	11	16	14	15
Sample No.	11	12	13	14	15	16	17	18	19	20
No. of defectives	10	6	7	18	16	10	5	14	7	13

Solution:

Given sample size n = 100

Sample No.	d_i	$p_i = d_i/100$
1	9	0.09
2	17	0.17
3	8	0.08
4	7	0.07
5	12	0.12
6	5	0.05
7	11	0.11
8	16	0.16
9	14	0.14
10	15	0.15
11	10	0.10
12	6	0.06
13	7	0.07
14	18	0.18
15	16	0.16
16	10	0.10
17	5	0.05
18	14	0.14
19	7	0.07
20	13	0.13
Total	--	**2.20**

We have $\overline{P}$ = 2.2/20 = 0.11

$\Rightarrow$ $\overline{q}$ = 1 - $\overline{p}$ = 0.89

Therefore, the 3σ control limits for P – chart are

$$\overline{p} \pm 3 \sqrt{\frac{\overline{p}\overline{q}}{n}}$$

Therefore Central Line C.L = $\overline{P}$ = 0.11

Lower Control Limit (L.C.L) = $\bar{p} - 3\sqrt{\dfrac{\bar{p}\bar{q}}{n}}$

$$= 0.11 - 3\sqrt{\dfrac{(0.11)\,(0.89)}{100}}$$

$$= 0.11 - 0.09387$$

$$= 0.01613$$

Upper Control Limit (U.C.L) = $\bar{p} \pm 3\sqrt{\dfrac{\bar{p}\bar{q}}{n}}$

$$= 0.11 + 3\sqrt{\dfrac{(0.11)\,(0.89)}{100}}$$

$$= 0.11 + 0.09387$$

$$= 0.20387$$
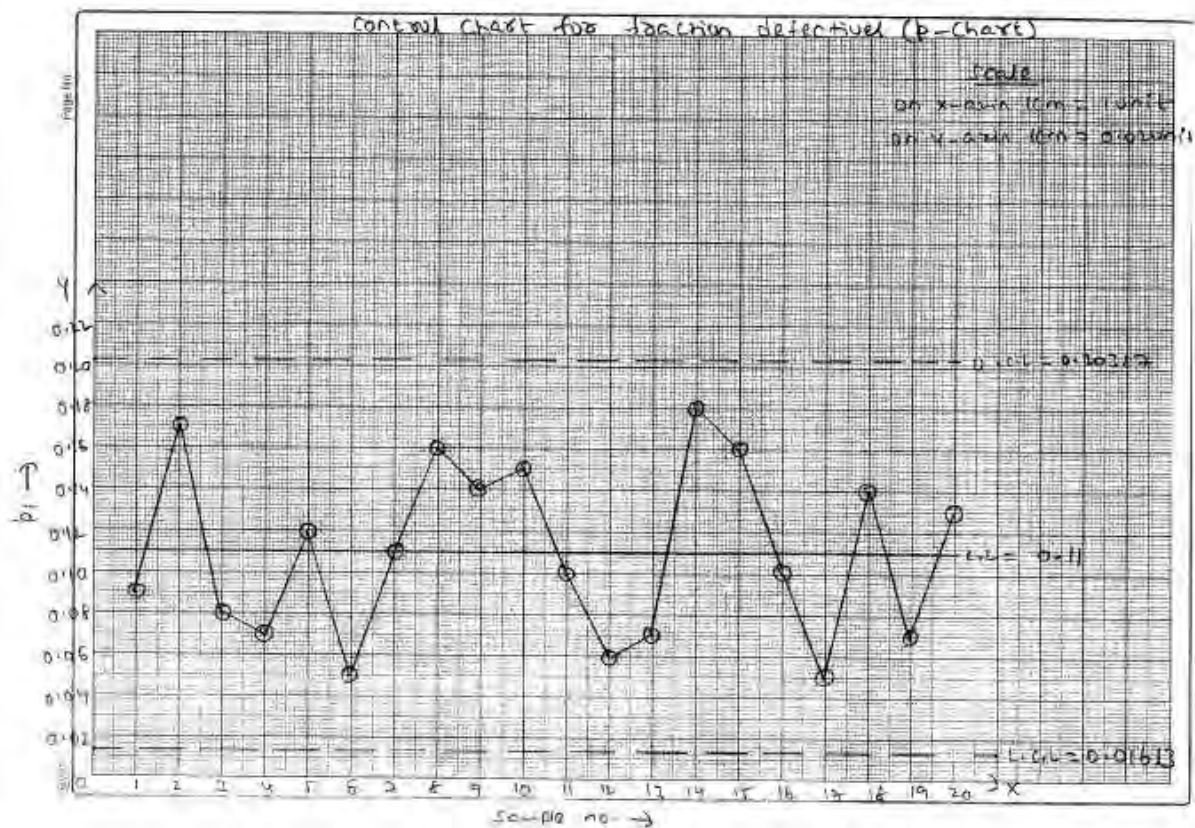
From the P chart we observe that all the sample points lies within the 3σ control limits. Hence the production process is in the state of statistical quality control.

Problem No.6.

The following table gives the result of inspection of 20 samples of 100 items each taken on working days. Draw a P-chart. What conclusion would you draw from the chart?

Sample No.	1	2	3	4	5	6	7	8	9	10
No. of Defectives	0	2	4	6	6	4	0	2	4	8
Sample No.	11	12	13	14	15	16	17	18	19	20
No. of Defectives	8	0	4	6	14	0	2	2	6	2

Solution:

Given sample size n = 100

Sample No.	d_i	$p_i = d_i/100$
1	0	0
2	2	0.02
3	4	0.04
4	6	0.06
5	6	0.06
6	4	0.04
7	0	0
8	2	0.02
9	4	0.04
10	8	0.08
11	8	0.08
12	0	0
13	4	0.04
14	6	0.06
15	14	0.14
16	0	0
17	2	0.02
18	2	0.02
19	6	0.06
20	2	0.02
Total	--	**0.80**

We have $\overline{P}$ = 0.8/20 = 0.04

⇨ $\overline{q}$ = 1 - $\overline{p}$ = 0.96

Therefore, the 3σ control limits for P – chart are

$$\overline{p} \pm 3\sqrt{\frac{\overline{p}\overline{q}}{n}}$$

Therefore Central Line C.L = $\overline{P}$ = 0.04

Lower Control Limit (L.C.L) = $\overline{p} - 3\sqrt{\frac{\overline{p}\overline{q}}{n}}$

$$= 0.04 - 3\sqrt{\frac{(0.04)\,(0.96)}{100}}$$

$$= 0.104 - 0.05879$$

$$= -0.01879 \cong 0$$

Upper Control Limit (U.C.L) = $\bar{p} + 3\sqrt{\frac{\bar{p}\bar{q}}{n}}$

$$= 0.04 + 3\sqrt{\frac{(0.04)\,(0.96)}{100}}$$

$$= 0.04 + 0.05879$$

$$= 0.09879$$
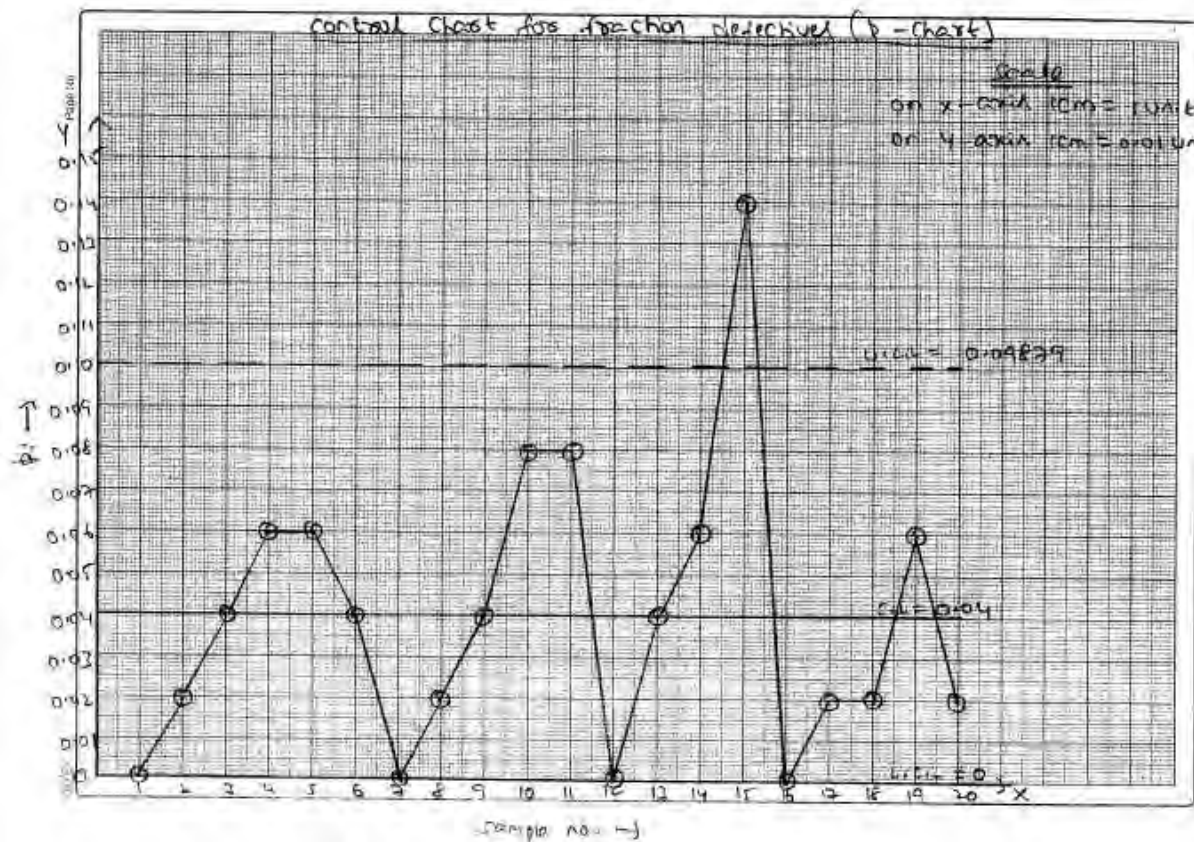
We observe that from P chart the 15th sample value lies above U.C.L. Hence the production process is not in the state of statistical quality control.

Problem No.7.

18 carpets had defects in their finish as follows. Supposing the defects follow the 'Chart' draws a control chart for the number of defects.

