Group - II
Paper 9 - Operations Management and Information Systems

Section A – Operation Management

1. **(a) Discuss the objectives of Product Design.**

   (b) Mentioning the generic components of innovation.

   (c) Define the Process Strategy.

   (d) Discuss the advantages of Vertical Integration.

   (e) The demand function of a firm is q = 200 – 10 p and the average cost function is $AC = 10 + \frac{q}{25}$. If the firm's objective is to maximize profit, what will be its profit maximizing output?

   (f) Consider the pay off matrix given below:

$$\begin{array}{cc} & \begin{array}{cc} B_1 & B_2 \end{array} \\ \begin{array}{c} \text{Player A} \\ \\ \end{array} & \begin{array}{c} A_1 \\ A_2 \end{array} \begin{bmatrix} 2 & 6 \\ -2 & \lambda \end{bmatrix} \end{array}$$

   (i) Show that whatever be the value of λ, the game is strictly determinate.
   (ii) Determine the value of game.

   (g) Discuss the techniques of Work Measurement.

   (h) A work sampling study is to be made of a typist pool. It is felt that typists are idle 30 percent of the item. How many observations should be made in order to have 95.5% confidence that accuracy is within ± 4%.

   (i) Define the Mean Absolute Deviation (MAD).

   (j) A workshop operates on 2 shifts of 8 hours per day. It has 10 machines. It works for 5 days in a week. Machine utilization is 90% and the efficiency of the machines is 85%. Calcutta the designed/ rated capacity of the workshop in standard hours.

   (k) What are the factors affecting the process planning?

   (l) Mentioning the different types of Layout.

   (m) Discuss about the Total Float.

   (n) A production manager of a plant must determine the lot size for a particular component that has a steady demand of 50 units per day. The production rate is 200 units per day, Annual demand is 10,000 units, set-up cost is ₹ 200, annual holding cost is rupee 0.20 per unit and the plant operates 350 days per year. Determine the economic production lot size.

   (o) Define Quality Function and Development (QFD)

Solution:

(a) The objectives of the Product Design are :

(i) The overall objective is profit generation in the long run
(ii) To achieve the desired product quality
(iii) To reduce the development time and cost to the minimum
(iv) To reduce the cost of the product
(v) To ensure producibility or manufacturability (design for manufacturing and assembly).

(b) Four generic components of technological innovation are: basic research, applied research, development, and implementation.

(i) **Basic research** is research for the advancement of scientific knowledge that has no specific commercial uses. Basic research may, however, be in the field of present or potential interest to the company.

(ii) **Applied research** is research for the advancement of scientific knowledge that has specific potential commercial uses.

(iii) **Development** is technical activity concerned with translating basic or applied research results into products or processes.

(iv) **Implementation** is activity concerned with designing and building pilot models, equipment, and facilities, and initiating the marketing channels for products or services emerging from research and development.

(c) A **process strategy** is an organization's approach to process selection for the purpose of transforming resource inputs into goods and services (outputs). The objective of a process strategy is to find a way to produce goods and services that meet customer requirement and product specification (i.e., design specifications) within the constraints of cost and other managerial limitations.

Key aspects in process strategy include**:**

(i) Make or buy decisions
(ii) Capital intensity and
(iii) Process flexibility

(d) Advantages of vertical integration are:

(i) Can sometimes increase market share and allow the firm enter foreign markets more easily.
(ii) Can achieve savings in production cost and produce higher quality goods.
(iii) Can achieve more timely delivery.
(iv) Better utilization of all types of resources.

(e) Here the equation of the demand curve is

$q = 200 - 10\,p$

or, $10\,p = 200 - q$

or, $p = \frac{200 - q}{10} = 20 - \frac{1}{10}q^2$

So, total revenue (R) = $pq = 20q - \frac{1}{10}q^2$

$\therefore$ Marginal Revenue (MR) $\left(\frac{dR}{dq}\right) = 10 + \frac{2}{25}q$

Again, AC = $10 + \frac{q}{25}$

$\therefore$ Total Cost (C) = AC x q = $10q + \frac{q^2}{25}$

$\therefore$ Marginal Cost $\left(\frac{dc}{dq}\right) = 10 + \frac{2}{25}q$

Now, the first order condition for profit maximization requires, MR =MC.

$\therefore\ 20 - \frac{1}{5}q = 10 + \frac{2}{25}q$

or, $\frac{1}{5}q + \frac{2}{25}q = 20 - 10$

or, $\frac{7}{25}q = 10 \therefore q = \frac{10 \times 25}{7} = \frac{250}{7}$

The second order condition requires that slope of MC>Slope of MR.

Now, slope of MR= $\frac{d(MR)}{dq} = -\frac{1}{5} < 0$ and slope of MC= $\frac{d(MC)}{dq} = \frac{2}{25} > 0$.

So, the second order condition is fulfilled.

Hence, to get maximum profit, the firm will produce $\frac{250}{7}$ units of output.

(f) (i) We determine the maximin and the minimax value, ignoring λ.

$$\begin{array}{cccc} & B_1 & B_2 & r \\ \text{Player A} \quad A_1 & 2 & 6 & 2 \\ A_2 & -2 & \lambda & -2 \\ c & 2 & 6 & \end{array}$$

Here maximin value = 2 and minimax value = 2. Thus, maximin value = minimax value. So, whatever be the value of λ, the game is strictly determinable.

(ii) The value of the game is 2 to player A and – 2 to player B. The optimum strategy for A is A_1 and the optimum strategy for B is B_1. The Saddle point = (A_1, B_1).

(g) The main techniques used to measure work are:

1. Direct Time Study.
2. Synthesis Method.
3. Analytical Estimating.
4. Pre determined Motion Time System (PMTS).
5. Work sampling or Activity Sampling or Ratio Delay Method.

(h) Number of observations required for $N = = \frac{C^2pq}{E^2}$

Work sampling study

Where C = constant depending on confidence level

p = percentage of idling; q = percentage of activity; E = error

C = 2 for 95.5% confidence level; p = 0.3; q = 1 - p = 0.7; E = ±4%

$N = \frac{4 \times 0.3 \times 0.7}{(0.04)^2} = \frac{0.84}{0.0016} = 525$

(i) MAD is the ratio of sum of absolute deviations for all periods to the total number of periods studied. It is represented as below:

$$MAD = \frac{\text{Sum of absolute values of deviations for all periods}}{\text{Total number of periods studied}}$$

$$= \frac{\sum_{i=1}^{n} |\text{ForecastedDemand - Actual demand}|_i}{n}$$

Where n is the number of periods studied.

(j) Rated capacity of the workshop = No. of shifts x No. of hour's in each shift x No. of days /week x No. of Machines x Utilization factor x Efficiency
= 2 x 8 x 5 x 10 x 0.90 x 0.85
= 612 Standard hour per week.

(k) Factors affecting process planning

a. Volume (quantity) of production.
b. Delivery dates for components or products.
c. Accuracy and process capability of machines.
d. The skill and expertise of manpower.
e. Material specifications.
f. Accuracy requirements of components or parts.

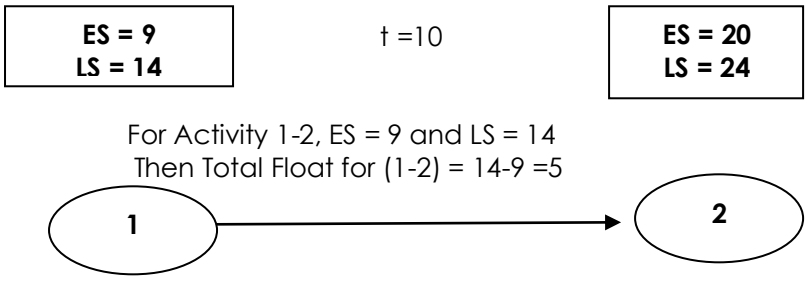
(l) The different types of layout are:

a. Process layout;
b. Product layout;
c. Fixed position layout;
d. Cellular Manufacturing (CM) layout;
e. A combination of the above.

(m) Total Float

Amount of time by which the completion of an activity could be delayed beyond the earliest completion time without affecting the overall project duration time. It is measured by the maximum time of the difference between maximum time available to perform activity and activity duration time or the difference between latest start time and earliest start time.

TS(a) = LS (a) – ES (a)



(n) Economic Lot Size (ELS) $= \sqrt{\frac{2AS}{\left(1-\frac{d}{p}\right)CI}}$

Where A = annual demand S = Set up cost, d = demand rate p = production rate

CI = Carrying cost (rupees) per year

A = 10,000 units S = ₹ 200 d = 50 p = 200 CI = 0.20

$$\text{Economic Lot Size (ELS)} = \sqrt{\frac{2 \times 10{,}000 \times 200}{\left(1 - \frac{50}{200}\right) 0.20}}$$

$$= 10^3 \times \sqrt{\frac{2 \times 2}{0.20 \times \frac{150}{200}}}$$

$$= 10^3 \times \sqrt{\frac{4 \times 200}{0.20 \times 150}}$$

$$= 10^3 \times \sqrt{26.666}$$

$$= 10^3 \times 5.16 = 5{,}160 \text{ units}$$

(o) "QFD is a systematic and organized approach of taking customer needs and demands into consideration when designing new product and services or when improving existing products and services." Another name for this approach is "customer-driven engineering" because the voice of the customer is diffused throughout the product (or service) development life cycle.

2. (a) Describe the principal functions of Operating systems.
(b) Discuss the benefits of Value Engineering in Product Design.
(c) "The concept of product failure is applicable both to new products and the existing ones. There may, however, be varying periods of life spans for each product: some falling immediately, other living for a longer period." – mentioning the different stages which is describe in the statement, give the strategic consideration.

Solution:

(a) The functions of an operating system are a reflection of the purpose it serves for its customers. The following four principal functions identified below also relate to the basic four operations done in any organization:

I. **Manufacture:** Manufacturing function is the one which involves some physical transformation or a change in the **form utility** of the resources. Something is physically created and the output consists of goods which differ physical (e.g., in terms of form, content etc.) from those materials input to the system.

II. **Transport:** This function of operating system provides a change in the **place utility** of something or someone in order to satisfy customer. The customer or something belonging to the customer is moved from place to place and thus results in the change in location. There is no major change in the form of resources.

III. **Supply:** This function provides a change in the **possession utility** of a resource, i.e., the ownership or possession of goods is changed. Unlike manufacture, outputs of the system are physically same as the inputs.

IV. **Service:** This function primarily results in a change in the **state utility** of a resource. The principal common characteristic is the treatment or accommodation of something or

someone. The state or condition of the physical outputs will differ from the inputs as they have undergone same kind of treatment.

Most large and complex organizations have to perform all the principal four functions of operating systems, discussed above. Thus we may redefine operating system **as a configuration of resources combined for the function of manufacture, transport, supply or service**.

(b) Value engineering or value analysis is concerned with the improvement of design and specifications at various stages such as research, development, and design and product development. Benefits of value engineering are:

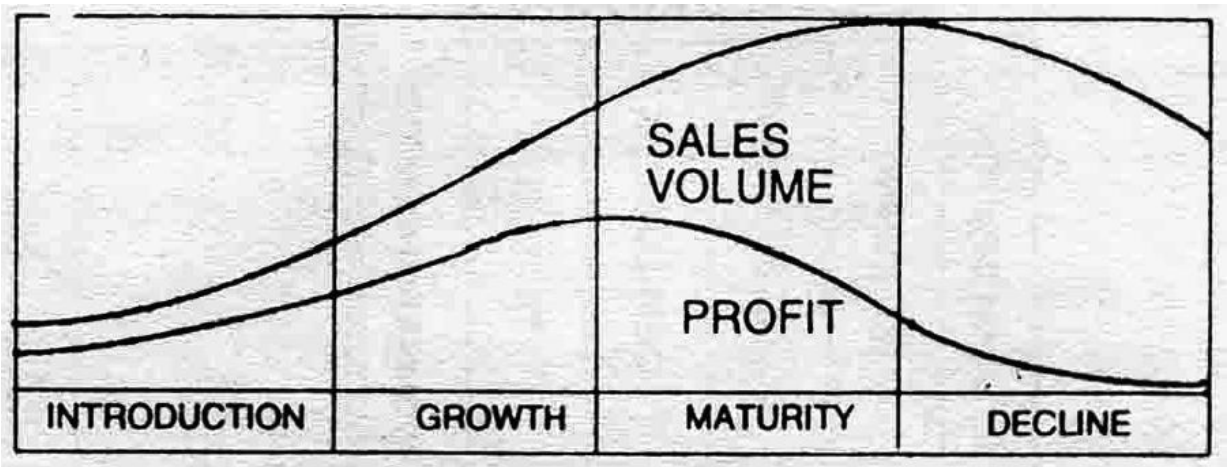
(i) Cost reduction.
(ii) Less complex products.
(iii) Use of standard parts/components.
(iv) Improvement in functions of the product.
(v) Better job design and job safety.
(vi) Better maintainability and serviceability.
(vii) Robust design.

(c) Products, like men, are mortal. They flourish for a time, then decline and die. The life cycle of a product has many points of similarity with the human life cycle. A product is born, grows lustily, attains a dynamic maturity, and then enters its declining years. Like a human being a product that has not built up its potential during its formative years is likely to be relatively unsuccessful on its maturity. But, there are critical differences between the product and the human life cycle. For instance, every person has an average life expectancy. But the life expected of a product varies widely.