No. of Defects	0	1	2	3	4	5	6
No. of carpets having specified No. of Defects	0	1	2	4	3	5	3

Solution:

X	f	fx
0	0	0
1	1	1
2	2	4
3	4	12
4	3	12
5	5	25
6	3	18
Total	18	72

Therefore $\bar{X} = \frac{\sum fx}{N} = \frac{72}{18} = 4$

The 3σ control limits for C-chart are $\bar{c} \pm 3\sqrt{\bar{c}}$

Where $\bar{c} = \bar{x} = 4$

Therefore, Central Line (C.L) = $\bar{c}$ **= 4**

Lower Control Limit (L.C.L)
$= \bar{c} - 3\sqrt{\bar{c}}$
$= 4 - 3\sqrt{4}$
$= 4 - 3.2$
$= 4 - 6$
$= -2 \cong 0$

Upper Control Limit (U.C.L)
$= \bar{c} + 3\sqrt{\bar{c}}$
$= 4 + 3\sqrt{4}$
$= 4 + 6$
$= 10$

We observe from the C-chart all the plotted points lies within the 3σ control limits. Hence the production process is in the state of statistical quality control.

Problem No.8.

Construct both $\overline{\overline{X}}$ and R chart from the following data assuming each sub-group contains four samples:

Sub-group number	$\overline{\overline{X}}$	R	Sub-group number	$\overline{\overline{X}}$	R
1	6.36	0.10	11	6.32	0.18
2	6.38	0.18	12	6.30	0.10
3	6.35	0.17	13	6.34	0.11
4	6.39	0.20	14	6.39	0.14
5	6.32	0.15	15	6.37	0.17
6	6.34	0.16	16	6.36	0.15
7	6.40	0.13	17	6.35	0.18
8	6.33	0.18	18	6.35	0.13
9	6.37	0.16	19	6.34	0.18
10	6.33	0.13	20	6.34	0.16

The constant values are given below:

Sub-group size	A_2	D_3	D_4
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
10	0.31	0.22	1.78

Only control limits are to be calculated.

Solution: Given sample size n = 4; No. of samples k = 20

Sub-Group No.	$\overline{X}$	R
1	6.36	0.10
2	6.38	0.18
3	6.35	0.17
4	6.39	0.20
5	6.32	0.15
6	6.34	0.16
7	6.40	0.13
8	6.33	0.18
9	6.37	0.16
10	6.33	0.13
11	6.32	0.18
12	6.30	0.10
13	6.34	0.11
14	6.39	0.14
15	6.37	0.17
16	6.36	0.15
17	6.35	0.18
18	6.35	0.13
19	6.34	0.18
20	6.34	0.16
Total	**127.03**	**3.06**

We have $\overline{\overline{X}}$ = 127.03/20 = 6.3515

$\overline{R}$ = 3.06/20 = 0.153

Control Limits for $\overline{\overline{X}}$ – Chart

Central Line (C.L) = $\overline{\overline{X}}$

= 6.3515

Lower Control Limit (L.C.L) = $\overline{\overline{X}} - A_2 \overline{R}$

= 6.3515 – 0.73 (0.153)

= 6.3515 – 0.1117

= 6.2398

Upper Control Limit (U.C.L) = $\overline{\overline{X}} + A_2 \overline{R}$

= 6.3515 + 0.73 (0.153)

= 6.3515 + 0.1117

= 6.4632
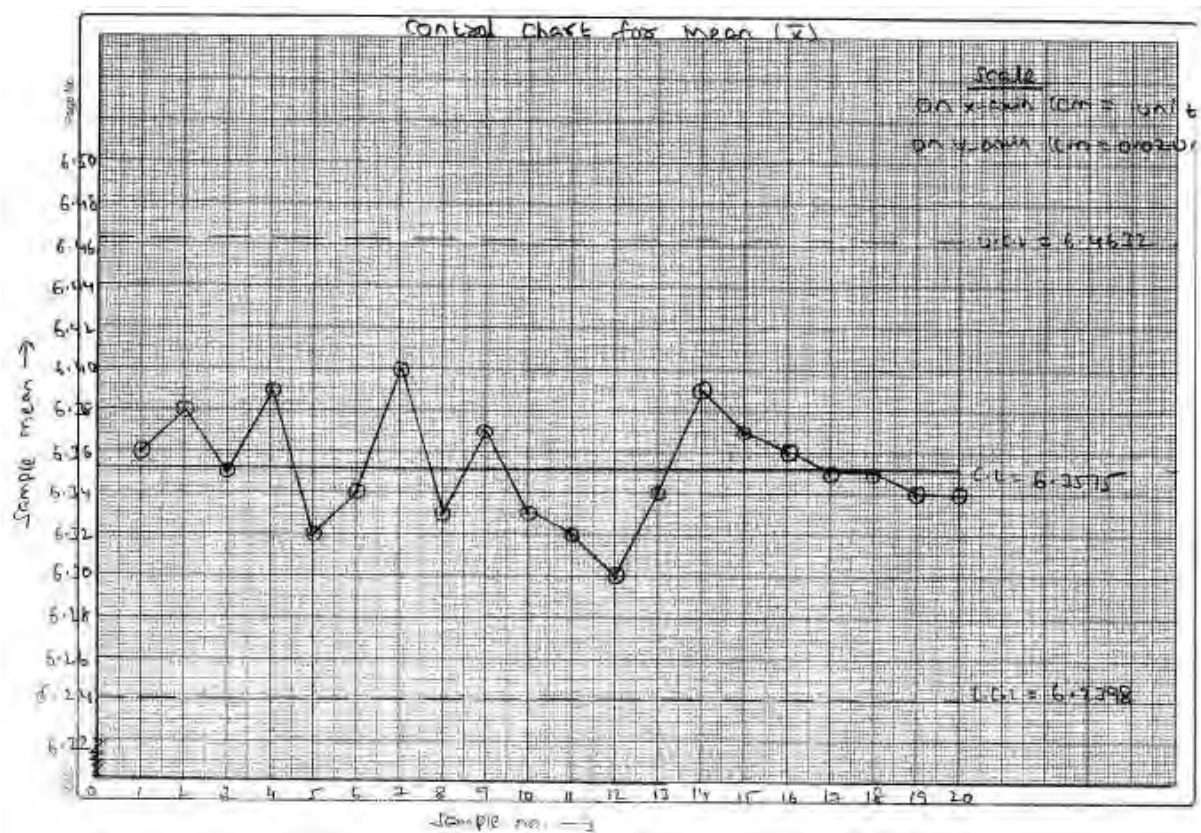
Control Limits for R-Chart:

Central Line (C.L) = $\overline{R}$

$\qquad\qquad\qquad$ = 0.153

Lower Control Limit (L.C.L) = $D_3 \overline{R}$

$\qquad\qquad\qquad\qquad$ = 0 x 0.153

$\qquad\qquad\qquad\qquad$ = 0

Upper Control Limit (U.C.L) = $D_4 \overline{R}$

$\qquad\qquad\qquad\qquad$ = 2.28 x (0.153)

$\qquad\qquad\qquad\qquad$ = 0.3488
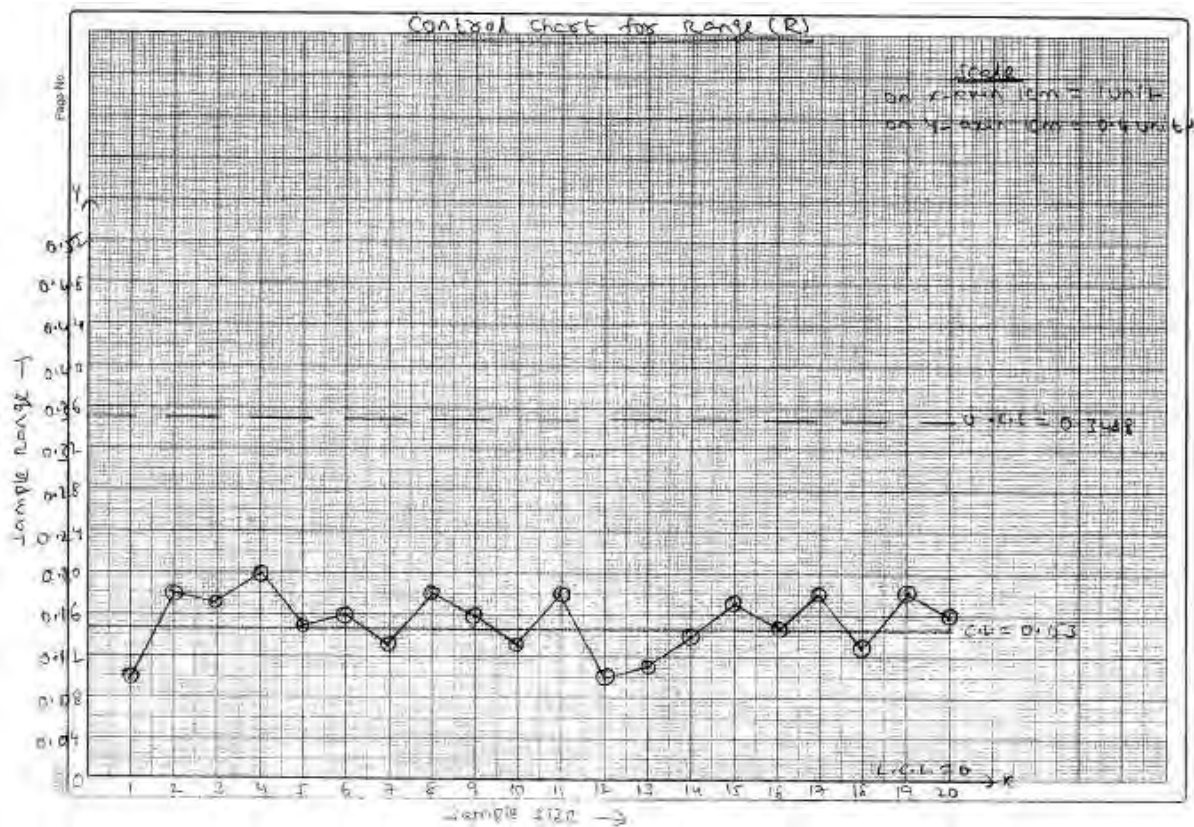
We observe that in both $\overline{X}$– chart and R chart all the sample points lies within the 3σ control limits. Hence the production process is in the state of Statistical Quality Control.

7

OBJECTIVE AND BIT QUESTIONS FROM ALL CHAPTERS

1. A company has the following budget based on orders from home market:

	Rs	Rs
Sales (2000 units)		10,000
Cost of Sales		
Direct Material	1,000	
Direct Labour	4,000	
Variable Overhead	1,000	
Fixed Overhead	3,000	9,000
		1,000

   At this level of output, the company has spare capacity and it is therefore planning to develop export market. It believes that it will be able to sell an additional 750 units – the limit of its production due to a shortage of raw materials. No additional fixed costs would be incurred and selling price and variable costs per unit would be the same as for the home market.

   Before launching its export campaign, however, the company is approached by a home buyer who wishes to purchase 200 deluxe models which twice as much materials as the standard model. What is the minimum price which should be charged if this order is accepted?

2. An investment in new machinery is being considered. The machine will cost Rs. 40,000 and will last for seven years. It is expected to yield savings in raw material cost of Rs. 4,000 p.a. (due to lower wastage) and it is hoped also to achieve labour savings of Rs. 7,000 p.a., however the arrangement have not yet been discussed with the trade union. The company's cost of capital is 12%.

   What percentage change in the estimated labour savings will render the project not viable? Given that the present value of an annuity for 7 years at 12% = Rs. 4.564.

3. The annual demand for an item of raw material is 3,000 units and the purchase price is Rs. 100 per unit. The incremental cost of processing an order is Rs. 150 and the carrying cost per annum is 10 per unit. What is the optimal order quantity and the total relevant cost of this order quantity?

4. Star Bicycle Company produced and sold 1,10,000 bicycle annually, under the brand name 'Smart' with a price tag Rs. 899. Like all other players in the industry, Star too was running under capacity. The manufacturing cost of these cycles was-material Rs. 300, labour Rs. 200 and Manufacturing Rs. 300, 40% of the manufacturing cost was variable. General and administration expenses were 50% of labour cost.

   Star has now received a proposal to sell 25,000 bicycles per year under the brand name 'Jeet' to a chain store at a price of Rs. 800. The brand will be exclusive for the chain stores as they will market it as their own product. Expenditure for producing 'Jeet' will be the same as that of Smart as design of 'Jeet' will exactly be same as that of 'Smart' with only some cosmetic changes. To produce 'Jeet' however, Rs. 6,00,000 additional fund will be required on an average. Further it estimated that sale of 'Jeet' through the chain store will reduce the sale of 'Star' by 10,000 units.

   You are required to calculate the relevant cost of 'Jeet', given that the weighted average cost of capital of Star Co. is 15%.

5. ABC Ltd. Initiated a quality improvement program at the beginning of the year. Efforts were made to reduce the number of defective units produced. By the end of the year, reports from the production manager revealed that scrap and rework had both decreased. Though pleased with the success, the

President of the company wanted some assessment of the financial impact of the improvements. To make this assessment, the following financial data were collected for the current and preceding year: -

	Preceding Year (2001-2002)	Current Year (2002-2003)
	Rs	Rs
Sales	1,00,00,000	1,00,00,000
Scrap	4,00,000	3,00,000
Rework	6,00,000	4,00,000
Product inspection	1,00,000	1,25,000
Product warranty	8,00,000	6,00,000
Quality training	40,000	80,000
Materials inspection	60,000	40,000

You are required to: -
   i)   Classify the costs as prevention, appraisal, internal failure, or external failure
   ii)   Compute the profit that has increased because of quality improvements?
6. A company has forecast sales and cost of sales for the coming year as Rs. 25 lakhs and Rs. 18 lakhs respectively.

   The inventory turnover has been taken as 9 times per year.   In case the inventory turnover increases to 12 times and the short term interest rate on working capital is taken as 10%, what will be saving in cost?

7. Given the projects:

	t_0	t_1	t_2	NPV
A	-100	-200	+50	+40
B	-150	+70	+70	+20
C	-200	-120	-30	+50

   External capital is limited to 190 at t_0, 110 at t_1 and zero at t_2.

 Formulate the problem into an LP, assuming projects are divisible.

 Cash generated from these investments can be reinvested in other projects in the same year.

8. A company has the capacity of production of 80,000 units and presently sells 20,000 units at Rs. 100 each. The demand is sensitive to selling price and it has been observed that with every reduction of Rs. 10 in selling price the demand is doubled.   What should be the target cost at full capacity if profit margin on sale is taken as 25%?

9. If the direct labour cost is reduced by 20% with every doubling of output, what will be the cost of labour for the sixteenth unit produced as an approximate percentage of the cost of the first unit produced?

10. The operating costs of a department over a five-year period were as follows:

Year	Cost Index	Rs	Hours worked
1	100	32,250	8,625
2	115	36,593	8,410
3	120	39,888	9,120
4	130	42,406	8,810
5	134	40,602	7,650

Estimated cost for year 6 when the cost index will be 140 and hours worked will be 8,720.

11. A division of a company employs capital of Rs. 2 million and its return on capital is 12%.   It is considering a new project requiring fresh capital of 5,00,000 and expected to yield profits of Rs. 90,000 per annum.   The company's interest rate is 10% p.a. If the new project is implemented, what will be the division's residual income?

12. When the time taken by the first unit is 10 hours and the learning rate is 80%, the average time taken for each of 20 units produced would be?

13. A Ltd., which manufactures small electronic circuits, has a capacity to produce 4 lakh units. The market demand is sensitive to the sale price and it has been estimated that the company could sell 1 lakh units when the price is Rs. 50 per circuit. Thereafter the demand would double for each Rs. 5 fall in the selling price. The company expects a minimum margin of 25%, what will be the target cost of the company to sell at full capacity?

14. The budgeted sales and cost of sales of Rahaman Brother for the coming year are Rs. 15 and Rs. 10 crores respectively. The current level of inventory turnover is 5 times. Considering that the inventory is financed at an average cost of 10% p.a. What will be the expected cost saving for the budget period by doubling inventory turnover.

15. A company determines its selling price by marking up variable costs 60%. In addition, the company uses frequent selling price mark down to stimulate sales. If the mark down average 10%, what is the company's contribution margin ratio?

16. B Ltd. Has earned net profit of Rs. 1 lakh, and its overall P/V ratio and margin of safety are 25% and 50% respectively. What is the total fixed cost of the company?

17. B Ltd. Which manufactures components for VCD, has a capacity to produce 4 lakh units. The market demand is sensitive to the sale price and the company could sell 1 lakh units at a price of Rs. 50 each. The demand thereafter would double for each Rs. 5 per unit fall in the selling price. The company expects a minimum margin of 25%. What would be the target cost of the company to sell at full capacity utilization?

18. A company issues commercial paper for Rs. 2 crore with a maturity period of 90 days. The interest rate is 12% p.a. What is the net amount received by the company?

19. If back orders can be taken (at an added cost per item back ordered)
> A) EOQ will decrease
> B) EOQ will increase
> C) Lead time will decrease
> D) No change will occur. Back orders do not affect the EOQ model

20. Which of the following would decrease unit contribution margin the most?
> A) 15% decrease in selling price
> B) 15% increase in variable costs
> C) 15% decrease in variable costs
> D) 15% decrease in fixed costs

21. When allocating service department costs to production departments, the method that does not consider different cost behavior patterns is the
> A) Step method
> B) Reciprocal method
> C) Single-rate method
> D) Dual-rate method.

22. The information relating to the direct material cost of a company is as under:

	Rs
Standard price per unit	3.60
Actual quantity purchased in units	1,600
Standard quantity allowed for actual production in units	1.450
Material price variance on purchase (favourable)	240

What is the actual purchase price per unit?

23. A company has 2,000 units of an absolute item which are carried in inventory at the original purchase price of Rs. 30,000. If these items are reworked for Rs. 10,000, they can be sold for Rs. 18,000.

Alternatively, they can be sold as scrap for Rs.3,000 in the market. In a decision model used to analyze the reworking proposal, the opportunity cost should be taken as

24. A company produces two joint products, P and V. In a year, further processing costs beyond split-off point spent were Rs. 8,000 and Rs.12,000 for 800 units of P and 400 units of V respectively. P sells at Rs. 25 and V sells at Rs. 50 per unit. A sum of Rs. 9,000 of joint cost were allocated to product P based on the net realization method. What were the total joint cost in the year?

25. A company is to market a new product. It can produce up to 1,50,000 units of this product. The following are the estimated cost data:

	Fixed Cost	Variable Cost
For production up to 75,000 units	Rs. 8,00,000	60%
Exceeding 75,000 units	Rs. 12,00,000	50%

Sale price is expected to be Rs. 25 per unit.

How many units must the company sell to break even?

26. The following details relate to two competing companies, Alps and Himalayas, for identical projects:
   i)   The net present value (NPV) of Alps is Rs. 20,000 and its internal rate of return (IRR) is 18%.
   ii)   For the same life period, Himalayas' estimated cash flows are:

Year	Rs. '000
0	(450)
1	300
2	200
3	100

And its cost of capital is 15%.

Which one of the following combinations is correct concerning the NPV and the IRR of the two projects?

Projects	
Alps	Himalayas
A) Higher NPV	Higher IRR
B) Higher NPV	Lower IRR
C) Lower NPV	Higher IRR
D) Lower NPV	Lower IRR

27. Nulook Ltd. Uses a JIT system and back flush accounting. It does not use a raw material stock control account During May, 8000 units were produced and sold. The standard cost per unit is Rs. 100; this includes materials of Rs. 45. During May, Rs. 4,80,000 of conversion costs were incurred.
   The debit balance on cost of goods sold account for May was

   A)   Rs. 8,00,000
   B)   Rs. 8,40,000
   C)   Rs. 8,80,000
   D)   Rs.9,20,000

28. A concern sells three products. The budgeted fixed cost for the period is R. 6,00,000. The budgeted contribution to sales ratio (C/S ratio) and the sales mix are as under

Product	C/S ratio	Mix
Super	25%	20%
Premium	40%	40%
Best	30%	40%

What is the Break Even sales revenue?
   A)   Rs. 30,10,181
   B)   Rs. 15,23,312

C) Rs. 18,18,181

D) Rs. 17,60,500

29. The selling price of product P is set at Rs. 1,500 for each unit and sales for the coming year are expected to be 500 units.

   If the company requires a return of 15% in the coming year on its investment of Rs. 15,00,000 in product P. The TARGET cost for each unit for the coming year is.

   A) Rs. 930

   B) Rs. 990

   C) Rs. 1,050

   D) Rs.1,110

30. A company makes and sells a single product. The selling price and marginal revenue equations are:

   Selling price = Rs. 50 – Re. 0.001X

   Marginal revenue = Rs. 50 – Re. 0.002 X

   Where X is the product the company makes. The variable costs amount to Rs. 20 per unit and the fixed costs are Rs. 1,00,000.

   In order to maximize the profit, the selling price should be

   A) Rs. 25

   B) Rs. 30

   C) Rs. 35

   D) Rs. 40

31. A company produces two products, X and Y, which pass through two production processes, P and Q. The time taken to make each product in each process is:

	Product X	Product Y
Process P	6 mins	10 mins
Process Q	20 mins	15 mins

The company offers a 16 hour day and the process have an average down time each day of

Process p	3 hours
Process Q	2 hours

The cost and revenue for each unit of each product are:

	Product X Rs.	Product Y Rs.
Direct Material	15	15
Direct labour	17	12
Variable O H	8	6
Fixed Costs	8	6
Total Cost	48	39
Selling price	90	80

Sales demand restricts the output of X and Y to 40 and 60 units a day respectively.