The concept of product failure is applicable both to new products and the existing ones. There may, however, be varying periods of life spans for each product: some failing immediately, other living for a longer period. The product, thus, has "life cycles" just as human beings have. From its birth, a product passes through various stages, until it is finally abandoned, *i*. e.. Discontinued from the market. These stages taken together are referred, to as "the product life cycle". This life cycle of the product comprises four stages: Introduction, Growth, Maturity and Decline. It should be noted that it is purely a theoretical concept.

This may graphically be represented on the next page.

The ***Introduction Stage*** is preceded by 'production planning and development'. This period requires greater investment. This investment should be gradually recouped as the sales pick up. The concept of life



cycle would give the management an idea as to the time within which the original investment could be recouped.
After testing, a product enters the introduction stage and the product will then become available in the national market. Sales would begin gradually as potential buyers learn of the product through advertising and other selling techniques. But the profits will be low as part of the investment is to be recouped besides heavy expenditure on selling.

In the ***Growth Stage***, both sales and profits will begin to increase. It is here that similar other new products begin to appear in the market as substitutes and offer competition. The management, therefore, should try to change its approach by changing its strategy from "buy my product" to "try my product". At the end of this stage, the distribution arrangement is likely to get completed and the prices, if necessary, are reduced a little.

The third stage is the ***Maturity Stage***. During this stage the manufacturers introduce new models or adopt methods such as trading-in, etc., to promote the sale of their brands with a view to retaining their position in the market. The number of buyers will continue to grow, but more slowly. In economic terms this is the stage where supply exceeds demand. Some of the promotional efforts may lengthen the span of this stage but they will not offer a permanent solution.

At the final stage of ***Decline***, profit margins touch a low level, competition becomes severe and customers start using newer and better products. It is here that the story of a product ends a natural but hard end.

The above discussion concentrates only on the life cycle of a product, beginning with its introduction into the market *(i.e.,* post-marketing). But a series of processes are to be undertaken by the management prior to the introduction of a product.

Strategic Consideration in the Product Life Cycle Concept

Stages in the product life cycle concept				
Effects and Responses	**Introduction**	**Growth**	**Maturity**	**Decline**
Competition	No importance	Some	Many rivals competing for same price	Few in number
Overall strategy	Market establishment persuade early adopters to try the product	Market penetration persuasion of mass market- Brand preferences	Creation of brand loyalty, prevention of competition	Preparation for removal or renewal
Profits	Negligible- high production and marketing cost	Reach peak levels as a result of high prices and growing demand	Increasing competition cuts profits margins	Declining volume pushes costs up and eliminates profits
Retail Price	High to recover some excessive cost of launching	High to take advantage of heavy consumer demand	Avoid price war principle: "What the tariff will bear"	Low
Distribution	Selective	Intensive	Intensive	Selective
Advertising strategies	Aims at the needs of early adopters	Make the mass market aware of brand benefits	Use advertising as vehicle for differentiation	Emphasis low price

			among otherwise similar brands.	
Advertising emphasis	High, to generate awareness and interest among early adopters	Moderate, to let sales rise- 'word of mouth' recommendations.	Moderate, since most buyers are aware of brand characteristics	Minimum expenditure
Consumer sales and promotion expenditures	Heavy, to entice target groups with samples, coupons, etc.	Moderate to create brand preferences- Advertising better suited.	Heavy to encourage brand switching	Minimum

3. (a) Discuss the characteristics of Good Product Design.
(b) Briefly explain about Designing for Manufacture and Assembly (DFMA).
(c) Discuss about the Computer Aided Design (CAD).

Solution:

(a) A good product design must ensure the following:

(i) Function or performance: The function or performance is what the customer expects the product to do to solve his/her problem or offer certain benefits leading to satisfaction. For example, a customer for a motor bike expects the bike to start with a few kicks on the kick peddle and also expects some other functional aspects such as pick-up, maximum speed, engine power and fuel consumption etc.

(ii) Appearance or aesthetics: This includes the style, colour, and look, feels, etc. which appeals to the human sense and adds value to the product.

(iii) Reliability: This refers to the length of time a product can be used before it fails. In other words, reliability is the probability that a product will function for a specific time period without failure.

(iv) Maintainability: Refers to the restoration of a product once it has failed. High degree of maintainability is desired so that the product can be restored (repaired) to be used within a short time after it breaks down. This is also known as serviceability.

(v) Availability: This refers to the continuity of service to the customer. A product is available for use when it is in an operational state. Availability is a combination of reliability and maintainability. High reliability and maintainability ensures high availability.

(vi) Productibility: This refers to the ease of manufacture with minimum cost (economic production).This is ensured in product design by proper specification of tolerances, use of materials that can be easily processed and also use of economical processes and equipments to produce the product quickly and at a cheaper cost.

(vii) Simplification: This refers to the elimination of the complex features so that the intended function is performed with reduced costs, higher quality or more customer satisfaction. A simplified design has fewer parts which can be manufactured and assembled with less time and cost.

(viii) Standardization: Refers to the design activity that reduces variety among a group of products or parts. For example, group technology items have standardized design which calls for similar manufacturing process steps to be followed. Standard designs lead to variety reduction and results in economies of scale due to high volume of production of

standard products. However, standardized designs may lead to reduced choices for customers.

(ix) Specification: A specification is a detailed description of a material, part or product, including physical measures such as dimensions, volume, weight, surface finish etc. These specifications indicate tolerances on physical measures which provide production department with precise information about the characteristics of products to be produced and the processes and production equipments to be used to achieve the specified tolerances (acceptable variations).
Interchangeability of parts in products produced in large volumes (mass production and flow line production) is provided by appropriate specification of tolerances to facilitate the desired fit between parts which are assembled together.

(x) Safety: The product must be safe to the user and should not cause any accident while using or should not cause any health hazard to the user. Safety in storage, handling and usage must be ensured by the designer and a proper package has to be provided to avoid damage during transportation and storage of the product. For example, a pharmaceutical product while used by the patient should not cause some other side effect threatening the user.

(b) Designing for Manufacture and Assembly (DFMA)

Traditionally the attitude of designers has been "we design it, you build it" which is termed as **"over-the-wall approach",** where the designer is sitting on one side of the wall and throwing the design over the wall to the manufacturing engineers. The manufacturing engineers have to deal with the problems that arise because they were not involved in the design effort. This problem can be overcome by an approach known as **concurrent engineering** (or simultaneous engineering). Concurrent engineering means bringing design and manufacturing people together early in the design phase to simultaneously develop the product and processes for manufacturing the product. Recently this concept has been enlarged to include manufacturing personnel, design personnel, marketing and purchasing personnel in loosely integrated cross-functional teams. In addition, the views of suppliers and customers are also sought frequently. This will result in product designs that will reflect customer wants as well as manufacturing capabilities in the design stage itself. **Design for Manufacturing (DFM)** and **Design for Assembly (DFA)** are related concepts in manufacturing. The term design for manufacturing is used to indicate the designing of products that are compatible with an organization's capability. Design for assembly focuses on reducing the number of parts in a product or on assembly methods and sequence that will be employed.

Designing for manufacture includes the following guidelines:

(i) Designing for minimum number of parts.
(ii) Developing modular design.
(iii) Designing for minimum part variations (i.e., communication or using standardized parts)
(iv) Designing parts for ease of fabrication.

(c) Computer Aided Design: Computers are increasingly used for product design. CAD uses computer graphics for product design. The designers can modify an existing design or create a new design on a computer monitor screen by means of a keyboard or a joy stick. The design can be maneuvered on the screen, it can be rotated to provide the designer different views of the product, it can be split apart to have a view of the inside and a position of the product can be enlarged for closer view. The printed version of the completed design can be taken and also the design can be stored electronically. A number of products such as printed circuit boards, transformers, automobile parts, aircraft parts etc. can be designed using CAD.

CAD increases the productivity of designers from 3 to 10 times and preparing mechanical drawings of product or parts and modifying them frequently becomes easier. Also a data base can be created for manufacturing which can supply required information on product geometry and dimensions, tolerances, material specifications etc. Also, some CAD systems facilitate engineering and cost analyses on proposed designs, for example, calculation of volume and weight and also stress analysis can be done using CAD systems. It is possible to generate a number of alternative designs using computer aided design systems and identify the best alternative which meets the designer's criteria.

4. (a) Discuss the Classification of Production Planning and Control Functions (PPC).

(b) Describe the benefits of Production Control.

(c) A manufacturing enterprise has introduced a bonus system of wage payment on a slab-rate based on cost of production towards labour and overheads.

The Slab – rate being:

Between 1% - 10%	**saving in production cost**	**5% of saving**
Between 11%-20%	**saving in production cost**	**15%**
Between 21%-40%	**saving in production cost**	**30%**
Between 41%-70%	**saving in production cost**	**40%**
Above 70%	**saving in production cost**	**50%**

The rate per hour for three workers A, B, C is ₹ 5, ₹5.50 and ₹ 5.25 respectively. The overhead recovery rate is 500% of production wages and the material cost is ₹40 per unit. The standard cost of production per unit is determined at ₹ 160 per unit.

If the time taken by A, B, C to finish 10 units is 26 hours, 30 hours and 16 hours respectively, what is the amount of bonus earned by the individual workers and actual cost of production per unit?

Solution:

(a) The functions of PPC can be classified under the following:

(i) Materials: Raw materials, spare parts and components which must be available in the correct quantities and specifications at the right time.

(ii) Methods: It involves deciding the best sequence of operations for manufacturing the parts, building up subassemblies and major assemblies which in turn will make up the finished product, within the limitations of existing layout and workflow.

(iii) Machines and Equipments: PPC is concerned with selection of machines and equipments and also with maintenance policy, procedure and schedules, replacement policy and tooling. (Design and manufacture of tools).

(iv) Routing: Routing prescribes the flow of work in the plant and is related to consideration of layout, of temporary storage locations for raw materials, components and semi processed parts, and of material handling systems. Routing is a basic PPC function.

(v) Estimating: The processing times (both set up time and operation time per piece) required for the parts to be manufactured in-house are estimated and the standard time (both machine time and labour time) are established as performance standards.

(vi) Loading and Scheduling: Machines have to be loaded according to their capacity and capability. Machine loading is carried out in conjunction with routing (as indicated in process layouts or operations analysis and routing sheets) to ensure smooth workflow and the

prescribed feeds. Speeds of machines are adhered to as well as the estimated time (standard time which is the allowed time to do a job).

(vii) Scheduling: Determines the utilization of equipment and manpower and hence the efficiency of the plant. Scheduling determines the starting time and completion time for each and every operation for each and every part to be manufactured and sub-unit to be assembled so that the finish product is ready to be shipped to the customer as per the predetermined delivery schedules.

(viii) Dispatching: This is concerned with the execution of planning functions. Production orders and instructions are released according to the schedule, sequences indicated in route sheets, and machine loading schedules are adhered to and authorization is given for release of materials and tools to the operators to carry out the work.

(ix) Expediting or Progressing: This means follow-up or keeping track of the progress made in completing the production as per schedules. This follows dispatching function logically.

(x) Inspection: This function relates to checking the quality of production and of evaluating the efficiency of the processes, methods and workers so that improvements can be made to achieve the desired level of quality.

(xi) Evaluating or Controlling: The objective of evaluation or controlling is to improve performance. Methods and facilities are evaluated to improve their performance. To sum up, we can state that PPC is a management tool, employed for the direction of the manufacturing operations and their Co-ordination with other activities of the firm.

(b) Benefits of Production Control

Benefits of Production Control can be classified by two ways:

(i) Improvement in profits through

(a) Maintenance of a balanced inventory of materials, parts, work-in-process and finished goods.
(b) Balanced and stabilized production.
(c) Maximum utilization of equipment, tooling, labour (manpower) and storage space.
(d) Minimum investment in inventory.
(e) Reduction in indirect costs.
(f) Reduction in set up costs.
(g) Reduction in scrap and rework costs.
(h) Reduction in inventory costs.

(ii) Competitive advantage

(a) Reliable delivery to customers.
(b) Shortened delivery schedules to customers.
(c) Lower production costs and greater pricing flexibility.
(d) Orderly planning and marketing of new or improved products.

(c)

Sl No.	Particulars	A	B	C
(i)	Unit Produced	10	10	10
(ii)	Wage rate/hr.	5.00	5.50	5.25
(iii)	Time Taken	26 hours	30 hours	16 hours
(iv)	Wages Payable (ii x iii)	130.00	165.00	84.00
(v)	Overhead Recovery (iv x 500%)	650.00	825.00	420.00
(vi)	Materials (i x ₹ 40 each)	400.00	400.00	400.00
(vii)	Total Cost of Production(iv+v+vi)	1,180.00	1,390.00	904.00
(viii)	Standard cost of Production (i x ₹160)	1,600.00	1,600.00	1,600.00

(ix)	Saving in cost of production (vii – viii)	420.00	210.00	696.00
(x)	% of savings (ix /x)x 100	26.25%	13.13%	43.50%
(xi)	Bonus Slab	30%	15%	40%
(xii)	Bonus Amount (ix) x (xi)	126.00	31.50	278.40
(xiii)	Actual cost of production [vii + xii]	1,306.00	1,421.50	1,182.40
(xiv)	Cost/ unit (₹) [xiii / i]	130.60	142.15	118.24

5. (a) Discuss the limitations of Linear Programming.

(b) The demand curve faced by a firm is p = 20 - 4x and the cost function is C = 4x (where p= price, x = output, and C = total cost).

(i) Determine the optimum level of output, price and maximum profit if the objective of the firm is to maximize profit.

(ii) What will be the new price if a unit tax of ₹ 0.50 is imposed?