The daily production plan that would maximize the THROUGHPUT contribution is:

   a) 40 units of X

   b) 36 units of X and 4 units of Y

   c) 34 units of X and 5 units of Y

   d) 56 units of Y

32. The total cost of manufacturing a component is as under at a capacity of 50,000 units of production

	Rs
Prime cost	10.00
Variable overheads	2.40
Fixed Overheads	4.00
	16.40

The selling price is Rs. 21 per unit. The variable selling and administrative expenses is 60 paise per component extra. 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 per quarter. When the plant is operating, the fixed overheads are incurred at a uniform rate throughout the year. Additional costs of plant shutdown for the quarter are estimated at Rs. 14,000.

The shut down point for the quarter in units of product will be

a) 25,000
b) 14,000
c) 11,000
d) 20,000

33. Division J of NZ Ltd. produced the following results in the last financial year:

	Rs ('000)
Net Profit	720
Capital employed in fixed assets	3,000
Capital employed: net current assets	200

For performance appraisal purposes, all divisional assets are valued at original cost. The division is considering a project which will increase annual net profit in Rs. 50,000 that will required average stock levels to increase by Rs. 60,000 and fixed assets to increase by Rs. 2,00,000.

NZ Ltd imposes a 16% capital charge on its divisions. Given these circumstances, will the appraisal criteria Return on Investment (ROI) and Residual Income (RI) motivate division? J management to accept the project?

	ROI	RI
A	YES	YES
B	YES	NO
C	NO	NO
D	NO	YES

34. A company manufactures two products using common material handling facility. The total budgeted material handling cost is Rs. 60,000. The other details are:

	Product X	Product Y
Number of units produced	30	30
Material moves per product line	5	15
Direct labour hour per unit	200	200

Under activity based costing system the material handling cost to be allocated to product X (per unit) would be:

A) Rs. 1,000
B) Rs. 500
C) Rs. 1,500
D) Rs. 2,500

35. When a manager is concerned with monitoring total cost, total revenue, and net profit conditioned upon the level of productivity, an accountant should normally recommend.

	Flexible Budgeting	Standard Costing
A	Yes	Yes
B	Yes	No
C	No	Yes
D	No	No

36. A company's approach to a make-or-buy-decision
   A) Depends on whether the company is operating at or below normal volume
   B) Involves an analysis of avoidable costs
   C) Should use absorption (full) costing
   D) Should use activity-based-costing

37. A company operates throughput accounting system. The details of product X per unit are as under.

Selling Price	Rs. 50
Material Cost	Rs. 20
Conversion cost	Rs. 15
Time on bottleneck resources	10 minutes

The return per hour for product X is

A) Rs. 210   C) Rs. 300
B) Rs. 180   D) Rs. 90

38. A firm engaged in the profession of rendering software services provides three different kinds of services to its clients. The following are the data relating to these services.

Types of services	A	B	C
	Rs./job	Rs./job	Rs./job
Annual fee	3,000	2,400	1,800
Annual variable costs	1,350	800	810
Annual fixed costs	600	320	225

The total annual fixed costs are budgeted at Rs. 5,74,200 and none of these costs are specific to any type of service provided by the firm.

The firm has estimated the number of service contracts to be sold in the next year in the proportion of 20%, 30% and 50% respectively for the three types of services namely A, B and C.

The annual revenue needed by the firm to break even is

A) Rs. 3,16,800   C) Rs. 5,74,200
B) Rs. 9,76,800   D) Rs. 7,20,000

39. A company has estimated the selling prices and the variable costs of one of its products as under:

Selling Price (per unit)		Variable costs (per unit)	
Probability	Rs	Probability	Rs
0.25	60	0.25	30
0.45	75	0.40	45
0.30	90	0.35	60

The company will be able to produce and sell 4,000 units in a month irrespective of the selling price. The selling price and variable cost per unit are independent of each other. The specific fixed cost relating to this product is Rs. 20,000. The probability that the monthly net profit of the product will be ≥ Rs. 1,20,000 is

A) 0.2525   C) 0.3825
B) 0.4512   D) 0.3075

40. The current price of a product is Rs. 8,000 per unit and it has been estimated that for every Rs. 200 per unit reduction in price, the current level of sale, which is 10 units, can be increased by 1 unit. The existing capacity of the company allows a production of 15 units of the product. The variable cost is Rs. 4,000 per unit for the first 10 units, thereafter each unit will cost Rs. 400 more than the preceding one. The most profitable level of output for the company for the product will be

      A) 11 units   C) 13 units

      B) 12 units   D) 14 units

41. In calculating the life cycle costs of a product, which of the following items would be included?

    i)   Planning and concept design costs

    ii)   Preliminary and detailed design costs

    iii)   Testing costs

    iv)   Production costs

    v)   Distribution costs

      A) All of the above   C) ii), iv) and v)

      B) iv) and v)   D) iv)

42. Market research has revealed that the maximum demand lies for products X and Y. the standard variable costs per unit of the products are as follows:

	X (Rs)	Y(Rs)
Materials (Rs 40 per Kg)	200	160
Other variable costs	400	440
Total variable costs	600	600

The Management Accountant determined the optimal production plan by using graphical linear programming. He noticed that the optimal plan was given at any point on the part of the feasible region that was formed by the constraint line for the availability of materials.

If the selling price of Product X is Rs. 1,000, the selling price of Product Y is (Rs)

      (A)   800

      (B)   860

      (C)   920

      (D)   980

43. A company which sells three products furnishes the following sales information for November, 2006:

		Budgeted		Actual	
		Units	Price/unit	Units	Price/unit
X		200	50	210	52
Y		300	25	330	24
Z		500	18	440	19

The Expected size of the market was 5,000 units and the size of the market for November, 2006 was 5,300 units.

The market share variance and sales mix variance are:

	Market share variance	Sales mix variance
	Rs.	Rs.
A	1,590 F	2,120 A
B	170 F	1,590 F
C	2,120 A	700 F
D	530 A	1,420 A

44. A company is preparing a quotation for a new product. The time taken for the first unit is 30 hours. The company expects 85% learning curve (index is – 0.2345). The company desires that the quotation should be based on the time taken for the final output within the learning period which is expected to end after the company has produced 200 units.

The time per unit of product to be used for the quotation is:

A   13.34 hours

B   25.50 hours

C   30.00 hours

D   6.67 hours

45. The normal capacity of a company is 5,000 units of product P per month. The company planned to produce an output of 4,800 units in November 2006 and accordingly prepared the following budget of expenses:

	Rs
Variable direct costs	48,000
Variable production overheads	19,200
Fixed Production overheads	40,000
Total	1,07,200

The company had an opening stock of 400 units on 1st November 2006 and at the November 2006, the closing stock was 600 units. The selling price is Rs. 25 per unit. The actual output produced and fixed costs incurred during November 2006 were same as budgeted. There is no change in the rate of variable costs.

The profit for November 2006 as per absorption costing method is:

A   Rs. 3,200 lower than under marginal costing method

B   Rs. 1,600 higher than under marginal costing method

C   Equal to the profit under marginal costing method

D   Rs. 4,800 higher than under marginal costing method

46. If the time taken to produce the first unit of a product is 4000 hrs, what will be the total time taken to produce the 5th to 8th unit of the product, when a 90% learning curve applies?

a)   10,500 hours

b)   12,968 hours

c)   9,560 hours

d)   10,368 hours

47. In a process, three raw materials are mixed together to produce a product. The standard mix of inputs required to produce 160 kgs of finished product is as under:

Raw Material	Kgs	Price/Kg (Rs)
A	100	150
B	60	200
C	40	250

During May 2007, the company produced 920 Kgs of output and the actual consumption of raw materials is as under:

Raw Material	Kgs	Price/Kg (Rs)
A	595	140
B	330	212
C	255	270

The material yield and mix variances respectively for May, 2007 are

a)   Rs. 5,550 (A) and Rs. 8,000 (A)
b)   Rs. 700 (F) and Rs. 5,500 (A)
c)   Rs. 5,550 (A) and Rs. 700 (A)
d)   Rs. 11,500 (A) and Rs. 1,180 (F)

(A) or (F) under brackets after the figures denotes 'Adverse' or 'Favourable'.

48. A company proposes to undertake a capital project. The life of the project is 4 years and the annual cash inflows are estimated at Rs. 40,000. The internal rate of return of the project is 15% and the cumulative present value factor for 15% for 4 years is 2.855. The profitability index is 1.064.

The nest present value of the project is

A) Rs. 7,309   B) Rs. 10,000   C) Rs. 10,000   D) Rs. 14,200

49. Back flush costing is most likely to be used when
   a)   Management desires sequential tracking of costs
   b)   A Just-in-Time inventory philosophy has been adopted
   c)   The company carries significant amount of inventory
   d)   Actual production costs are debited to work-in-progress.

50. A particular job requires 800 kgs of a material. 500 kgs of the particular material is currently in stock. The original price of the material was Rs. 300 but current resale value of the same has been determined as Rs. 200. The current replacement price of the material is Re. 0.80 per kg.

A) Rs. 640   B) Rs. 440   C) Rs. 300   D) Rs. 540

51. A company presently sells 90,000 units of a product at a price of Rs. 100 per unit. The variable cost of the product is Rs. 42 per unit. The annual fixed costs amount to Rs. 24 lacs.

Sales quantity	Probability
100000 units	0.45
120000 units	0.55

The finance director has stated that at either of the aforesaid higher sales and production levels, the variable cost per unit with the associated probability of it occurring will be as under:

Variable cost per unit	Probability
Rs. 40	0.40
Rs. 36	0.60

The probability that the reduction of selling price to Rs. 90 will increase the overall profit will be:

A: 0.82   B: 0.21   C: 0.25   D: 0.18

52. Appliances Division of a company has reported an annual operating profit of Rs. 402 lacs after charging Rs. 60 lacs of full cost of launching a new product that is expected to last three years. The risk adjusted cost of capital of the Appliances Division is 11% and the division is paying interest on substantial bank loan at 8%. The historical cost of the division as per its balance sheet is Rs. 1000 lacs and the replacement cost is estimated at Rs. 1,720 lacs.

Ignore taxation.

The EVA of the Appliances Division in lacs of rupees is:

A: 308   B: 309.6   C: 332   D: 252.8

53. A company has developed a new product and just completed the manufacture of the first four units of the product. The first unit took 3 hours to manufacture and the first four units together took 8.3667 hours to produce. The learning curve rate is:

A: 69.5%   B: 59.6%   C: 75.0%   D: 83.5%

54. Zee Ltd., is preparing its annual Profit plan. As part of its analysis of the Profitability of individual products, the accountant estimates the amount of overhead that should be allocated to the individual product lines from the information given below:

	Wall Mirrors	Specialty Windows
Unit Products	25	25
Material moves / Product line	5	15
Direct labour hrs./units	200	200

Budgeted material handing costs Rs. 50,000

Under Activity – Based – Costing (ABC), the material handling costs allocated to one unit of Wall mirrors would be:

A) Rs. 100   B) Rs. 500   C) Rs. 1,500   D) Rs. 2,500

55. A mobile phone manufacturer, Siemens Ltd., is planning to introduce a new mobile phone. The potential market over the next year is 10,00,000 units.

Siemens Ltd. has the capacity to produce 4,00,000 units and could sell 1,00,000 units at a price of Rs. 50. Demand would double for each Rs. 5 fall in the selling price.

The Company has an 80% cost experience curve for similar products. The cost of the first batch of 1000 phones was Rs. 1,03,000.

What is Siemens Ltd.'s target cost/unit to the nearest Re?

A) Rs. 40   B) Rs. 30   C) Rs. 32   D) Rs. 37.50

State whether the statements from Q.No.56 to Q.No.69 True or False.

56. It is appropriate to view the value chain from the customer's perspective, with each link being seen as the customer of the previous ling

57. One of the goals JIT seeks to achieve is batch sizes of one.

58. Examples of value added and non-value added activities are 'move time' and 'storage time' respectively.

59. JIT manufacturing, based as it is on 'push through philosophy' helps to provide the right parts at the right time in the quantity.

60. A 'cost of quality report' indicates the total cost to the organization of producing products or services conforming with quality of requirements.

61. A balanced score card studies the performance of management by comparing a financial achievement with the amount spent thereon.

62. While using a matrix method, in the event of close-down of a service centre (say, own generated electricity) the number of units of service number of units produced internally by the diagonal element of the concerned service. In the inverse of the matrix

63. Safety stock is that level of stock that is stored in fire-proof insurable storage.

64. Differential cost decision excludes fixed cost and qualitative factors.

65. Back Flash Accounting compares profit with the cost of producing a product.

66. EVA encourages short-term performance.

67. The useful purpose that budgets seek to serve include coordinating the activities of the various parts of the organization and ensuring that the parts are in harmony with each other.

68. to convert the assignment problem into a maximization problem, all elements of the matrix are deducted from the highest element in the matrix.

69. In a transportation problem VAM stands for Vogel's approximation method.

State the correct answer in each of the following statements by writing only the capital letter given under it:

70. Synergy is often expressed as

    A. 2+2 is 5

    B. 2+2 is 4

    C. 2+2 is < 4

    D. 2+2 is > 4

71. Control in management parlance consists of five actions

    1. Planning;

    2. Comparison of achievement of plan;

    3. Assessment of deviations;

    4. Corrective action for mismatch of performance with the plan;

    5. Execution

    The correct sequence of these activities is

A. 1-2-3-4-5

B. 1-5-3-4-2

C. 1-4-5-3-2

D. 1-5-2-3-4

72. The Basic problems in design of organization structure are

    1. Ensuring functional excellence;

    2. Ensuring coordination;

    3. Ensuring sense of belonging;

    4. Ensuring Control.

    As a matter of fact, the problems are

A. 1+2+3+4

B. 1+2

C. 1+2+4

D. 2+3+4

73. The formula suggested by E.H.Bowman for optimum production rate P_1 for a period is

    A. $aW_{t-1} + bI_{t-1} + cF_{t+1} + K$

    B. $aW_{t-1} - bI_{t-1} + cF_{t+1} + K$

    C. $aW_{t-1} - bI_{t-1} - cF_{t+1} + K$

    D. $aW_{t-1} - bI_{t-1} - cF_{t+1} + K$

Where W_{t-1} = the workforce in the previous period.

$F_{t+1} =$ the forecast of demand for the next period

a,b,c K are constants the values whereof are obtained by using regression analysis.

74. The theory of constants, as developed by Dr. Goldratt, evaluates performance by three measures, viz, Throughput (T), Inventory (I), and operating expense (O) Of these measures, the most important one is

    A. T as it focuses on sales

    B. I as it puts a zero value on unsold inventory

    C. O as it aims a reducing operating expense

    D. T, I and O in a judicious combination, as they are separate but interrelated process and concepts to increase return on investment and cash flow.

State which of the two words given in brackets should better fill in the gap in each of the following statements:

75. In operations management TOC, in a word, is "balance of flow, not the…….? (Capacity/Production)

76. Data mining, or the process of analyzing empirical data, allows for the ……….of the information. (interpolation / extrapolation)

77. …………can help users to locate and view information faster. (Internets/Intranets)

78. The process of determining gross requirements of components is termed "the …………. process". (explosion / inclusion)

79. The central focus of distribution is to increase the officiency of time, place and …………. utility. (customer / delivery)

State if each of the following statements is T (True) or (False):

80.   Value Analysis (VA) process is a less important tool than Function analysis System Technique (FAST).

81.   The term 'value' has four different meanings, namely exchange value, cost value, use value, wealth value.

82.   Internal quality costs consist of Preventive costs, appraisal costs, and Failure costs.

83.   The phrases – right first time or zero defects – were promoted by the Japanese quality expert Kaoru Ishikawa

84.   The BSC (Balanced Scorecard) puts more stress on financial parameters than on non-financial parameters since its objective is the growth of the organization.

85.   Match the items in Group X with the relevant items in Group Y, using filure mode and effects Analysis (FMEA)

Group X	Group Y
i) A Top – down analysis	a) Looks at failure from the product user's stand point
ii) B Bottom – up analysis	b) FEMAs are done on smallest price first
iii) C Component analysis	c) FMEAs are done on physical parts of the systems
iv) D Functional analysis	d) FMEAs are done on larger items first

Note: Your answer should consist of two letters only like

i)   Aa, Ab, Ac, or Ad

ii)   Ba, Bb, Bc, or Bd etc.

86.   Management ………… consists of shared values, beliefs and norms of organization.

87.   ………. Philosophy suggests that a firm should eliminate any reliance upon the EOQ.

88.   The internet sometimes refers only to the most visible service – the internal…………..

89.   ………… is a listing of the type and number of parts needed to produce one unit of finished product.

90.   The concept of …………. emphasizes linkage among all of the value-adding activities.

91.   ………… provides risk assessment services and insurance advice and solution to the clients.

92.   ………. are associated with the potential for not receiving payments owed by debtors.

93.   ……… is a Japanese strategy for continuous improvement.

94.   CRP: Capacity requirements planning

95.   DBR: Drum – Buffer – Rope

96.   DRP: Distribution Requirements Planning

97.   PLCM: Product Life Cycle Management

98.   SQC: Statistical Quality Control

99.   EFQM: European Foundation for Quality Management

100.   DMAIC: Define, Measure, Analyze, Improve, Control

101.   JUSE: Union of Japanese Scientists and Engineer

State whether the following statements are 'True' or 'False'. If false, you are to put up the correct statement.

102.   In fact, the 'effector' is another name for Management Information system (MIS).

103.   The concept of value analysis was first conceived by Jerry Kaufman.

104.   'Symbiotic relationship' is one in which the cooperative action of semi-independent sub-systems taken together produces a total output greater than the sum of their outputs taken independently.

105.   A 'level strategy', one of Aggregate Planning Strategies, implies matching demand and capacity period by period.

106.   Balance Score Card is a performance measurement tool for controlling individual productivity.

Choose the most appropriate one from the stated options and write it down:

107.   The concept of Management Control System (MCS) should be credited to

      A.   Joseph Maciariello and Calvin Kirby;

      B.   Calvin Kirby and L. Von Bertanffy;

      C.   Joseph Macieariello and Jack Welch;

      D.   Jack Welch and Robert Anthony.

108.   The structural decision components of the operations strategy are

      a.   Capacity, Organisation and Workforce;

      b.   Capacity, Facilities, Vertical Integration & Technology;

      c.   Capacity, Organisation and Technology;

      d.   Technology, Organisation and Information Systems;

109.   Back Flush Costing is most likely to be used when

      A.   Management desires sequential tracking of costs.

      B.   JIT inventory philosophy has been adopted;

      C.   Company carries significant amount of inventory;

      D.   Actual production costs are debited to work-in-progress;

110. The phrases 'Zero Defects' and 'Right First Time' were coined by

      A.   Kaoru Ishikawa;

      B.   Philip Crosby

  C. Peter Drucker;

  D. None of the above;

111. A Company's approach to a make-or-buy decision –

  A. Depends on whether the company is operating at or below normal volumes;

  B. Involves an analysis of avoidable costs;

  C. Should use absorption costing;

  D. Should use Activity – Based Costing.

Define the following terms, in not more than two sentences:

112. Learning curve effect

113. Quality Circle

114. Operations strategy

115. Linear Programming

116. Cost Driver

Write out what the following abbreviations stand for in the context of Enterprise Performance Management.

117. CRP

118. TOC

119. IBCH

120. QFD

121. CWQC

State whether the following statement are 'True' or 'False'. If 'False' put the corrected statement.

122. Theory Y style of management is a highly autocratic style.

123. The matrix organization structure is suitable for large projects.

124. The key factors of 'Theory of Constraints' are Contribution and Profit.

125. Life Costing is a technique to establish the total cost of ownership.

126. To convert the assignment problem into a maximization problem, all elements of the matrix are deducted from the highest element in the matrix.

Choose the most appropriate one from the stated options and write it down.

127. An effective reward system requires:

 (A) Increase production

 (B) Establishment of goals

 (C) All process are fully utilized

 (D) None of the above

128. Demand stimulation could be due to:

 (A) Pricing

 (B) Promotion

 (C) New demand creation

 (D) All of the above

129. Target cost management is

 (A) A management technology to establish a cost target

 (B) Is a structured approach for determining cost

 (C) Both of the above

 (D) None of the above

130. Balanced Scorecard is a new approach developed by
    - (A) Dr. J.M. Juran and Philip Crossby
    - (B) Dr. W.A. Shewart and Dr. W.E. Edwards
    - (C) Robert Kaplan and David Norton
    - (D) Joseph Maciariello and Calvin Kirby

131. Quality Circle is
    - (A) People – building philosophy
    - (B) Based on the value of the worker
    - (C) Is a problem – solving technique
    - (D) All of the above

Explain the following terms, in not more than one-two sentences:

132. Zero defects
133. Kaizen
134. EFQM
135. Simulation
136. Experience Curve

Write out what the following abbreviations stands for in the context of Enterprise Performance Management.