(iii) Determine the rate of unit tax so that tax revenue is maximum.

(c) If the demand function is $X = \frac{20}{p+1}$ determine the price elasticity of demand if p = 3.

Solution:

(a) Linear programming itself suffered from several limitations:

(i) It assumes all functions to be linear which implies perfect competition. Take, for example, the maximization of profit, sales, or revenue. When an objective function is expressed in a linear form, if is assumed that all the output can be sold at a given (constant) price. This is possible only when a firm faces "Horizontal Straight Line demand curve, a feature of perfect competition.

(ii) It deals with a single objective and given constraints.

(iii) It is confined to non-negative values only.

(iv) It accepts rational values, which sometimes an awkward situation. For example, it may be difficult to acquire half a machine or truck or warehouse.

(v) It is a "deterministic" technique, which means that the values of all the variables and all the coefficients must be known with certainty.

(vi) There are several practical limitations particularly related to: (a) difficulties in calculation and (b) the exorbitant cost of gathering data.

(vii) It also suffers from several other limitations common to operations research techniques as a group.

(b)

(i) Suppose R = Total revenue and π = total profit.

Then $R = px = (20 - 4x)\, x = 20x - 4x^2$

$\therefore \pi = R - C = 20x - 4x^2 - 4x = 16x - 4x^2$

To maximize π, the fist order condition requires, $\frac{d\pi}{dx} = 0$.

So, $\frac{d\pi}{dx} = 16 - 8x = 0$

Or, $8x = 16$

Or, $x = \frac{16}{8} = 2$.

The second order condition requires that $\frac{d^2\pi}{dx^2} < 0$. Here,

$\frac{d^2\pi}{dx^2} = -8 < 0$. So the second order condition is fulfilled.

So, x = 2. Then p = 20 – 4 x 2 = 20 - 8 = 12

The amount of maximum profit $\pi = 16(2) – 4\ (2)^2 = 32 – 16 = 16$.

(ii) When tax per unit is Rs. 0.50, net profit (N) = $20x – 4x^2 – 4x – 0.5x$

Or , $N = 15.5x - 4x^2$

To maximize N, the first order condition requires $\frac{dN}{dx} = 0$

Or, 15.5 – 8x = 0

Or, 8x = 15.5

$\therefore x = \frac{15.5}{8} = 1.9375$

Here $\frac{d^2N}{dx^2} = -8 < 0$. So the second order condition is fulfilled. $\therefore x = 1.9375$.

When x = 1.9375, p = 20 – 4(1.9375) = 20 – 7.75 = 12.25.

(iii) Let the tax per unit be t.

Then, net profit $N = 20x – 4x^2 – 4x – tx = 16x – 4x^2 – tx$

To maximize N, $\frac{dN}{dx} = 0$ and $\frac{d^2N}{dx^2} < 0$

Non, $\frac{dN}{dx} = 16 - 8x – t = 0$

Or, 8x = 16 – t

$\therefore x = \frac{16-t}{8} = 2 - \frac{t}{8}$

$\frac{d^2N}{dx^2} = -8 < 0$ i.e., the second order condition is fulfilled.

$\therefore x = 2 - \frac{t}{8}$. Now, total revenue $T = tx = t(2 - \frac{t}{8}) = 2t - \frac{t^2}{8}$

To maximize T, the first order condition requires

$\frac{dT}{dt} = 0 \text{ and } \frac{d^2T}{dt^2} < 0$

Now, $\frac{dT}{dt} = 2 - \frac{t^2}{8} = 0$

Or, $\frac{t}{4} = 2$

$\therefore t = 8$

Again $\frac{d^2T}{dt^2} = -\frac{2}{8} < 0$. So the second condition is fulfilled. Hence tax revenue will be maximum if t = 8.

(c) Here, $X = \frac{20}{p+1} \quad \therefore \quad \frac{dx}{dp} = \frac{20}{(p+1)^2}$

Now, price elasticity of demand, say,

$$e_p = \frac{p}{x} \cdot \frac{dx}{dp} = \frac{p}{20} \times (p+1) \times -\frac{20}{(p+1)^2}$$

If $p = 3$, $e_p = 4 = \frac{3}{20} \times 4 \times -\frac{20}{4 \times 4} = -\frac{3}{4}$

$$|e_p| = \frac{3}{4}$$

Comment: As $|e_p| = \frac{3}{4} < 1$ demand is inelasticity at $p = 3$.

6. (a) Define the term "Work Design" , "Work Study" , " Methods Engineering", "Method Study", "Work Measurement", "Time Study".

(b) Explain the benefits of Work Study.

(c) Discuss the advantages of Method study.

Solution:

(a)

Term	Definition
Work Design	Systematic investigation of contemplated and present work systems in order to formulate, through the ideal system concept, the easiest and most effective systems and methods for achieving the necessary functions/goals/purposes.
Work Study	The generic term used for those techniques, particularly method study and work measurement, which are used in the examination of human work in all its contexts and which lead systematically to the investigation of the facts which affect efficiency and economy of the situation being reviewed, in order to effect improvement.
Methods Engineering	That body of knowledge concerned with the analysis of the methods and the equipment used in performing a job, the design of an optimum method and the standardization of the proposed methods. Also frequently referred to as "Work Study".
Work Measurement	The application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance.
Time Study	A technique of work-measurement used for determining as accurately as possible from a limited number of observations, the time necessary to carry out a given activity at a denned standard of performance. A stop watch is used for the purpose of recording the actual time taken by the worker under observation to perform various elements of the work or task.

(b) Benefits of work study are given following:

(i) Increased productivity and operational efficiency.
(ii) Reduced manufacturing costs.
(iii) Improved work place layout.
(iv) Better manpower planning and capacity planning.

(v) Fair wages to employees.
(vi) Better working conditions to employees.
(vii) Improved work flow.
(viii) Reduced material handling costs.
(ix) Provides a standard of performance to measure labour efficiency.
(x) Better industrial relations and employee morale.
(xi) Basis for sound incentive scheme.
(xii) Provides better job satisfaction to employees.

(c) Following are the advantages of Method Study:

(i) Work simplification
(ii) Improved working method (cheaper method)
(iii) Better product quality
(iv) Improved workplace layout
(v) Improved equipment design
(vi) Better working conditions/environment
(vii) Better material handling and lesser material handling cost
(viii) Improved work flow
(ix) Less fatigue to operator
(x) Optimum utilization of all resources
(xi) Higher safety to workmen
(xii) Shorter production cycle time
(xiii) Higher job satisfaction for workmen
(xiv) Reduced material consumption and wastages
(xv) Reduced manufacturing cost and higher productivity

7. (a) Discuss the objectives of TIME STUDY.

(b) Define the Predetermined Motion Time System. Discuss the advantages of Predetermined Motion Time Systems (PMTS).

(c) For a certain element of work, the basic time is established to be 20 seconds. If for three observations, a time study observer records ratings of 100, 125 and 80 respectively, on a "100-normal scale", what are the observed timings?

(d) If Premabai wants to be confident at 95 per cent level that the 'ratios' for disentangling and knitting are within ± 2 per cent of the real value, what is the total number of observations which Hema should perform? Taking the knitting and disentangling activities only, to what extent are the time standards precise?

Solution:

(a) Objective of time study

The main objective is "to determine by direct observation, the quantity of human work in a specified task and hence to establish the standard time, within which an average worker working at a normal pace should complete the task using a specified method".

The other objectives are:

(i) To furnish a basis of comparison for determining operating effectiveness.
(ii) To set labour standard for satisfactory performance.
(iii) To compare alternative methods in method study in order to select the best method.
(iv) T o determine standard costs.
(v) To determine equipment and labour requirements.
(vi) To determine basic times/normal times.
(vii) To determine the number of machines an operator can handle.

(viii) To balance the work of operators in production or assembly lines.
(ix) To provide a basis for setting piece rate or incentive wages.
(x) To set the completion schedules for individual operations or jobs.
(xi) To determine the cycle time for completion of a job.

(b) Predetermined motion time system is defined as a work measurement technique by which normal or basic times are established for basic human motions and these time values are used to build up the time for a job at a defined level of performance.

PMTS is an improvement over motion study because besides affording detailed analysis of the motion, it makes it possible to set a measure of the time that a series of motion ought to take.

Advantages:

(i) Affords fine analysis and improvement of work methods.

(ii) Since the time for each basic motion is predetermined, the computation of standard time for a job or an operation is faster and more economical than time study using stop watch.

(iii) Offers a precise means of recording time, avoiding subjective judgment or bias of the rater.

(iv) Involves no interference in the normal work routine and hence faces little resistance from workers.

(v) More effective and economical tool for work measurement for repetitive jobs of short duration.

(c) $[(\text{observed time}) \times (\text{Observed rating}) = (\text{Basic or Normal time}) \times (\text{Standard rating})$

$$\text{Observed time} = \frac{(\text{Basic or Normal time}) \times (\text{Standard Ratings})}{\text{Observed Rating}}$$

Data: Basic or Normal Time = 20 seconds
Given Standard rating = 100
For Observation No.1, observed rating = 100

$\therefore$ Observed time = $\frac{20 \times 100}{100} = 20$ seconds

For observation No. 2 , Observed time = $\frac{20 \times 100}{125} = 16$ seconds

For observation No.3 , Observed time = $\frac{20 \times 100}{80} = 25$ seconds

(d) $n = \frac{4p(1-p)}{E^2} = \frac{4(0.25)(0.75)}{(0.02)^2} = 1,875$

Where p = 0.25 for disentangling.
However, looking at knitting we have the following requirement:

$$n = \frac{4(0.40)(0.60)}{(0.02)^2} = 2,400$$

Where p = 0.40 for knitting.

Therefore, the total number of observations should have been 2400. The number of observations Performed by Hema are much lower than those required.

The answer to the second part of the question is derived:

$n = 300 = \frac{4(0.40)(1-0.40)}{E^2}$

Therefore $E = \sqrt{\frac{4(0.40)(0.60)}{300}} = \pm 0.0565 = \pm 5.65\%$

The time standard for knitting will be precise only to that extent, i.e. ± 5.65 per cent making similar calculations for 'disentangling'.

$$E = \sqrt{\frac{4(0.25)(1-0.25)}{300}} = \pm 0.05 = \pm 5\%$$

The time standard for disentangling activity will be precise to the extent of ± 5 per cent. It may be noted that the above figures reflect the looseness of the time standards more than what they show. The error is relative to the activity's own fractional ratio. In other words the disentangling ratio is 25 ± 5 per cent, i.e. 20 to 30 per cent. This is a margin of as much as ± 20 per cent error compared to itself.

8 .(a) Describe the advantages of Forecasting.

(b) Explain about the Tracking Signal.

(c) The following data on the exports of an item by a company during the various years fit a straight line, (for the time being, assume that a straight line gives a good fit). Give a forecast for the years 2013 and 2014.

Year	No. of items ('000)
2004	13
2005	20
2006	20
2007	28
2008	30
2009	32
2010	33
2011	38
2012	43

Solution:

(a) Advantages of forecasting are stated as under:

- Past data provides guidance for future and is a tool to train. Forecasts based on past data helps in correct planning.
- Forecasting of customer's demand help in strategy planning, capacity planning, location planning and layout planning.
- Past data provides trends, which are used to forecast the future trends and helps to decide on products or services pursued or to be stopped or abandoned.
- Forecast of manufacturing is essential to ensure the availability of materials for sub-assemblies and final assemblies.

- Forecasting helps in optimizing various costs as it lays down benchmarks to control the project. Actual demand and actual output are monitored, compared with previous plans and give feedback for the demand forecasting sub-system.

- Forecasting by specifying future demands reduce the costs of readjustment of operations in response to the unexpected deviation.

- Accurate estimation of future demands of goods and services through forecasting increases the operating efficiency.

- Forecasting is an important component of strategic and operational planning.

- Utilization of the plant is improved with correct forecasts.

(b) Tracking Signals (TS)

Tracking Signals are often used to monitor the forecasts especially when the overall forecast is suspect. If the TS is around zero, the forecasting model is performing well. A forecast is considered out of control, if the value of Tracking Signal exceeds plus or minus 4. Tracking Signal (TS) is calculated to indicate the deviations in cases where cumulative actual are either above or below the forecast by a substantial amount. The TS indicates the direction of the forecasting error, if TS is positive – increase the forecasts, but if it is negative – decrease the forecasts. It is the ratio of the cumulative algebraic sum of the deviations between the forecasts and the actual values to the mean absolute deviation. Mathematically, Tracking Signal is presented as below:

$$\text{Tracking Signal (TS)} = \frac{\text{Algebric sum of deviations}}{\text{Mean Absolute Deviations (MAD)}}$$

$$= \sum_{i-1}^{n} \frac{(\text{Actual Demand}_i - \text{Forecast demand}_i)}{\text{MAD}}$$

(c) We can call the years as 'X' and exports as 'Y'. In order to use the normal equations for the least square line, we need ΣX, ΣY, ΣXY and ΣX_2. If we arrange X in such a way that $\Sigma X = 0$, it will simplify our calculations.
Therefore, we call the year 2008 as 0, 2007 as -1 and 2009 as + 1 and likewise for the other years in the data.
The rearrangement is shown in the table as follows:

X	Y	X^2	XY
-4	13	16	-52
-3	20	9	-60
-2	20	4	-40
-1	28	1	-28
0	30	0	0
1	32	1	32
2	33	4	66
3	38	9	114
4	43	16	172
$\sum x = 0$	$\sum Y = 257$	$\sum x^2 = 60$	$\sum XY = 204$

The normal equations are:

$$\sum Y = a_0 N + a_1 \sum x$$

$$\sum XY = a_0 \sum x + a_1 \sum x^2$$

As $\sum x = 0$ and $\sum y = a_0 N$ and $\sum XY = a_1 \sum X^2$

Therefore,

$$a_0 = \frac{\sum y}{N} = \frac{257}{9} = 28.56$$

$$a_1 = \frac{\sum XY}{\sum x^2} = \frac{204}{60} = 3.4$$

The equation of a straight line fitting the data is:
Y = 28.56 + 3.4 X

(a) Forecast for 2013 (i.e., X= 5) : Y = 28.56 + 3.4 (5) = 45.56
(b) Forecast for 2014 (i.e., X= 6): Y = 28.56 + 3.4 (6) = 48.96

9. (a) Define the Capacity.
(b) Describe about the Resource Requirement Planning (RRP).
(c) An item is produced in a plant having a fixed cost of ₹ 6,000 per month, variable cost of ₹ 2 per unit and a selling price of ₹ 7 per unit. Determine
i. The break-even volume.
ii. If 1000 units are produced and sold in a month, what would be the profit?
iii. How many units should be produced to earn a profit of ₹ 4000 per month?