137. JUSE
138. BSC
139. EPMS
140. VAM
141. FAST

142. A company has budgeted break-even sales revenue of Rs. 8,00,000 and fixed costs of Rs. 3,20,000 for the next period. The sales revenue needed to achieve a profit of Rs. 50,000 in the period will be:
    - (A) Rs. 8,50,000
    - (B) Rs. 9,25,000
    - (C) Rs. 11,20,000
    - (D) Rs. 12,00,000

    Your answer must be backed up by your workings.

Expand the following in the context of enterprise performance management.

143. CMS
144. LCP
145. SCP
146. CPOF:
147. CRP
148. MRP
149. MRP-II
150. MPS.
151. CB
152. RP
153. FCS
154. APS
155. AH
156. LPP
157. MPP

158. LDR
159. MCM
160. SDR
161. FOS
162. JIT
163. ICS
164. EOQ
165. SCRS
166. PMS
167. QIS
168. AQL
169. PIS
170. CIM
171. OPT
172. TOC
173. ECE
174. DBR
175. BM
176. BOM
177. EIS
178. CRM
179. ERP
180. MPC
181. DRP
182. IBC
183. APQC
184. ALM
185. HCM
186. PLCM
187. LTM
188. OMP
189. SCM
190. SCP
191. KIP
192. WAITRO
193. QFD
194. FMEA
195. FAST
196. VAM
197. CFM
198. TCM
199. LCC
200. WLC
201. BEP
202. CVP
203. USCF
204. RSCFA
205. RFID

206. BSC
207. SMS
208. TQM
209. JUSE
210. SQC
211. CWQC
212. DPMO
213. CWTQM
214. TQC
215. PDCA
216. PDSA
217. DMAIC
218. COC
219. CONC
220. AHT
221. DMADV
222. DMIAD
223. DMAIC
224. EQS
225. ISO
226. QMS
227. EMS
228. EFQM
229. ISI

ANSWERS:

1. **Ans:**

    1. If the company accepts the Deluxe order, it will lose export sales due to shortage of materials.
    2. Contribution per unit Rs. 2 (SP 5 – MC 3)
    3. Contribution per Rupee 1 of material = Rs. 4 (on export sale)
    4. Each Deluxe model uses Rupee 1 worth of raw material.

The company must obtain a contribution of at least Rs. 4/unit – the opportunity cost of raw material.

The minimum price therefore would be: -

	Rs.
Direct material	1.0
Direct Labour	2.0
Variable Overhead	0.5
Required contribution	4.0
Selling price per unit	**7.5**

2. **Ans:**

Present value of an annuity for seven years at 12% = 4.564

Annual cash saving required Rs. 40,000/4.567=8,764 i.e., there must be Rs. 4,764 from labour savings assuming planned material savings of Rs. 4,000 are achievable.

Note: The required percentage change in labour cost from the original estimate cannot be worked out as the original estimate is not given.

3. **Ans:**

Optimum order quantity = $\sqrt{\dfrac{2 \times 3000 \times 150}{10}} = 300\,\text{units}$

Total relevant cost when quantity is 300 units.

Ordering cost + carrying cost = (3000 / 300) x 150 + (1/2 x 300 x 10) = Rs. 3,000

4. **Ans:**

The relevant cost of "Jeet" bicycle will be:

Material	300
Labour	200
Variable overhead (0.4 x 300)	120
Cost of Capital (0.15 x 600000)/25000	3.60
	623.60

Should Star accept the offer of making "Jeet" for the chain stores, the loss in contribution due to sale of Star going down by 10000 units is relevant, which loss is Rs. (899-300-200-120) = Rs. 279

The price then should be Rs. 623.60 + 279 = Rs. 902.60. This is higher than the price of Rs. 800 as offered by the chain store. So, the offer cannot be accepted.

Since the cahin store has decided to launch a product like "Jeet", it will do so whether or not Star bicycle accept the proposal as there is excess capacity in the industry it will be able to do so. In that case, the loss of contribution is Rs. 279 is not relevant and Star can accept the proposal of the chain store. Star should have a closure look in the market condition and the chain store's ability to get a replica of "Jeet" from other manufacturer before Star reaches a final decision.

5. Ans:

i) Costs Classified:

Prevention costs: quality training

Appraisal costs: Product inspection and materials inspection

Internal failure costs: scrap and rework

External failure cost: warranty

ii) Increase in Profit:

Preceding year – Total quality costs, 2001-2002: Rs. 20,00,000;

Current year – Total quality costs: Rs. 15,45,000;

Profit has increased by Rs. 4,55,000

6. Ans:

$$\text{Saving in cost} = \frac{1800,000}{9} \times \frac{10}{100} - \frac{1800,000}{12} \times \frac{10}{100} = Rs.5,000$$

7. Ans:

Formulation of LPP: Maximise Z=40A + 20B+50C

Constraints:

100A+150B+200C	$\leq$ 190
200A + 120C	$\leq$ 110 + 70 B
30C	$\leq$ 50A+70B

A, B, C $\leq$ 1: A, B, C $\geq$ 0

8. Ans:

Demand	Price (Rs)
20,000	100
10,000	90
80,000	80

Target Cost = Rs. 80 – (25% of 80) = Rs 80 – 20 = Rs 60

9. Ans:

1st Unit	100%
2nd	80% x 100%
4th	80% of 2nd
8th	80% of 4th
16th	80% of 8th = 0.80 x 0.80 x 0.80 x 0.80 = 40.96%

Say, 41% of the time required for the 1st unit.

10. Ans:

	At year 6 prices	Hours
	Rs	Rs
Year 3 – Rs 39,888 x 140/120	46,536	9,120
Year 5 – Rs. 40,602 x 140/134	42,420	7,650
	4,116	1,470

: Hence, variable cot per hour Rs. 4,116/1,470=Rs.2.80

Fixed Cost = Rs. 46,536 – (9,120 x Rs. 2.80) = Rs.21,000

∴ Forecast for year 6 = Rs. 21,000 + 8,720 x Rs. 2.8) Rs. 45,416

11. Ans:

New profit will be Rs. 3,30,000 (Rs. 2,40,000 + Rs. 90,000)

New capital will be Rs. 25,00,000 (Rs. 20,00,000 + Rs.500,000)

∴ Interest notionally charged = Rs. 2,50,000

∴ Residual income = Rs. (3,30,000 – 2,50,000) = Rs. 80,000

12. Ans:

Putting the value in the I.C. mode of Y = a x b and with the help of log table or a calculator (scientific – non programmable which is allowed to a 'final' examinee) we get Y (the average time for 20 units) 10 x 20 $^{-0.3219}$=3.81

13. Ans:

Target cost = selling price at capacity – 25% of price = 75% of selling price = 75% of Rs. 40 = Rs.30

14. Ans:

Current level of inventory held = Rs. 10 cr/5 = Rs.2 cr

With stock turnover doubling, the average level of inventory will be Rs. 1 cr. Hence, inventory financing cost would be 10% of Rs. 1 cr = Rs. 10 lakh.

15. Ans:

When V (Var. cost) = 100, SP = 160, M.Cost/SP = 60/100

SP after 10% mark down of SP = 144, Cost = 60-16=44

Contribution Margin Ratio = 44/144=0.3056=30.6%

16. Ans:

MS=Profit/PV Ratio = Rs. 4 Lakh: MS=50%; BE Sales = (1-0.50) = 0.50

Hence BES = Rs. 4 lakh

Fixed Cost 25% of Rs. 4,00,000 = Rs. 1,00,000

17. Ans:

Target cost = Selling Price at capacity – 25% PV = Rs 40 – 25% of Rs. 40

= Rs 40 – Rs 10 = Rs 30

18. Ans:

12% p.a. interest for 90 days on Re.1

=0.12 x 90/365   = 0.02959

Amount after 90 days   =1.02959

Net amount received   = Rs. 20,000,000/1.02959

= Rs. 1,94,25,226

Say Rs. 1.94 Crore

19. Ans:

With back order, EOQ formula is modified as $\left[\sqrt{\dfrac{2\,AD}{h\left(\dfrac{b}{h+b}\right)}}\right]$

A is incorrect because EOQ will increase.

C is incorrect because lead time is not affected

D is incorrect because back order cost must be included in the model as back order system replaces inventory.

20. Ans:

A given percentage change in unit sale price must have greater effect on contribution margin than any other factor affected by the same percentage change.

21. Ans:

Answer is C

The single rate method combines fixed and variable costs without regard to cost behaviour patterns.

A and B do not exactly fit in with the given question as they can be used on a single or dual rate; and Ans D allows variable costs to be allocated on different basis from fixed costs.

22. Ans:

Actual quantity bought x standard price

= 1,600 x Rs. 3.60 = Rs. 5,760

Deduct favorable price variance 240

Actual quantity x actual price = 5,520

Or, 1,600 x actual price = Rs. 5,520

So, Actual price = Rs. 5,520/1,600 = Rs. 3.45

23. Ans:

Original price is not relevant

Rework income	Rs 18,000
Deduct cost of rework	10,000
Net inflow	Rs. 8,000 It is relevant

The other alternative relevant cash flow is from sale as scrap = Rs. 3,000

Hence, the opportunity cost is Rs. 3,000.

24. Ans:

Products	P	V	Total
Units	800	400	
S.P. (Rs)	25	50	
Sales (Rs)	20,000	20,000	
Further costs (Rs)	8,000	12,000	
NRV (Rs)	12,000	8,000	20,000

Joint cost appropriated Rs. 9,000

Total Joint Cost = (9,000/12,000) x 20,000 = Rs. 15,000

25. Ans:

At a production of 75,000 units or less the fixed costs amount to Rs. 8 lakh Contribution is Rs. 10 per unit (Rs. 25 – 60% of Rs. 25). Production will however, be more than this level. Total fixed cost is then Rs. 12 lakh.

Contribution for first 75,000 units = Rs. 7,50,000

Hence, to meet Rs.12 lakh fixed cost, further Rs. 4,50,000 contribution is required.

Contribution beyond 75,000 units is Rs. 12.5 (Rs. 25 – 50% of Rs. 25).

Additional units to be sold = Rs. 4,50,000 / Rs. 12.50 = 36,000) units = 1,11,000 units.

26. Ans:

Working for Himalayas

Year	CF Rs	DF at 15%	PV Rs	DF at 20%	PV Rs
0	(450)	1.000	(450)	1.000	(450)
1	300	0.870	261	0.833	250
2	200	0.756	151	0.694	139
3	100	0.658	66	0.57	58
		NPV	28		(3)

Hence IRR = 20% (approx.)