Solution:

(a) Capacity:
Capacity is the rate of output from an operating system per unit time. Capacity is based on the output that the system can produce, store, and transport. For example, a cement plant could be capable to produce 3000 tons per day (tpd) of cement. Output could be also measured on the basis of resources available. The availability of resources can be in terms of number of machine hours, number of labour hours, number of tools, and square meters of the area. In case of a cement plant of 3000 tpd capacity, it could be said that there is one kiln of 3000 tpd capacity or there are two kilns of 1500 tpd capacity each to produce the cement. Output is also measured in terms of number of products that could be produced from the process.

(b) Resource Requirement Planning (RRP)
Resource Requirement Planning (RRP) serves the production plan and covers a number of years. Longer-term capacity requirements are difficult to determine due to the uncertainties in the future market demand and technologies. RRP is interactive. What-if module is used to check if the long term sales and operation plan would fit into the resources planned to be made available. RRP examines the future demand and capacity for the products by identifying future stages of its cycle. What new products would be adopted in future and what are their expected or planned growth rates? Capacity requirements are dependent on the marketing plans and forecasts.

It is also important to consider the technological changes in the process. The changes in technology could be so dramatic that it might be difficult to forecast them. Capacity also depends on technology plans and forecasts.

RRP checks the viability of the senior management's plan. If this does not fit, the need for changing the resources or reducing the plan is considered. In other words, the volume of output is decided based on the quantity of production needed in future. Absence of this planning would result in overloads, missed schedules, and general disturbances.

(c)

(i) Break – even Volume	
Fixed Cost (FC)	= ₹ 6,000 per month
Variable cost (VC)	= ₹ 2 per unit
Selling price (SP)	= ₹ 7 per unit
For Q to be break-even volume,	
Break Even Volume	= Fixed Cost / Contribution per unit
Contribution per unit	Selling price per unit – Variable price per unit
Contribution per unit	₹ (7 - 2) = 5
	= 6000/5
	= 1200 units / month
(ii) For Q = 1000,	
Profit	= Sales Revenue - Total cost
	= SR - (FC + VC × Q)
	= (7 × 1000) - (6000 + 2 × 1000)
	= (7000) - (6000 + 2000)
	₹ (7,000 – 8,000) = - ₹ 1,000 (i.e. loss of ₹ 1,000)
(iii) For profit of ₹ 4000 and Q =	
Contribution per unit= Selling price per unit – contribution per unit	Total Contribution = FC + Profit
7- 2 =5	= 6000 + Profit
	= (6000 + 4000)
	= 10,000
	10,000 /5 = 2000 units

10. (a) Two layout alternatives are shown below. The facility's products, their travel between departments and the distances between departments for each layout alternative are also shown below. The layout alternative that minimizes the monthly product travel through the facility has to be determined.

Layout A

8	**4**	**10**	**2**	**5**
3	**7**	**1**	**9**	**6**

Layout B

7	**1**	**9**	**6**	**3**
4	**10**	**2**	**5**	**8**

Department Movement Combination	**Distance between Department (feet)**		**Department Movement Combination**	**Distance between Department (feet)**	
	Layout A	**Layout B**		**Layout A**	**Layout B**
1-5	**30**	**30**	**3-9**	**30**	**20**
1-7	**10**	**10**	**4-5**	**30**	**30**
1-9	**10**	**10**	**4-7**	**10**	**10**
1-10	**10**	**10**	**4-10**	**10**	**10**

2-5	**10**	**10**	**5-6**	**10**	**10**
2-6	**20**	**20**	**6-9**	**10**	**10**
2-10	**10**	**10**	**7-8**	**20**	**50**
3-6	**40**	**10**	**8-10**	**20**	**30**

Products	Department Processing Sequence	Number of products processed per month	Products	Department Processing Sequence	Number of products processed per month
a	**1-5-4-10**	**100**	**d**	**1-7-8-10**	**100**
b	**2-6-3-9**	**200**	**e**	**2-5-6-9**	**200**
c	**2-10-1-9**	**300**	**f**	**1-7-4-10**	**400**

(b) Discuss the steps in the process planning.

(c) Discuss the advantages and disadvantages of Product Layout.

Solution:

(a) Step 1: Compute the total travel for each product through each layout alternative as given below:

Product	Department Processing Sequence	Distance moved per product	
		Layout A	**Layout B**
a	1-5-4-10	30+30+10=70	30+30+10=70
b	2-6-3-9	20+40+30=90	20+10+20=50
c	2-10-1-9	10+10+10=30	10+10+10=30
d	1-7-8-10	10+20+20=50	10+50+30=90
e	2-5-6-9	10+10+10=30	10+10+10=30
F	1-7-4-10	10+10+10=30	10+10+10=30

Step 2: Compute the total distance travelled per month for each product through each layout alternative as below:

Product	Products per month (load/ units)	Distance per product (feet)		Load x Distance per month (units x feet)	
a	100	70	70	7,000	7,000
b	200	90	50	18,000	10,000
c	300	30	30	9,000	9,000
d	100	50	90	5,000	9,000
e	200	30	30	6,000	6,000
f	400	30	30	12,000	12,000
		Total		**57,000**	**53,000**

Step 3: Determine the layout alternative to be chosen based on the minimum (load x distance) per month. Layout B results in the least total (load x distance) per month and hence the choice.

(b) Steps in process planning

(i) Detailed study of the component drawings to identify the salient features that influence process selection, machine selection, inspection stages and toolings required.

(ii) List the surfaces to be machined.

(iii) The surfaces to be machined are combined into basic operations. This step helps in selection of machines for operation.
(iv) Determine the work centre, tools, cutting tools, jigs and fixtures and inspection stages and equipment.
(v) Determine the speed, feed and depth of cut for each operation.
(vi) Estimate the operation time.
(vii) Find the total time to complete the job taking into account the loading and unloading times, handling times, and other allowances.

(c) Advantages of Product Layout

(i) There is mechanization of materials handling and consequently reduction in materials handling cost.
(ii) This type of layout avoids production bottlenecks.
(iii) There is economy in manufacturing time.
(iv) This type of facilities better production control.
(v) This type of layout requires less floor area per unit of production.
(vi) Work-in-progress is reduced and investment thereon is minimized.
(vii) Early detection of mistakes or badly produced item is possible.

Disadvantages of Product Layout

(i) Product layout is known for its inflexibility
(ii) This type of layout is also expensive.
(iii) There is difficulty of supervision.
(iv) Expansion is also difficult.
(v) Any breakdown of equipment along a production line can disrupt the whole system.

11. (a) Describe the characteristics of Project.
(b) Explain the role of Project Manager.
(c) Discuss about the Gantt chart.

Solution:

(a) It is customary to use terms, such as cement projects, power projects, refinery projects (not plant), and the term project is replaced by plant as soon as the plant is operational or project is completed.
All works that can be interrelated and are being performed to serve a common purpose can be grouped together and termed a project, only if it is a composite affair. The difference from a plant is that project as a whole has to be completed in one shot, once and for all. So, project has to achieve one mission, which may not be a physical objective or an end result e.g., holding an election, conducting a war, planning to prevent a riot.

The following inherent features are associated with any project:

(i) Projects have a purpose: Projects have clearly-defined aims and set out to produce clearly-defined results. Their purpose is to solve a "problem", and this involves analyzing needs beforehand. Suggesting one or more solutions, a project aims at lasting social change.
(ii) Projects are realistic: Their aims must be achievable, and this means taking account both of requirements and of the financial and human resources available.
(iii) Projects are limited in time and space: They have a beginning and an end and are implemented in (a) specific place(s) and context.
(iv) Projects are complex: Projects call on various planning and implementation skills and involve various partners and players.
(v) Projects are collective: Projects are the product of collective endeavors. They involve teamwork and various partners and cater for the needs of others.

(vi) Projects are unique: Projects stem from new ideas. They provide a specific response to a need (problem) in a specific context. They are innovative.

(vii)Projects are an adventure: Every project is different and ground-breaking; they always involve some uncertainty and risk.

(viii) Projects can be assessed: Projects are planned and broken down into measurable aims, which must be open to evaluation.

(ix) Projects are made up of stages: Projects have distinct, identifiable stages.

(b) The basic roles for a Project Manager could be broadly grouped under following heads:

(i) Projectising and problem solving. Projectising work as much as possible, e.g., create a number of projects such as daily, weekly, monthly, quarterly, biannually and annual package activities of entire plant.

(ii) Defining and maintaining integrity of a project.

(iii) Development of Project Execution Plan. Organization for execution of the plan.

(iv) Setting of cost and time targets for each of the projects, e.g., daily, weekly, monthly activities, etc

(v) Development of systems and procedures for accomplishment of project objectives and targets.

(vi) Line up vendors and contractors for the supply of materials and erection skills and contract management.

(vii) Negotiation for commitments and Man-management.

(c) Gantt chart is one of the oldest techniques used for planning, scheduling and controlling of projects. Gantt chart was developed by H.L. Gantt in 1917 and is in use till today. Gantt charts were used even before computer came on the scene. Even today, Gantt chart applies to manufacturing as well as service organizations.

Gantt chart is a graphical representation of a series of activities drawn to a time scale. Horizontal axis (X-axis) represents time and vertical axis (Y-axis) shows the activities to be performed. The Gantt chart shows activities to specific jobs at individual/work centers by horizontal bars. Also known as a 'bar chart' because of its graphic presentation of the information, the position and the length of the horizontal bar indicates the start and completion date of the activity. In the initial days Gantt charts used the following symbols:

Symbols	Explanation of the symbol
[	Start of an activity
]	End of an activity
[----]	Actual progress of the activity
V	Point of time to show 'where you are'

Over a period, only bars are used to show the start, end and duration of the activity. When the Gantt chart is used as a controlling technique, the planned and actual performances of the activities are presented on the same chart by two horizontal bars with different colors or by different presentation.

Gantt charts are initially prepared for planning purposes. However, as the work progresses, the actual performance or progress is shown on the Gantt chart to have a clear picture of any variation from the planned time. This provides a comparison between planned-time and actual time taken in completion of an activity.

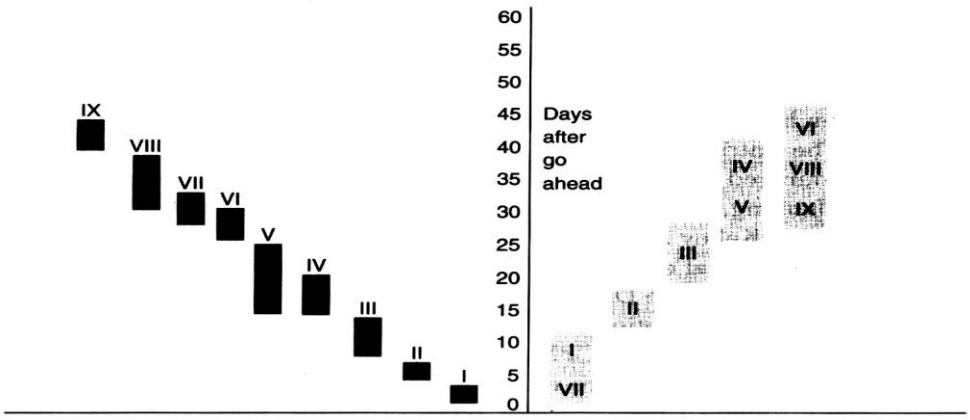
Advantages

1. It is simple to understand and easy to change.
2. It is the simplest and least complex means of portraying progress.
3. It can easily be expanded to identify specific elements that may be either behind or ahead of schedule.

Disadvantages

1. It does not show the interdependencies of the activities, and therefore does not represent a network of activities. For example, it does not explain if the procurement activity (V), in Figure 2.11, requires that the agreement be signed (III) before procurement can begin.

2. It cannot show the result of an early or a late start in activities. How will slippages of the operation scheduling activity (VIII), affect the completion date of the programme?



Source: Adapted from Kerzner 1992.
Bar chart activities (a) single (b) combined

3. It does not show the uncertainty involved in performing the activity and, therefore, does not readily admit itself to sensitive analysis. For instance, it cannot show the longest time, shortest time, or the average time that an activity might take.

12. (a) What is a Critical Path? Why is it so important in scheduling and controlling large projects?

(b) List the Applications of PERT.