Projects	
Alpas	Himalayas
Lower NPV	Higher IRR

27. Ans:

"B" is correct

	Rs
Cost of goods sold	8,00,000
(Less) Material cost	(3,60,000)
Conversion cost allocated	4,40,000
Conversion cost incurred	4,80,000
Excess charged to cost of goods sold account	40,000

Total bedit on cost of goods sold account = Rs. 8,00,000 + Rs. 40,000 = Rs. 8,40,000

28. Ans:

"C" is correct

The weighted average contribution to sales ratio

=0.25 x 0.20 + 0.40 + 0.30 x 0.40 = 0.33

BE Sales = Rs. 6,00,000/0.33 = Rs. 18,18,181

29. Ans:

"C" is correct

	Rs
Sales revenue 500 x Rs. 1,500	7,50,000
Return on investment required 15% x Rs. 15,,00,000	2,25,000
Total cost allowed	5,25,000
Target cost per unit (5,25,000/500)	Rs.1,050

30. Ans:

: "C" is correct

Selling Price = Rs. (50-0.001 x)

Marginal revenue = Rs. (50-0.002x)

Variable cost per unit

= Marginal cost per unit = Rs. 20

Optimal output for maximum profit: 20 = 50 – 0.002x

Whence, X = 30/0.002= 15,000 units

SP = 50-0.001x

= 50-0.001 (15,000)

=50-15

=Rs.35

31. Ans:

: "D" is correct

	Product X	Product Y
Throughput of P per day	13 x 60/6=130	13 x 60/10 = 78
Throughput of Q per day	14 x 60/20 = 42	14 x 60/15 = 56

So, Process ! is the bottleneck for both products.

Contribution per hour of product X = Rs. (90-15) x 60/20 = Rs. 225

Contribution per hour of product Y = Rs. (80-15) x 60/15 = Rs. 260

Processing product Y @ 56 units per day will give the larger contribution.

32. Ans:

"B" is correct

Contribution per unit of component	Rs	Rs
Variable Prime cost	10.00	
Variable overhead	2.40	
Selling/Administrative expenses	0.60	13.00
Contribution		Rs. 8.00

Avoidable fixed cost per quarter

= total fixed cost-(unavoidable fixed cost + additional shut down cost)

=(50,000 x Rs.4) – (Rs.74,000 + Rs.14,000) = Rs.1,12,000.

The required shut down point for the quarter = Rs.1,12,000 / Rs. 8 = 14,000 units.

33. Ans:

"D" is Correct

Current ROI – (720/3,200)x100%   = 22.5%

New ROI = (720+50)/(3,200+260)x100%= 22.25%

The new ROI is lower and is not acceptable to the divisional management

Current RI in Rs(000) = 720-(16% x 3,200) = 208

New RI in Rs(000) = (720+50)-{16%x (3200+260)}=216.4

The new RI is higher and will motivate the divisional management.

34. Ans:

"B" is correct.

Total moves in material handling = 5+15=20

Percentage move for Product A = 5/20=25%

Material handling cost to be allocated to Product A = Rs. 60,000/25%=Rs.15,000

i.e., Rs. 15,000/30=Rs.500 per unit.

35. Ans:

"A" is correct

A flexible budget is a set of static budgets prepared in anticipation of varying levels of activity. It permits evaluation of actual results when actual production and expected production differ. Setting cost standards facilitates preparation of a variable budget. For example, a standard unit variable cost is useful in determining the total variable cost for a given output.

36. Ans:

"B" is correct.

Available resources should be used as efficiently as possible before outsourcing. If the total 'relevant' cost of production is less than the cost to buy the item, it should be produced in-house. The relevant costs are those that can be avoided.

37. Ans:

"B" is correct. (Selling Price – Material Cost)/ Time of bottleneck resource = [(Rs. 50-Rs.20)/10 minutes] x 60 = Rs. 180 per hour.

38. Ans:

"B" is correct.

Services Type	A	B	C
	Rs./job	Rs./job	Rs./job
Annual fee	3,000	2,400	1,800
Annual variable costs	1,350	800	810
Contribution	1,650	1,600	990
Proportion of services	2	3	5
Contribution per set of three services	3,300	4,800	4,950

Total of contributions for a set = Rs. (3,300+4,800+4,950) = Rs. 13,050

Number of sets to break even = F/C = Rs. 5,74,200/Rs. 13,050 = 44

Annual fee for a set of services = Rs. 3,000 x 2 + Rs.2,400 x 3 + Rs. 1,800 x 5 = Rs.22,200

Break even sales = 44 x Rs. 22,200 = Rs. 9,76,800

39. Ans:

"D" is correct.

The sales demand is 4,000 units per month. The monthly contribution must absorb the fixed costs of Rs. 20,000 and leave at least a surplus of Rs. 1,20,000 profit. So, the contribution per unit must be Rs. 1,40,000/4,000 units = Rs. 35 in the minimum.

The following selling price and variable cost pairs will produce a contribution of more than Rs. 35.

Selling Price	Variable Cost	Contribution	Joint Probability of SP & VC
Rs.	Rs.	Rs.	
75	30	45	0.45 x 0.25 = 0.1125
90	30	60	0.30 x 0.25 = 0.0750
90	45	45	0.30 x 0.40 = 0.1200
			0.3075

40. Ans:

"B" is correct.

Units	Total Variable Cost	Selling Price	Total revenue	Total Contribution
	Rs.	Rs.	Rs.	Rs.
10	40,000	8,000	80,000	40,000
11	40000+4400=44,400	7,800	85,800	41,400
12	44000+4800=49,200	7,600	91,200	42,000
13	49200+5200=54,400	7,400	96,200	41,800
14	54400+5600=60,000	7,200	1,00,800	40,800

41. Ans:

"A" is correct.

All the costs mentioned in the question are parts of the total life cycle costs.

42. Ans:

Constraint is the Raw Material which are used in the Ratio of 5:4.

The Contribution from X = 1000 – 600 = 400.

Therefore, the contribution for Y should be = 400/5 x 4 = 320

Therefore, Selling Price of Y = 320 + 600 = 920

"C" is the correct answer.

43. Ans:

	1000	980	980	1060	980
	(1) **SQSP**	**(2)** **AQSP**	**(3)** **RSQSP**	**(4) Market** **RSQSP**	**(5)** **AQAP**
X	200 x 50	210 x 50	196 x 50	212 x 50	210 x 52
Y	300 x 25	330 x 25	294 x 25	318 x 25	330 x 24
Z	500 x 18	440 x 18	490 x 18	530 x 18	440 x 19
X	10000	10500	9800	10600	10920
Y	7500	8250	7350	7950	7920
Z	9000	7920	8820	9540	8360
	Rs.26500	**Rs.26670**	**Rs.25970**	**Rs.28090**	**Rs.27200**

(1) **AQSP**	**(2)** **RSQSP**	**(3)** **Market RSQSP**
Rs.26,670	**Rs.**25,970	**Rs.**28,090

(b) Sales Mix Variance = 1 – 2 = **Rs.**700 (F)

(a) Market share variance = 2 – 3 = **Rs.**2120 (A)

"C" is the correct answer.

44. Ans:

Average time per 200 units

Y = 30 x $200^{-0.2345}$ = 8.66 hours

Average time per 199 units

= 30 x $199^{-0.2345}$ = 8.67 hours

Total hours for 200 units = 8.66 x 200   = 1732.00

Total hours for 199 units = 8.67 x 199   = <u>1725.33</u> .

                                             <u>6.67 hours</u>

"D" is the correct answer.

45. **Ans**:

Profit under Absorption Costing Method.

			Rs.
Production Costs	14 x 4800		67,200
Fixed Costs absorbed		8 x 4800	38,400
			1,05,600
Add: Op. Stock	400 x 22		8,800
			1,14,400
Less: Cl. Stock	600/4800 x 1,05,600		13,200
			1,01,200
Add: Under Absorption			1,600
		Profit	1,02,800
			12,200
Sales		(4600 x 25)	**1,15,000**

Profit under Marginal Costing

				Rs.
I.	Sales			1,15,000
II.	Variable Cost		67,200	
	(+) Op. Stock (400 x 14)	5,600		
			72,800	
	(-) Cl. Stock (600 x 14)	8,400		64,400
III.	Contribution			50,600
IV.	Fixed Cost			40,000
V.	Profit			10,600

Profit under Absorption costing is Rs. 1600/- higher than Marginal Costing Method 12,200 – 10,600 = 1,600.

"B" is the Correct Answer.

46. **Ans**:

Units	Average Time (hours)	Total Time (hours)
1	4000	4000
2	3600	7200
4	3240	12960
8	2916	23328

Total time for 5th to 8 units = 23328 – 12960 = 10368 hrs.

"D" is the Correct Answer.

47. Ans:

	Standard Data				Actual Data		
	Q	**P**	**V**		**Q**	**P**	**V**
A	590	150	88,500		595	140	83,300
B	354	200	70,800		330	212	69,960
C	236	250	59,000		255	270	68,850
	1180		2,18,300		1180		2,22,110
Less:	236		--		260		--
	944		2,18,300		920		2,22,110

	1 SQSP	**2** RSQSP	**3** AQSP	**4** AQAP
A	575 x 150		595 x 150	
B	345 x 200		330 x 200	
C	230 x 250		255 x 250	
A	86,250		89,250	
B	69,000		66,000	
C	57,500		63,750	
	Rs.2,12,750	Rs.2,18,300	Rs.2,19,000	Rs.2,22,110

SQ for   A = 590/944 x 920 = Rs.575

         B = 354/944 x 920 = Rs.345

         C = 236/944 x 920 = Rs.230

Yield Variance (1-2)   = Rs.5,550 (A)
Mix Variance (2-3)   =   Rs.700 (A)
"C" is the Correct Answer.

48. Ans:

Present values of Cash Inflows = 40,000 x 2.855 = 1,14,200 which is the cost of the   project.

$$\frac{1.064}{Profitability\ Index} = \frac{P.V\ of\ Inflows}{1,14,200}$$

P.V of Inflows = 121508.8
Therefore NPV = 121509 – 1,14,200 = 7309
"A" is the Correct Answer

49. Ans:
"B" is the Correct Answer.

Because when JIT is used change in inventory is minimum and back flush costing is used in association with JIT and Back Flush costing minimizes efforts and expenses of Inventory.

50. Ans:
Relevant cost of Material for the Job = 200 + 300 x 0.8 = Rs. 440

     "B" is the Correct Answer

51. Ans

Answer is "A": Present contribution: Rs. (100-42) = Rs.58/unit. Total contribution for 90,000 units = Rs. 52,20,000. With fixed costs of Rs. 24,00,000. Profit = Rs. 28,20,000. The proposed revised selling price is Rs. 90. The resultant increased sales volume and reduced variable costs together should bring in profit exceeding Rs. 28,20,000, i.e., the total contribution must exceed Rs. 52,20,000. The probability of contribution exceeding Rs. 52,20,000 will be as follows:

Sales unit	SP	VC/Unit	Contbn/Unit	Total Contribution	Probability		Joint
				Rs.	SP	VC	Probability
1,00,000	90	40	50	50,00,000	0.45	0.40	0.18
1,00,000	90	36	54	54,00,000	0.45	0.60	0.27
1,20,000	90	40	50	60,00,000	0.55	0.40	0.22
1,20,000	90	36	54	64,80,000	0.55	0.60	0.33

Probability of contribution increasing beyond the present level of Rs. 52,20,000 = 0.27+0.22+0.33=0.82

52. Ans

Answer is "D"

	Rs.
Annual operating profit	402
Add: New product cost	60
Total	**462**
Less: New product cost for one year (amortization)	20
Net profit	**442**

Replacement cost of asset Rs. 1,720 L

Cost of Capital 11% of 1,720 L = Rs. <u>189.20 L</u>

EVA = Rs. (442-189.20) L = Rs. 252.80L

53. Ans: **"D" is the correct answer.**

The formula for learning curve rate is y = ax – b

From the given data, Y = 8.366/4 = 2.0917 and 2.0917 = 3* 4-b [as x = 4 and a = 3]

Taking log of the equation, log 2.0917 = log 3 – b log 4

or, 0.3205 = 0.4771 – 0.6021b

When, b = 0.2601

Now b = -log P/log 2 [Where P is the learning percentage]

or, - log P = b log 2

or, - log P = b* log 2 = 0.2601*0.3010

or, log P = -0.0783

So, P = antilog (-0.0783) = 0.8350 = 83.5%.

[Alternately, we can find the value of the learning rate as under:

Let the learning rate be X.

Since the first unit took 3 hours, the average time for the first 2 units = 3*X and the average time for the first 4 units = 3*X*X

So, $3X^2$ = 8.3667 / 4 = 2.0917

or, X^2 = (2.0917 / 3)

$Therefore\ X = \sqrt{(2.0917/3)} = (0.835\ i.e.\ 83.5\%)$

54. Ans:"B" is the Correct Answer

Zee Ltd. Allocates overhead to the activity that specifically drives the overhead cost. There will be 20 moves caused by Wall mirrors and Specially windows, of which Wall mirrors require 5. So, Wall mirrors shall be allocated 5/20 of the material handling costs of Rs. 12,500. 25 units of Wall mirrors will be moved. Hence material handling cost per unit of Wall Mirror = Rs. 12,500 / 5 = Rs. 500.

55. Ans: "B" is the Correct Answer

Target cost = Selling price at capacity – 25% profit margin.
The price – demand figures are projected as:

Price Rs.	Demand Units
50	1,00,000
45	2,00,000
40	4,00,000

Therefore Target cost/unit = Rs. 40 – (25% of Rs. 40) = Rs. 30

> **Note:**
> 1. If the profit margin is taken to be on cost, then the target cost will be Rs. 32
> 2. The information about Siemen's cost experience curve is not relevant for this work.

56. True

57. True

58. False

59. False

60. False

61. False

62. True

63. False

64. False

65. False

66. False

67. True

68. True

69. True

70. A

71. D

72. C

73. B

74. D

75. Capacity

76. Extrapolation

77. Intranets

78. explosion

79. delivery

80	TRUE
81	FALSE
82	TRUE
83	FALSE
84	FALSE
85	i) - Ad ii) –Bb, iii) - Cc, iv) – Da
86	culture
87	JIT
88	Website
89	Bill of Material
90	supply chain management
91	Insurance Agents
92	Credit risks
93	Kaizen
94	Capacity requirements planning
95	Drum – Buffer – Rope
96	Distribution Requirements Planning
97	Product Life Cycle Management
98	Statistical Quality Control
99	European Foundation for Quality Management
100	Define, Measure, Analyze, Improve, Control
101	Union of Japanese Scientists and Engineer
102	False, The correct term is 'Detector' and not "Effector".
103	False, The correct answer is 'Lawrence Milies and not Jerry kaufman.
104	False, The correct term is 'Synergistic' and not 'Symbiotic'.
105	False, The correct term is 'Chase strategy' and not 'Level strategy'.
106	False, The correct statement is – Balanced Score Card is not a performance measurement tool.
107	A
108	B
109	B
110	B
111	B
112	It states that the more times a task has been performed, the less time will be required on each subsequent iteration.
113	It is a small group of employees, doing similar work, who voluntarily meet together on a regular basis, to identify improvements in their respective work areas;

114	It is the total pattern of decision, which shape the long-run capabilities of operations and their contribution to the overall strategy, thru' the requirements with operations resources.
115	Linear Programming is an optimization technique that allows the user to find a maximum profit / revenue or a minimum cost, based on the availability of limited resources and certain constraints.
116	Cost Driver, is the one that is selected and used as a basis with a view to assigning costs attached/attributed to an activity cost centre to cost objects – a term commonly used in ABC costing.

117	CRP – Capacity Requirements Planning
118	TOC- Theory of Constraints
119	IBCH – International Benchmarking Clearing House
120	QFD – Quality Function Deployment
121	CWQC – Company Wide Quality Control.
122.	False: Theory Y style of management is a highly participative style.
123.	False: The matrix organization structure is not suitable for large projects.
124.	False: The key factors of 'Theory of Constraints' are Throughout Inventory & Operating expense
125.	True:
126.	True
127.	(B) – Establishment of Goals
128.	(D) – All of the above
129.	(C) – Both of the above
130.	(C) – Robert Kaplan and David Norton
131.	(D) – All of the above
132.	Zero defects: does not mean mistakes never happen, rather that there is no allowable number of errors built into a product or process and that you get it right first time.
133.	Kaizen: Kaizen is a Japanese strategy for continuous improvement.
134.	EFQM: stands for European Foundation for Quality Management. It is the hub of excel globally minded organizations – both private & public.
135.	Simulation: Stands as the technique of last resort by developing a model of the real phenomenon using Random Nos.
136.	Experience Curve: Effect is broader in scope than the 'Learning Curve'. It states that the no. often a task is performed; the lower will be the cost of doing it.

137.	JUSE – Japanese Union of Scientists and Engineers
138.	BSC – Balance Score Card
139.	EPMS – Enterprise Performance Measurement System
140.	VAM – Vogel's Approximation Method
141.	FAST – Function Analysis System Technique.
142.	PV Ratio = Fixed cost/B.E. Sales = 3,20,000/8,00,000 x 100 = 40% Contribution required = FC + Profit = Rs. (3,20,000 + 50,000) = Rs. 3,70,000 Sales = 3,70,000/40% = Rs. 9,25,000 Hence the alternative B is the right answer.

143. CMS: Capacity Management Strategy
144. LCP: Long term Capacity Planning
145. SCP: Short Term Capacity Planning
146. CPOF: Capacity Planning Using Overall Factors
147. CRP: Capacity Requirement Planning
148. MRP: Material Requirement Planning
149. MRP-II: Manufacturing Resources Planning
150. MPS: Master Production Schedule
151. CB: capacity Bills
152. RP: Resource Profiles
153. FCS: Finite Capacity Scheduling
154. APS: Aggregate Planning Strategy
155. AH: Annualized Hours
156. LPP: Linear Programming Problem
157. MPP: Mixed- integer Programming Problem.
158. LDR: Linear Decision Rule
159. MCM: Management Coefficients Models
160. SDR: Search Decision Rule
161. FOS: Function Objective Search Approach
162. JIT: Just In Time
163. ICS: Inventory Control Systems
164. EOQ: Economic Ordering Quantity
165. SCRS: Setup Cost Reduction System
166. PMS: Preventive Maintenance System
167. QIS: Quality Improvement System.
168. AQL: Acceptable Quality Level
169. PIS: Productivity Improvement System
170. CIM: Computer Integrated Manufacturing
171. OPT: Optimized Production Technology
172. TOC: Theory of Constraints
173. ECE: Effect Cause Effect Diagram
174. DBR: Drum Buffer Rope
175. BM: Buffer Management
176. BOM: Bill of Material
177. EIS: Executive Information System
178. CRM: Customer relationship Management
179. ERP: Enterprise Resource Planning
180. MPC: Manufacturing Planning and Control
181. DRP: Distribution Requirements Planning
182. IBC: International Benchmarking Clearing House.
183. APQC: American Productivity and Quality Center
184. ALM: Asset Life Cycle Management
185. HCM: Human Capital Management
186. PLCM: Product Life Cycle Management
187. LTM: Logistics & Transportation Management
188. OMP: Order Management & Pricing

189. SCM: Supply Chain Management
190. SCP: Supply Chain Planning
191. KIP: Knowledge Improvement processes.
192. WAITRO: World Association of Industrial and Technological Research Organization.
193. QFD: Quality Function Deployment
194. FMEA: Failure Modes and Effects Analysis
195. FAST: Function Analysis System Technique
196. VAM: Value Analysis Method.
197. CFM: Cost Function Matrix
198. TCM: Total Cost Management
199. LCC: Life Cycle Costing
200. WLC: Whole Life Costing
201. BEP: Break Even Point
202. CVP: Cost Volume Profit Analysis
203. USCF: Upside Supply Chain Flexibility
204. RSCFA: Return on Supply Chain Fixed Assets
205. RFID: Radio Frequency Identification
206. BSC: Balanced Score Card
207. SMS: Strategic Management Systems
208. TQM: Total Quality Management
209. JUSE: Union of Japanese Scientists and Engineers
210. SQC: Statistical Quality Control
211. CWQC: Company Wide Quality Control
212. DPMO: Defects per Million Opportunities
213. CWTQM: Company Wide Total Quality Management
214. TQC: Total Quality Control / Total Quality Costs
215. PDCA: Plan – Do Check – Act
216. PDSA: Plan – Do Study – Act
217. DMAIC: Define, Measure, Analyze, Improve, Control
218. COC: Cost of Conformance
219. CONC: Cost of Non-Conformance
220. AHT: Average Handling Time
221. DMADV: Define, Measure, Analyze, Design, Verify
222. DMIADV: Define, Measure, Analyze, Design , Verify
223. DMAICR: Define, Measure, analyze, Improve, Control, Realize
224. EQS: External Quality Standards
225. ISO: International Organization for standardization
226. QMS: Quality Management System
227. EMS: Environmental Management Systems
228. EFQM: European Foundation for Quality Management
229. ISI: Indian Statistical Institute