(c) A product comprised of 10 activities whose normal time and cost are given as follows:

Activity	1-2	2-3	2-4	2-5	3-5	4-5	5-6	6-7	6-8	7-8
Normal Time (days)	3	3	7	9	5	0	6	4	13	10
Normal Cost (Rs.)	50	5	70	120	42	0	54	67	130	166

Indirect Cost is ₹ 9 per day.

(i) Draw the Net work and identify the Critical Path.
(ii) What is the Project Duration and Associated Cost?
(iii) Find out the Total Float associated with each activity.

Solution:

(a) Critical Path

The Longest Path through the network is called as the Critical Path. The length of the Critical Path determines the minimum duration in which the project can be completed.

Importance:

The Critical Path is important in monitoring large projects, due to the following reasons :

(i) **Start and Finish Times:** A schedule consisting of the Start and Finish Times for each activity/event may be prepared and the objective of project control can be activity within the scheduled time.

(ii) **Activities for Crashing:** If the project is to be completed earlier than its expected time, the Project Manager should concentrate on the Critical Path activities first. Extra Cost may be incurred in completing such activities sooner.

(iii) **Activity Monitoring:** If any one of the critical activities consumes more time than planned, the project accomplishment date will be delayed. The Project Manager should concentrate on the remaining activities on the Critical Path and try to complete them sooner.

(iv) **Resource Allocation and Smoothing**: The Project Manager can identify the time by which he can delay the non-critical activities, without affecting the overall project duration. These activities offer flexibility to the Project Manager in scheduling and transferring resources.

(b) Applications of PERT :

PERT is useful in the following situations:

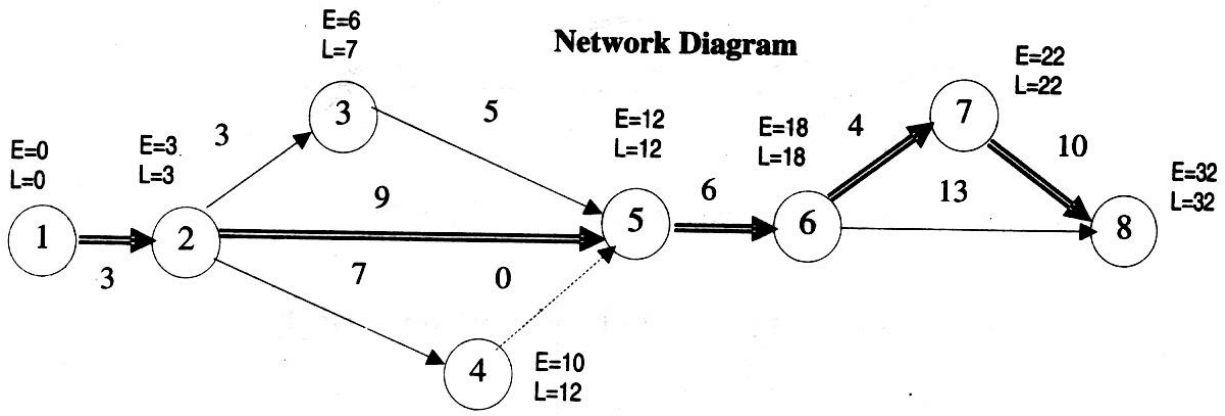
(i) The project should have identifiable activities.

(ii) The activities should have clear starting and ending points.

(iii) Project is complicated and consists of many inter-related tasks.

(iv) Technique is good for projects, where alternative options, sequence of activities and time period are involved.

(c)



Critical Path 1-2-5-6-7-8

Project Duration 32 days. **(Note: Observer the use of Dummy Activity, where Time & Cost=0)**

Network Table

Activity	Duration	EST	LST	EFT	LFT	TF	Normal Cost
1-2	3	0	0	3	7	0	50
2-3	3	3	4	6	10	1	5
2-4	7	3	4	10	11	1	70
2-5	9	3	3	12	12	0	120
3-5	5	6	7	11	12	1	42
4-5	0	10	12	10	12	2	0

5-6	6	12	12	18	18	0	54
6-7	4	18	18	22	22	0	67
6-8	13	18	19	31	32	1	130
7-8	10	22	22	32	32	0	166
							714

Project Duration = 32 days
Associated Cost = Normal Cost + Indirect Cost = ₹ 714 + (₹ 9 x 32) = ₹ 1002

13. (a) Discuss the advantages and Limitations of Simulation.

(b) A company manufactures around 200 mopeds. Depending upon the availability of raw materials and other conditions, the daily production has been varying from 196 mopeds to 204 mopeds, whose probability distribution is as given below:

Production per day	**196**	**197**	**198**	**199**	**200**	**201**	**202**	**203**	**204**
Probability	**0.05**	**0.09**	**0.12**	**0.14**	**0.20**	**0.15**	**0.11**	**0.08**	**0.06**

The finished mopeds are transported in a specially designed three storied lorry that can accommodate only 200 mopeds. Using the given 15 random numbers viz. 82, 89,78,24,53,61,18,45,04,23,50,77,27,54,10. Simulate the process to find out:

(i) What will be the average number of mopeds waiting in the factory?
(ii) What will be the average number of empty spaces on the lorry?

(c) A maintenance service facility has Poisson arrival rates, negative exponential service times and operates on a first – come first served queue discipline. Breakdowns occur on an average of three per day with a range of zero to eight. The maintenance crew can service on an average six machines per day with a range from zero to seven. Find the:

(i) Utilization factor of the service facility.
(ii) Mean time in the system.
(iii) Mean number in the system in breakdown or repair.
(iv) Mean waiting time in the queue.
(v) Probability of finding 2 machines in the system.
(vi) Expected number in the queue.

Solution:

(a) Advantages of Simulation:

(i) It provides a means of solving problems or providing information in situations where the application of analytical methods could be unsuitable i.e., for strategic planning model.

(ii) Sometimes analytical method can be used, but some managers place greater reliance on simulation solutions. This is particularly the case when numbers of uncertain variables is large so that probability analysis and Expected value (EV) calculations would not give a true impression of possible variations in outcome.

(iii) Simplifying assumptions are not so great in simulation exercises, as they are with other mathematical models.

(iv) Simulation is cheaper than tampering with the real systems.

Limitations of Simulation:

(i) To obtain representative information, the amount of calculations required in all but the simplest examples will be substantial.

(ii) Unlike some other mathematical models, simulation is non- optimizing. There is a possibility that optimum policy will not be tested or selected.

(b) The random numbers based on cumulating probability are given below:

Production per day	Probability	Cumulative production	Random Numbers
196	0.05	0.05	00-04
197	0.09	014	05-13
198	0.12	0.26	14-25
199	0.14	0.40	20-39
200	0.20	0.60	40-59
201	0.15	0.75	60-74
202	0.11	0.86	75-85
203	0.08	0.94	86-93
204	0.06	1.00	94-99

Based on the 15 numbers given production per day can be simulated

S.No	Random No.	Production Per day	No. of mopeds waiting			No. of empty	
			Opening Balances	Current Excess Production	Current Short Production	Total waiting	Space in the lorry
1	82	202	-	2	-	2	-
2	89	203	2	3	-	5	-
3	78	202	5	2	-	7	-
4	24	198	7	-	2	5	-
5	53	200	5	-	-	5	-
6	61	201	5	1	-	6	-
7	18	198	6	-	2	4	-
8	45	200	4	-	-	4	-
9	04	196	4	-	4	0	-
10	23	198	0	-	2	0	2
11	50	200	0	-	-	0	-
12	77	202	0	2	-	2	-
13	27	199	2	-	1	1	-
14	54	200	1	-	-	1	-
15	10	197	1	-	3	0	2
Total						**42**	**4**

Average number of mopeds waiting = 42 /15 = 2.80
Average number of empty spaces in lorry = 4/15= 0.2666.

(c)
Here,

$\lambda = 3$ per day
$\mu = 6$ per day

(i) Utilization factor of the service facility: $\rho = \frac{\lambda}{\mu} = \frac{3}{6} = 0.5$ or 50%

(ii) Mean time in the system: $W_s = \frac{1}{\mu - \lambda} = \frac{1}{6-3} = \frac{1}{3}$ day

(iii) Mean number in the system in breakdown or repair: $L_s = \frac{\lambda}{\mu-\lambda} = \frac{3}{6-3} = 1$machine

(iv) Mean waiting time in the queue: $W_s = \frac{\lambda}{\mu} x \frac{\lambda}{\mu-\lambda} = \frac{3}{6} x \frac{1}{6-3} = \frac{1}{6}$ day

(v) Probability of finding two machines in the system:
Probability that there are n customers in the system

$$P_n = \left(\frac{\lambda}{\mu}\right)^n P_o$$

Or, $$P_2 = \left(\frac{\lambda}{\mu}\right)^2 \left(1-\frac{3}{6}\right) = (0.5)^2(0.5) = 0.125$$

(vi) Mean number in the queue: $L_q = \frac{\lambda}{\mu} x \frac{\lambda}{\mu-\lambda} = \frac{3}{6} x \frac{3}{6-3} = \frac{1}{2}$ Machine

(vii) Per cent idle time = 1 - % utilization time
= 1 – 0.50 = 50%

Alternatively $P_o = 1-\frac{\lambda}{\mu} = 1-\frac{3}{6} = 0.5$ or 50%.

14. (a) Describe the importance of Human Resource Planning.
(b) Write a note on 'Short – Term Resource planning.'
(c) Five different machines can do any of the five required jobs, with different profits resulting from each assignment as shown in the adjoining Table. Find out maximum profit possible through optimal assignment.

Job ↓	Machine				
	A	B	C	D	E
1	30	37	40	28	40
2	40	24	27	21	36
3	40	32	33	30	35
4	25	38	40	36	36
5	29	62	41	34	39

Solution:

(a) Importance of Human Resource Planning

HRP is of primacy nature and therefore, it precedes all other HRM functions. Without HRP, no other functions can be undertaken in any meaningful way. HRP translates the organizational objectives and plans into the number and kind of personnel needed to achieve those objectives. Without a clear-cut planning estimation of the organization's human resource need is reduced to mere guesswork. In particular, HRP contributes in the following ways in managing human resources in an organization.

(i) Defining Future Personnel Need: Planning defines future personnel need and this becomes the basis of recruiting and developing personnel. In its absence, there is likelihood of mismatch between personnel needed and personnel available. Lack of systematic HRP has resulted into large scale overstaffing in many public sector organizations. For example, in Steel Authority of India Limited, there are170,000 employees and McKinsey & Company, consultancy firm engaged by SAIL to devise its revival strategy, has suggested pruning of this level to bring it to 100,000.Similar problem exists in many other organizations. This type of problem exists in many private-sector organizations and they have gone for voluntary retirement scheme offering huge

compensation. This has happened because of lack of systematic HRP. Lack of systematic. HRP has created another type of problem. Many public-sector enterprises have remained top-less for a considerable period of time, prominent ones being Gas Authority of India (27 months), National Hydroelectric Power Corporation (18 months), State Farms Corporation (17 months), and so on. This is all because of faulty or no HRP. Occurrence of such phenomena can be avoided by proper HRP.

(ii) Coping with Changes: In the Indian and international business scenes, fast changes are taking place. In the Indian context, such changes have been brought by liberalization of economy. At the international level, there is growing global competition because of the freedom in international trade initiated by World Trade Organization. Every organization is trying to compete on the basis of technology and managerial talents which have resulted into global talent war. In this war, only those companies will survive which adopt a formal, meticulous HRP. Change in technology has attached more premiums to knowledge and skills resulting into surplus manpower in some areas and shortage in other areas. HRP helps in creating a balance in such a situation as through this, manpower needs and availability can be identified much in advance.

(iii) Providing Base for Developing Talents: Jobs are becoming more and more knowledge oriented. This has resulted into changed profile of manpower. For example, in Larsen and Toubro, MBAs, engineers, and technicians constitute about 70 per cent of its total employee strength of 20,000. Because of increasing emphasis on knowledge, there is shortage of certain category of personnel and there are frequent movements of personnel from one organization to another. The replacement cost of such personnel is estimated to be 1.5 times of the expenses incurred on these personnel. Therefore, an organization must be ready to face such an eventuality by taking proper HRP.

(iv) Increasing Investment in Human Resources: The cost of acquiring, developing and retaining personnel is increasing much faster than the average rate of inflation. Cost of acquiring MBAs from reputed institutes is increasing by more than 20-25 percent per annum. This increasing cost can be taken care of by proper HRP which provides the way for effective utilization of such talents. In fact, such a high cost has forced many companies to have a relook at their HRM functions and particularly HRP and to align these with new situations.

(v) Forcing Top Management to involve in HRM: Systematic HRP forces top management of an organization to participate actively in total HRM functions, an area that has been neglected by most of the companies until recently. As we shall see shortly, if there is active involvement of top management in the preparation of human resource plans, it is expected to appreciate the real value of human resources in achieving organizational effectiveness.

(b) Short-Term Human Resource Planning

Short-term HRP is derived out of the long-term HRP and attempts to contribute to the achievement of objectives of long-term HRP. In the short-term which may be a year or so, there is no fundamental change in human resources at organizational operations. Whatever the changes take place; these are the results of the characteristics and events of short-term. For example, there may be change in organization's human resources due to resignation, death, separation, and promotion. Therefore, the basic problem involved in managing human resources in the short-term is the effective utilization of existing human resources by matching them with existing organizational jobs. Matching jobs and individuals may be taken up for organization as a whole or at the levels e: certain individuals.

(c)

Steps 1: The given maximization assignment problem can be converted into a minimization assignment problem as shown in adjoining Table by sub-tracting from the highest element, (i.e., 62), all the elements of the given table.

Job ↓	Machine A	B	C	D	E
1	32	25	22	34	22
2	22	38	35	41	26
3	22	30	29	32	27
4	37	24	22	26	26
5	33	0	21	28	23

Steps 2: Subtract the minimum element of each row from the elements of that row and then subtract he minimum element of each column from the elements of that column to get the adjoining reduce matrix

Job ↓	Machine A	B	C	D	E
1	10	23	0	8	0
2	0	16	13	15	4
3	0	4	7	6	5
4	15	2	0	0	4
5	33	0	21	24	23

Steps 3: Draw the minimum number of horizontal and vertical lines which cover all the zeros. Since the number of lines (=4) is less than the order of the matrix, the solution is not optimal.

Job ↓	Machine A	B	C	D	E
1	~~10~~	~~3~~	~~0~~	~~8~~	~~0~~ →
2	~~0~~	16	13	15	4
3	~~0~~	8	7	6	5
4	~~15~~	~~2~~	~~0~~	~~0~~	~~4~~ →
5	~~33~~	~~0~~	~~21~~	~~24~~	~~23~~ →

Steps 4: The least uncovered element 4 is subtracted from all the uncovered elements and added to the intersection elements to obtain the following reduced matrix. Draw more minimum possible number of lines so as to cover the new zeros.

Job ↓	Machine A	B	C	D	E
1	~~14~~	~~3~~	~~0~~	~~8~~	~~0~~ →
2	~~0~~	~~12~~	~~9~~	~~11~~	~~0~~ →
3	~~0~~	4	3	2	1
4	~~19~~	~~2~~	~~0~~	~~0~~	~~4~~ →
5	~~37~~	~~0~~	~~21~~	~~24~~	~~23~~ →

Steps 5: Now, since the number of lines is equal to the order of the matrix, an optimal solution has been attained. To consider this optimal assignment, we consider now only the zero elements of the matrix. Examine successively the rows of the matrix to find out one with exactly one zero. The third row has exactly one zero, encircle this zero and mark a cross (x) on the remaining zeros of the first column. Repeat the procedure until there is exactly one encircled zero in each column and each row.

Job ↓	Machine A	B	C	D	E
1	14	3	[0]	8	~~0~~
2	~~0~~	12	9	11	[0]
3	[0]	4	3	2	1
4	19	2	~~0~~	[0]	4
5	37	[0]	21	24	23

The adjoining optimal assignment schedule is thus obtained.

Job	Machine	Profit
1	C	40
2	E	36
3	A	40
4	D	36
5	B	62
		Total 214

15. (a) Discuss the benefits of Material Planning.

(b) Discuss the Material Requirement Planning (MRP).

(c) A farmer has a 100 – acre Farm. He can sell all the tomatoes, lettuce or radishes, he can raise. The price he can obtain is Re.1 per kilogram for tomatoes, Re 0.75 a head for lettuce and ₹ 2 per kilogram for radishes. The average yield per acre is 2,000 kilogram of tomatoes, 3,000 heads of lettuce and 1,000 kilograms of radishes. Fertilizer is available at Re 0.50 per kilogram and the amount required per acre is 100 kilograms each for tomatoes and lettuce, and 50 kilograms for radishes. Labour required for sowing, cultivating and harvesting per acre is 5 man- days for tomatoes and radishes and 6 man –days for lettuce. A total of 400 man – days of labour are available at ₹ 20 per man – day.

Formulate this problem as a Linear Programming Model to maximize the farmer's total profit

Solution:

(a) Benefits of Materials Planning

(i) Materials planning both quantity and value in terms of rupees - for each item and overall, tries to avoid the practice of crisis management of struggling in the last minute to procure materials to meet the production requirements or pressurizing unnecessarily the purchase people by sitting on their neck to get the materials in the last moment.

(ii) It helps to get things done efficiently and effectively by better forecasting of future material needs and working pro-actively rather than reacting to the situations.

(iii) A well-designed materials planning system provides steps for effective materials budgeting, follow-up of suppliers to procure materials in-time, thereby avoiding material shortages and its undesirable effects on production.

(iv) Purchase planning which is based on materials planning, if carried out properly, will enable the buyer to know not only the prices of the materials but also their costs.

(b) Material Requirement Planning :

MRP is a technique of working backward from the scheduled quantities and needs dates for end items specified in a master production schedule to determine the requirements for components needed to meet the master production schedule. The technique determines what components are needed, how many are needed, when they are needed and when they should be ordered so that they are likely to be available as needed. The MRP logic serves as the key component in an information system for planning and controlling production operations and purchasing. The information provided by MRP is highly useful in scheduling because it indicates the relative priorities of shop orders and purchase orders.

"Materials Requirement Planning (MRP) is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master production schedule requirements."

MRP is one of the powerful tools that, when applied properly, helps the managers in achieving effective manufacturing control.

MRP Objectives:

(i) Inventory reduction: MRP determines how many components are required, when they are required in order to meet the master schedule. It helps to procure the materials/components as and when needed and thus avoid excessive build up of inventory.

(ii) Reduction in the manufacturing and delivery lead times: MRP identifies materials and component quantities, timings when they are needed, availabilities and procurements and actions required to meet delivery deadlines. MRP helps to avoid delays in production and priorities production activities by putting due dates on customer job orders.

(iii) Realistic delivery commitments: By using MRP, production can give marketing timely information about likely delivery times to prospective customers.

(iv) Increased efficiency: MRP provides a close coordination among various work centres and hence helps to achieve uninterrupted flow of materials through the production line. This increases the efficiency of production system.

(c)

Step 1. Key decision is to determine number of units (in kgs) of tomatoes, lettuce and radishes to be produced to maximize the profit.

Step 2. Let x_1 be the weight in kgs of tomatoes to be produced.
Let x_2 be the numbers of lettuce to be produced.
Let x_3 be the weight in kgs of radishes to be produced.

Step 3. Feasible alternatives are sets of x_1 , x_2 ,and x_3.
Where, x_1 , x_2, $x_3 \geq 0$

Step 4. The objective is to maximize profit per acre for tomatoes, lettuce and radishes is calculated below:

	Tomatoes	Lettuce	Radishes
(1) Sale (₹)	1 x 2,000 = ₹ 2,000	0.75 x 3,000 = ₹ 2,250	2 x1,000 = ₹ 2,000
(2) Cost of Fertilizer	0.50 x 100 = 50	0.50 x 100 = 50	0.50 x 50 = 25
(3) Labour Cost	20 x 5 = 100	20 x 6 = 120	20 x 5 = 100
(4) Total Cost [2+3]	150	170	125
(5) Profit (per acre) [1-4]	1,850	2,080	1,875

Formulation of LP Model:
The objective function is to:

Maximize $Z = 1,850\ x_1 + 2,080\ x_2 + 1,875\ x_3$

Subject to constraint

$X_1+X_2+X_3 \leq 100$ **(Land)**

$5x_1 + 6x_2 + 5x_3 \leq 400$ **(Man –days)**

$x_1, x_2, x_3 \geq 0$

16.(a) When does degeneracy happen in transportation problem? What is an unbalanced transportation problem?

(b) Consider the following data for the transportation problem:

Factory	Distribution			Supply
	1	2	3	
A	5	1	7	10
B	6	4	6	80
C	3	2	5	15
Demand	75	20	50	

Since there is no enough supply, some of the demands at the three destinations may not be satisfied. For the unsatisfied demands, let the penalty costs be ₹ 1,2 and 3 for destinations (1), (2) and (3) respectively.

Find the optimal allocation the minimizes the transportation and penalty costs.

(c) Explain the Prohibited Route in the transportation.

Solution:

Degeneracy:
In transportation problem with m orgins and n destinations, if a Basic Feasible solution has less than m+n-1 Allocations, the problem is said to be a degenerate problem.

Unbalanced transportation
If the total availability from all origins is not equal to the total demand of all destinations, then it is called unbalanced transportation problem.

(b)

Transportation Problem

Factory	Distribution			Supply
	1	2	3	
A	5	1	7	10
B	6	4	6	80
C	3	2	5	15
Dummy	1	2	3	145-105=40
Demand	75	20	50	145

Initial Basic Feasible Solution

Factory	Destination (1)	Destination (2)	Destination (3)	Supply	u_i
A	5	1	7	10	$u_1 = 2$
	3	10	5		
B	6	4	6	80	$u_2 = 6$
	30 (–)	–1	50 (+)		
C	3	2	5	15	$u_3 = 3$
	5 (+)	10 (–)	2		
Dummy	1	2	3	40	$u_4 = 1$
	40	2	2		
Demand	75	20	50	145	
v_j	$v_1 = 0$	$v_2 = -1$	$v_3 = 0$		

Revised Solution - Optimal

Factory	Destination (1)	Destination (2)	Destination (3)	Supply	u_i
A	5	1	7	10	$u_1 = 2$
	3	10	5		
B	6	4	6	80	$u_2 = 6$
	30 (–)	–1	50 (+)		
C	3	2	5	15	$u_3 = 3$
	5 (+)	10 (–)	2		
Dummy	1	2	3	40	$u_4 = 1$
	40	2	2		
Demand	75	20	50	145	
v_j	$v_1 = 0$	$v_2 = -1$	$v_3 = 0$		

Since all Δ_{ij} values are either positive or zero, the solution given in above table is optimal with a minimum total transportation cost:
(1 x 10) + (6 x 20) + (4 x 10) + (6 x 50) + (3 x 15) + (1 x 40) = ₹ 555

(c) Prohibited Routes in the context of transportation:

Sometimes in a given transportation problem some route(s) may not be available. This could be due to a variety of reasons like the unfavourable weather conditions on a particular route, strike on a particular route etc. In such situations, there is a restriction on the routes available for transportation. To handle a situation of this type, we assign a very large cost represented by M to each of such routes which are not available. Then the problem is solved in the usual way. The effect of adding a large cost element would be that such routes would automatically be eliminated in the final solution.

17. (a) Discuss about the Push versus Pull systems in the context of Just – in- Time.

(b) A fleet owner finds from his past records that the costs per year of running a vehicle whose purchase price is ₹ 50,000 are as under:

Year	1	2	3	4	5	6	7
Running cost (₹)	5,000	6,000	7,000	9,000	11,500	16,000	18,000
Resale Value (₹)	30,000	15,000	7,500	3,750	2,000	2,000	2,000

Thereafter, running cost increases by ₹ 2,000, but resale value remains constant at ₹ 2,000. At what age is a replacement due?

(c) Explain the need for Productivity Improvement.

Solution:

(a) Push versus Pull System:

The concept behind JIT is that of a pull system. It is a JIT concept that results in material being produced or supplied only when requested and moved to where it is needed just as it is needed.. A pull system uses signals to request production and delivery from upstream sections to the station that has production capacity available. This concept is used both within the immediate production process and with suppliers. By pulling material through the system in very small lots, just as it is needed, the cushion of inventory that hides problems is removed, problems become evident and continuous improvement is emphasized. Removing the cushion of inventory also reduces both investments in inventory and manufacturing cycle time.

Push system is a system that pushes materials into downstream workstations, regardless of their timeliness or availability of resources to perform the work. Push systems are the antithesis of JIT. Manufacturing cycle time is the time between the arrival of raw materials and the shipping of finished products. JIT helps in reducing the manufacturing cycle time.

(b) Chart Showing Optimal Replacement Period

Year (1)	Net Capital (Cost – Resale value) (2)	Annual Maintenance Cost (₹) (3)	Cumulative Operation Costs (₹) (4)	Total Costs (₹) (5)	Average annual Cost (₹) (6)= (5 /1)
1	20,000	5,000	5,000	25,000	25,000
2	35,000	6,000	11,000	46,000	23,000
3	42,500	7,000	18,000	60,500	20,167
4	46,250	9,000	27,000	73,250	18,313
5	48,000	11,500	38,500	86,500	17,300
6	48,000	16,000	54,500	1,02,500	17,083
7	48,000	18,000	72,500	1,20,500	17,214

Optimal replacement at the end of 6th year.

(c) Need for Productivity Improvement

Productivity improvement is vital not simply for firms but also nations, which are facing international competition. At the firm level, it is one of the most important instruments to reduce costs, improve profitability, and enhance competitive strength of the firm in the market. At the national level, it is means not to improve the nation's competitive position in the international market but also to check inflationary pressures in the economy. In fact, it is the backbone of supply-side Economics. At both the micro and the macro levels, increased productivity implies economy in use of productive resources.

In business, improved productivity may lead to:
(i) Better consumer service through lowering of prices;
(ii) Increased cash flows, improved return on assets, and greater profits;
(iii) Increased profits that would enhance stock price substantially;
(iv) Increased profits that would lead to expansion of capacity and creation of new jobs;
(v) Greater investment in R/D and development of new products; and
(vi) Better living standards. "Economists do not agree on many things, but all agree that improved living standards are dependent absolutely on increasing productivity."

18. (a) Describe the Eight most common Benchmarking Errors.

(b)In a simulated operation, a firm's maintenance crew received requests for service and provided service during an 8 hour period as shown below:

Request arrival (clock) time	Service Time
0.00	1.5
1.00	0.5
3.30	2.0
4.00	0.5
7.00	1.0

The maintenance labour cost is ₹ 140 per hour and the delay time cost is ₹ 450 per hour.
(i) Find the idle time cost for the maintenance crew.
(ii) Find the delay time cost for the machinery.

(c) The Mini Transport Company owns three mini buses, two of which are two years old while the third one is only a year old. Each of these buses was purchased for ₹ 80,000. The company contemplates replacing the three buses by two full-sized buses, each such bus containing 50% more seating capacity than a mini bus. Cost of each is ₹ 1,20,000. Using the following data on the running costs and the resale value of both the types of buses, state whether the mini buses be replaced by the full-sized buses. If not, state why? If yes, state when?

Year	For a Mini Bus		For a Full – sized Bus	
	Running Cost	Resale Value	Running Cost	Resale Value
1	3,000	70,000	3,400	1,00,000
2	3,600	61,000	3,900	92,000
3	4,800	55,000	4,700	86,000
4	5,000	49,000	5,800	81,000
5	8,000	32,000	7,200	76,000
6	11,200	20,000	9,000	66,000
7	15,000	10,000	12,000	54,000
8	20,000	5,000	16,000	40,000

Solution:
Eight most common Benchmarking Errors:
(i) **Lack of Self-Knowledge:** Unless you've thoroughly analyzed your own operations, your benchmarking efforts will not pay off. You have to know how things work in your company, how effective your current processes are, and what factors are critical. That's why internal benchmarking is an important first step.
(ii) **Error in selection of area for Benchmarking:** Benchmarking another company's employee food service will usually not be worth the time, energy, and cost. Your TQM effort as a whole will point out the areas where benchmarking is most likely to pay off.

(iii) **Benchmarking projects are broad instead of focused:** The more specific the project, the easier it is and the more likely it will generate useful ideas. Benchmark a successful company's hiring procedures, not their entire human resources operations. Focus on accounts receivable handling, not the accounting department as a whole.

(iv) **Benchmarking produces reports, not action:** Studies have indicated that 50% of benchmarking projects result in no specific changes. The process is not an academic exercise. It should be geared toward generating and implementing actual changes.

(v) **Benchmarking is not continuous:** Benchmarking is a process. Even before you reach the benchmark you've set, you should take another look at your partner's performance, or at other companies. New goals should be established and new techniques adopted. The process never ends.

(vi) **Looking at the numbers, not the issues:** While the measures are important, they are not the heart of the process. At some companies, benchmarking is used to set goals, but not to generate the important changes needed to meet them.

(vii) **Participants are not motivated:** Make sure benchmarking team members have the time to do the job. Even if the project is simply added on their regular jobs, make sure each has a stake in the success of the project. Don't consider benchmarking as "busy work" to be assigned to a group of low-level employees.

(viii) **Too much data:** Action are what's important, not information for its own sake. Don't measure benchmarking success by quantity of information. Always focus on key issues.

(b)

Request arrival time (clock time)	Repair time for one crew		Repair time begins – ends (clock time)		Machine down time		
	Hours	minutes	Begins	ends	Waiting time	Repair time	Total time
00.00	1.50	90	00.00	1.30	Nil	1.5	1.5
01.00	0.50	30	01.30	02.00	0.5	0.5	1.0
03.30	2.00	120	03.30	05.30	Nil	2.0	2.0
04.00	0.50	30	05.30	06.00	1.5	0.5	2.0
07.00	1.00	60	07.00	08.00	Nil	1.0	1.0
	5.50 hrs.				2.0	5.5	7.5

Idle time for the maintenance crew = 8 – 5.5 = 2.5 hrs.

(i) Idle time cost for maintenance crew = 2.5 × 140 = ₹ 350

Delay time or waiting time = [7.5 – 5.5] = 2.0 hours

(ii) Delay time cost for the machinery = 2.0 × 450 = ₹ 900

(c) We shall first calculate the minimum average cost for each type of the buses. This is given in Tables below.

For Mini Buses

Determination of Average Cost

Year	M_t (1)	Cum M_t (2)	C-S (3)	T(n) (4= 1+3)	A(n) (5= 4/year)
1	3,000	3,000	10,000	13,000	13,000
2	3,600	6,600	19,000	25,600	12,800
3	4,800	11,400	25,000	36,400	12,133
4	5,000	16,400	31,000	47,400	11,850
5	8,000	24,400	48,000	72,400	14,480
6	11,200	35,600	60,000	95,600	15,933
7	15,000	50,600	70,000	1,20,600	17,229
8	20,000	70,600	75,000	1,45,600	18,200

Where M_t = Running cost , c = cost , s= sales , T(n)= Total cost and A(n) = Average cost

For Full Sized Bus

Determination of Average Cost

Year	M_f (1)	Cum M_f (2)	C-S(3)	T(n)(4=1+3)	A(n) (5= 4/year)
1	3,400	3,400	20,000	23,400	23,400
2	3,900	7,300	28,000	35,300	17,650
3	4,700	12,000	34,000	46,000	15,333
4	5,800	17,800	39,000	56,800	14,200
5	7,200	25,000	44,000	69,000	13,800
6	9,000	34,000	54,000	88,000	14,667
7	12,000	46,000	66,000	1,12,000	16,000
8	16,000	62,000	80,000	1,42,000	17,750

Where M_f = Running cost, c = cost, s= sales, T(n)= Total cost and A(n) = Average cost

Thus, the minimum average cost for a mini bus is ₹ 11,850 p.a. and ₹ 13,800 p.a. for a full-sized bus. However, these two should not be compared directly because three mini buses are equivalent to two full-sized buses. Thus,

Average cost for all 3 mini buses = 11,850 x 3 = 35,550
Average cost for 2 large buses = 13,800 x 2 = 27,600.

Clearly, then, it is prudent to replace the mini buses by the full-sized buses.

To decide the timing at which the replacement be done, we shall first find the total yearly costs for the new buses. The year in which the average cost of the new buses shall be lower than the total cost of maintaining and running the old ones shall be the year when the replacement should be done. The calculations are given in Table below.

Determination of Yearly Cost of a Mini Bus

Year	Running Cost	Depreciation	Total Cost
1	3,000	10,000	13,000
2	3,600	9,000	12,600
3	4,800	6,000	10,800
4	5,000	6,000	11,000
5	8,000	17,000	25,000
6	11,200	12,000	23,200
7	15,000	10,000	25,000
8	20,000	5,000	25,000

For calculation of depreciation:
1st year = 80,000/8= 10,000 , 2nd year to end = Previous year resale value – current year resale value.

Total cost for next year would be: 2 x 10,800 + 12,600 = ₹ 34,200 (since two of the buses would be running in the third year and the third one in the second year). Total cost for the subsequent years shall be:

2 x 11000 + 10800 = ₹ 32,800
2 x 25000+ 11000 = ₹ 61,000 etc.

Since the total average cost of running the two buses is ₹ 27,600 whereas in the years to come the cost of owning and running the old buses would be greater than this, the conclusion is that the buses should be replaced immediately.

Section B – Information System

19. Explain the following terms in 2 or 3 sentences :

(a) Key pair in relation to Cyber Law
(b) Transaction Processing System
(c) Mathematical Model used for representing the information
(d) Database Management System (DBMS)
(e) Data Manipulation Language (DML)
(f) Database Schema
(g) System Components Matrix
(h) System Analysis
(i) Executive Information System
(j) Non-programmed Decisions in the context of decision making

Solution :

(a) "**Key pair**", in an asymmetric crypto system, means a private key and its mathematically related public key, which are so related that the public key can verify a digital signature created by the private key.

(b) Transaction Processing System – an information system designed to process information relating to monetary transactions in the business activities like purchase, sale, payment, receipts etc. It is a computer based processing for different functional areas to generate all required reports for day-to-day use in the organization. It seeks time - and cost-efficiency by automating repetitive operations in large volumes.

(c) Mathematical Model represents a data set in the form of graph, picture or frictional diagram. It uses highly mathematical or statistical algorithm to interpret data of huge volume with ease. The algorithm varies depending on the complexity of analysis of data sets and the type of analysis.

(d) A **Database Management System (DBMS)** is a collection of programs that enables users to create and maintain a database. Constructing the database is the process, of storing the data itself on some storage medium that is controlled by the DBMS. The DBMS is hence a general-purpose software system that facilitates the processes of defining, constructing, and manipulating databases for various applications.

(e) Once the database schemas are compiled and the database is populated with data, users must have some means to manipulate the database. Typical manipulations include retrieval, insertion, deletion, and modification of the data. For these purpose the Database Management System provides **Data Manipulation Language (DML).**

(f) In any data model it is important to distinguish between the description of the database and the database itself. The description of a database is called the **Database Schema**, which is specified during database design and is not expected to change frequently.

(g) System Components Matrix: It highlights how the basic activities of input, processing, output, storage and controls are accomplished in an information system, and how the use of hardware, software and other resources can convert data resources into information products.

(h) System Analysis is a step which involve in breaking a system into different parts and process of gathering and interpreting facts, diagnosing problems, and using the information to recommend improvements to the system.

(i) An **Executive Information System** (EIS) is a special type Management Information System meant for top management of an organization. In other words, it is a Decision Support System (DSS) for Executives. It aims at providing information to top executives of an organization who are involved in strategic decision making.

(j) **Non-programmed Decisions:** Decisions which are unstructured and complex are known as Non - programmed decisions. In other words, decisions which are not automated are Non-programmed decisions. For example, new product line, capital budgeting etc. Non-programmed decision making has no pre established decision procedure.

20. (a) Discuss the features of Inventory Management in SAP.
(b) List the benefits of ERP.
(c) What is Business Process Re-engineering (BPR)?
(d) State the major characteristics of Transaction Processing System.

Solution :

(a) Following are the features of Inventory Management in a SAP environment:

i. Entry of goods movements (receipt, issue, transfer posting etc.) are on real time basis. Goods movements include both "external" movements (e.g. goods receipts from external procurement, goods issued for sales orders) and "internal" movements (e.g. goods receipts from production, withdrawals of material for internal purposes, stock transfers, and transfer postings).
ii. Creation of a document for every goods movement.
iii. Automatic updating of quantity & value for inventory management and creation of accounting documents (Cost Accounting and Financial Accounting).
iv. Division of the stocks into different categories (such as Unrestricted-use stock, stock in quality inspection or blocked stock).
v. Batch management.
vi. Management of special stocks (e.g. Vendor consignments, material provided to vendor etc.).
vii. Physical Inventory (Stock verification).
viii. Various analyses (such as the stock overview, Age Analysis etc.).

(b) Some of the benefits of ERP system are mentioned below:

Implementation of ERP, however, does not lead to headcount reduction (redundancies of few lower ended positions of payroll and accounts payable gets counterbalanced by additional higher paid IT staff).

i. Reduced level of inventory, including raw material, work in progress and finished goods, through improved planning and control.
ii. Reduced materials cost through improved procurement and accounts payable practices, less obsolescence and wastage.
iii. Reduced labor cost through better allocation and reduction of overtime of workmen directly involved with production such as technicians and skilled workers.
iv. Improved production throughput through better scheduling of critical equipment and sub-contracting operations, thereby minimizing shortages, interruption and rework.
v. Reduction in the cost of after sales services.

In addition to the above mentioned tangible benefits, following intangible benefits also occur:

i. Integration of information resulting efficiency, transparency and effective MIS.
ii. Error reduction, accuracy of inventory record.

iii. Improved customer service, on time shipment, shorter order to shipment cycle.
iv. Establishment of standardized procedures.
v. Improved accounting control and shorter sales to cash cycle.
vi. Legal and regulatory compliance.

(c) Enterprise Resource Planning (ERP) and Business Process Re-engineering (BPR) evolved almost at the same time i.e. 1st half of 1990. Business Process Re-engineering (BPR) relates to radical redesign of an organization at a relatively short period. It is having the primary intend to optimize workflow and improve productivity. This change is achieved by complete revamp of organizational structure, business process workflow, job description, performance measurement and adoption of information technology.

Some of Basic characteristics of BPR are:

- View business as a set of customer (both internal and external) oriented processes rather than a set of departmental functions.
- Processes must have clear cut ownership.
- Non value adding activities within a process should be eliminated.
- Gather information only once at the point of origin.

(d) The major characteristics of Transaction Processing System are :

- Large amounts of data are processed;
- The sources of data are mostly internal, and the output is intended mainly for an internal audience;
- The Transaction Processing System processes information on a regular basis - daily, weekly, monthly, etc.;
- Large storage (database) capacity is required;
- High processing speed is needed due to the high volume;
- Transaction Processing System basically monitors and collects past data;
- Input and output data are structured (i.e., standardized);
- Low computation complexity is usually evident in Transaction Processing System;
- A high level of accuracy, data integrity, and security is needed;
- High reliability is required;
- Inquiry processing is a must.

21. (a) List the limitations of Management Information System (MIS).
(b) Write a note on On-line Analytical Processing (OLAP).
(c) What is Program Debugging? Mention the steps involved therein.
(d) Discuss the characteristics of a good coding system.

Solution:

(a) Limitations of the Management Information System (MIS) are :

- MIS is not a substitute for effective management.
- MIS may not have requisite flexibility to quickly update itself with changing needs of time.
- MIS cannot provide standard information packages suitable for the purpose of every type of decision made by executives.
- MIS takes into account mainly quantitative factors, thus it ignores the non-quantitative factors like morale and attitude of members of the organization.
- MIS is less useful for making non-programmed decisions.
- The effectiveness of MIS decreases due to frequent changes in top managements, organisational structure and operational team.

There are some constraints which come in the way of operating an information system

and these will also be treated as limitations of Management Information System:

- Non-availability of experts, who can provide a desired direction for installing and operating the system aligning with the objectives of the organization.
- Approach adopted by experts for designing and implementing MIS is a non-standardized one.
- Non-availability of cooperation from staff is a critical problem.
- There is high turnover of experts in MIS.
- There is a difficulty in quantifying the benefits of MIS.

(b) An On-line Analytical Processing (OLAP) software does the analysis of information from data warehouse. The OLAP applications are widely scattered in divergent application areas like Finance Management, Sales Analysis. The real test of an OLAP system is inefficient use of data from databases and computational capability of data to develop model establishing the relationship of various parameters. In fact, it provides the services of 'just-in-time' information.

Though OLAP software are found in widely divergent functional areas, they have three common key features which are :

- Multidimensional views of data
- High analytical ability
- 'Just-in-time' information delivery

Rarely a business model limited a fewer than three dimensions. The common dimensions in business environment are organization, line item, time, product, channel, place etc. OLAP system should have the ability to respond the queries from a manager within a specified time. The OLAP software must provide a rich tool kit of powerful capability of analytical ability.

(c) Program Debugging: Debugging is the form of testing activity which refers to correcting programming language syntax and diagnostic errors so that the program compiles cleanly and thus in this process, errors are found and then they are corrected.

Debugging consisting of following four steps:

i. Inputting the source program to the compiler.
ii. Letting the compiler find errors in the program.
iii. Correcting lines of code that are erroneous.
iv. Resubmitting the corrected source program as input to the compiler.

(d) A good coding system should have the following characteristics:

(i) **Individuality:** The code should be universally used over the entire organization.
(ii) **Convenience:** The code number should be short and simple and consists of digits or alphabets.
(iii) **Reliability:** Poor setting of parameters and hard coding may subsequently could result in the failure of a program.
(iv) **Robustness:** It refers to the process of taking into account all possible inputs and outputs of a program.
(v) **Efficiency:** It refers to the performance which should not be affected with the increase in input values.
(vi) **Usability:** It refers to a user-friendly interface and easy-to-understand.
(vii) **Readability:** The maintenance of program must be easier.

22. (a) The top management of a company has decided to develop a computer Information System for its operations. Is it necessary to conduct the feasibility study of system before implementing it? If the answer is yes, state the reasons. Also discuss three different angles through which the feasibility study is to be conducted.
(b) State the risks associated with System Development life cycle (SDLC).
(c) Discuss the fact finding techniques used by a system analyst?
(d) List the major factors to be considered in designing user input.

Solution:

(a) Yes it is necessary to conduct the feasibility study of the project before its implementation. Feasibility Study refers to a process of evaluating alternative systems through cost/benefit analysis so that the most feasible and desirable system can be selected for development.

Different angles through which the feasibility study of the system is to be conducted:

(i) Technical Feasibility: In this study an analyst ascertains whether the proposed system is feasible with existing or expected computer hardware and software technology. The technical issues include the following:-
• Does the proposed equipment have the technical capacity to hold the data required to use the new system?
• Can the proposed application be implemented with existing technology?
• Can the system be expanded in future?
• Are there technical guarantees of accuracy, reliability, ease of access, and data security?

(ii) Economic Feasibility/Cost-Benefit Analysis: It includes an evaluation of all the incremental costs and benefits expected if the proposed system is implemented. The financial and economic questions raised by analysts during the preliminary investigation for estimating the following:

• The cost of conducting a full systems investigation.
• The cost of hardware and software for the class of applications being considered.
• The benefits in the form of reduced costs.
• The cost if the proposed system is not developed

(iii) Operational Feasibility: It is concerned with ascertaining the views of workers, employees, customers and suppliers about the use of computer facility. Some of the questions which help in testing the operational feasibility of a project are stated below:

• Is there sufficient support for the system from management and from users?
• Are current business methods acceptable to users?
• Are the users been involved in planning and development of the project?
• Will individual performance be poorer after implementation than before?

Feasibility study can also be done in some other areas :

(iv) Financial Feasibility: It is to be analysed that whether the cost of the proposed system is communes rate with the size of the organization.

(v) Schedule or Time Feasibility: If new system will take long time, the organizations can go for other alternative that the company can implement in a shorter time frame.

(vi) Resources Feasibility: This focuses on human resources and their reluctance to move to such other locations.

(vii) Behavioral Feasibility: If the data input for the system is not readily available or collectable, then the system may not be successful.

(viii) Legal Feasibility: A revised system should comply with all applicable federal and state statutes about financial reporting requirements, as well as the company's contractual obligations.

(b) Following are the risks associated with System Development Life Cycle :
(i) The development team may find it cumbersome,
(ii) The users may find that the end product is not visible for a long time,
(iii) It may not be suitable for small and medium sized projects.

(c) Various fact-finding techniques, which are used by the system analyst for determining the needs/ requirements of an organization are briefly discussed below :

(i) Documents: Analysts collect the hierarchy of users and manager responsibilities, job descriptions for the people who work with the current system, procedure manuals, program codes for the applications associated with the current system to understand the existing system.

(ii) Questionnaires: Users and managers are asked to complete questionnaire about the problems with the existing system and requirement of the new system. Using questionnaires, a large amount of data can be collected.

(iii) Interviews: Users and managers may also be interviewed to extract information in detail.

(iv) Observation: Observation plays a key role in requirement analysis. Only by observing how users react to prototypes of a new system, the requirement can be clearly known , the system can be successfully developed.

(d) Major factors to be considered in designing user inputs:

Various issues that should be considered while designing systems input are briefly discussed below:
Input design consists of developing specifications and procedures for data preparation, developing steps which are necessary to put transactions data into a usable form for processing, and data-entry.

Important factors to be considered in the input design:

i. **Content:** The system designer has to prepare new documents for collecting the information which are needed to generate user output.

ii. **Timeliness:** In data processing, it is very important that data is inputted to computer in time because outputs cannot be produced until certain inputs are available.

iii. **Media:** Media is just a device by which data is entered in the system and includes magnetic tapes, magnetic disks, key-boards, optical character recognition and voice input etc.

iv. **Format:** After the data contents and media requirements are determined, input formats are to be considered. The type and length of each data field as well as any other special characteristics must be defined.

v. **Input volume:** Input volume refers to the amount of data that has to be entered in the computer system at any one time. In many real-time transaction processing systems, input volume is light. In batch-oriented transaction processing systems, input volume could be heavy which involve thousands of records and also more than it.

23. (a) What is flowchart? Discuss the benefits and limitations of flowcharts.
(b) "The final step of the system implementation is its evaluation." What functions are being served by the system evaluation? Discuss different aspects of evaluation.
(c) Discuss - The types of Unit testing.

Solution:

(a) Flowcharts: Flowcharting is a graphic technique that can be used by analysts to represent the inputs, outputs and processes of a business in a pictorial form.

Types of Flow charts
Flowcharts are divided into four major categories:

- **Document flowchart –** showing a document - flow through systems.
- **Data flowchart –** showing data flows in a system.
- **System flowchart –** showing the controls at a physical or resource level.
- **Program flowchart –** showing the controls in a program in a system.

Benefits of Flowchart

- **Communication:** Flowcharts are better way of communicating the logic of a system and easily understandable.
- **Effective analysis:** With the help of flowchart, problem can be analyzed in more effective way.
- **Proper documentation:** Program flowcharts serve as a good program documentation.
- **Efficient Coding:** The flowcharts act as a guide during the systems analysis and program development phase.
- **Proper Debugging:** The flowchart helps in debugging process.
- **Efficient Program Maintenance:** The maintenance of operating program becomes easy with the help of flowchart. It helps the programmer to put efforts more efficiently on that part.

Limitations of Using Flowcharts

- **Complex logic:** Sometimes, the program logic is quite complicated. In that case, flowchart becomes complex.
- **Alterations and Modifications:** If alterations are required, the flowchart may require redrawing completely.
- **Reproduction:** As the flowchart symbols cannot be typed, reproduction of flowchart becomes a problem.

(b) Evaluation of the new system: The final step of the system implementation is evaluation. Evaluation provides the feedback necessary to assess the value of information and the performance of personnel and technology included in the newly designed system.

There are two basic areas of information systems that should be evaluated. The first area is concerned with whether the newly developed system is operating properly. The other

area is concerned with whether the user is satisfied with the information system with regard to the reports supplied by it.

Development evaluation: Evaluation of the development process is primarily concerned with whether the system was developed on schedule and within budget.

Operation evaluation: The evaluation of the information system's operation pertains to whether the hardware, software and personnel are capable to perform their duties and they do actually perform.

Operation evaluation answers such questions:

(i) Are all transactions processed on time?
(ii) Are all values computed accurately?
(iii) Is the system easy to work with and understand?
(iv) Is terminal response time within acceptable limits?
(v) Are reports processed on time?
(vi) Is there adequate storage capacity for data?

Information evaluation: The extent to which information provided by the system is supportive to decision making is the area of concern in evaluating the system. User satisfaction can be used as a measure to evaluate the information provided by an information system. If management is generally satisfied with an information system, it is assumed that the system is meeting the requirements of the organization.

(c) Types of Unit Testing

(i) Static Analysis Testing: Some important Static Analysis Tests are as follows :

- **Desk Check:** Logical syntax errors and deviation from coding standards are checked through desk check.
- **Structured walk-through:** The application developer leads other programmers through the text of the program and explanation.
- **Code inspection:** Review is done with formal checklists by formal committee,

(ii) Dynamic Analysis Testing:

- **Black Box Testing:** The test designer selects valid and invalid inputs and determines the correct output. If a module performs a function which is not supposed to, the black box test does not identify it as it is not concerned with the internal structure. Thus in black box testing, it has no relation with the internal functioning of a system.

- **White Box Testing:** White box testing uses an internal perspective of the system to design test cases based on internal structure. It requires programming skills to identify all paths through the software.
After obtaining a clear picture of the internal workings of a product, tests can be conducted to ensure that the internal operation of the product conforms to specifications and all the internal components are adequately exercised.

- **Gray Box Testing:** Gray box testing is a software testing technique that uses a combination of black box testing and white box testing. In gray box testing, the tester applies a limited number of test cases to the internal workings of the software under test. In the remaining part of the gray box testing, one takes a black box approach in applying inputs to the software under test and observing the outputs.

24. (a) Discuss when not to use a Database Management System.
(b) What is Electronic Data Interchange? State the benefits of Electronic Data Interchange.
(c) Differentiate between Closed System and Open System.

Solution:

(a) In spite of the advantages of using a Database Management System (DBMS), there are a few situations in which such a system may involve unnecessary overhead costs as that would not be incurred in traditional file processing. The overhead costs of using a DBMS are due to the following:

• High initial investment in hardware, software, and training.
• Generality that a DBMS provides for defining and processing data.
• Overhead for providing security, concurrency control, recovery, and integrity functions.

Additional problems may arise if the database designers and DBA do not properly design the database or if the database systems applications are not implemented properly.

Hence, it may be more desirable to use regular files under the following circumstances:

• The database and applications are simple, well defined, and not expected to change.
• There are stringent real-time requirements for some programs that may not be met because of DBMS overhead.
• Multiple-user access to data is not required.

(b) Electronic Data Interchange (EDI) is the system where data is transferred electronically in machine readable or processable form. In a moment any message is sent through EDI then it would be immediately processed by receiving computer without any human intervention or interpretation or rekeying.

EDI has following benefits:

(i) The use of EDI eliminated many problems associated with traditional information flow such as the delay associated with making of documents.
(ii) As data is not repeatedly keyed (typed) therefore the chances of error are reduced.
(iii) Time required to re-enter data is saved.
(iv) As data is not re-entered at each step in the process, therefore labour costs are reduced.
(v) As time delays are reduced therefore more certainty in information flow is there.
(vi) EDI generates functional acknowledgement that the EDI message has been received by the recipient and is electronically transferred to sender. Therefore this acknowledgement which is sent electronically by the recipient to sender, states that the message has been received.

(c) Difference between Closed System and Open System:

A Closed System is self-contained and does not interact or make exchange across its boundaries with its environment. Closed systems do not get the feedback they need from the external environment and tend to deteriorate. A Closed Systems one that has only controlled and well defined input and output. Participant in a closed system become closed to external feed back without fully being aware of it.

Open System actively interact with other systems and establish exchange relationship. They exchange information, material or energy with the environment including random and undefined inputs. Open systems tend to have form and structure to allow them to adapt to changes in their external environment for survival and growth.

25. (a) Explain the term Case Tools. Describe briefly various Case Tools.
(b) List and describe the contents of a system manual.
(c) What is vendor evaluation? Discuss the factors contributing to the evaluation and validation process of vendors' proposal.

Solution:

(a) Case Tools: CASE (Computer-Aided-Software Engineering) is the automation of anything that humans do to develop systems and support virtually all phases of traditional system development process. These can be used to create internally requirements specifications with graphic generators and using of specifications languages.

The various CASE tools are - Menu Generator, Screen Generator, Report Generator and Code Generator.

- **Layout form and Screen Generator:** They are for printed report used to format or paint the desired layouts.
- **Menu Generator:** Menu generator outlines the functions.
- **Report Generator:** It indicate totals, paging, sequencing and control breaks in creating samples of the desired report.
- **Code Generator:** It allows the analyst to generate modular units of source code.

Some of the other features that various CASE products possess are - Repository / Data Dictionary, Computer aided Diagramming Tools; Word Processing; Screen and Reverse Engineering.

(b) A system manual is an output of the system design that describes the task to be performed by the system with complete layouts and flow charts. It contains:

i. **General description of the existing system:** It describes the general structure of the existing system from top management to the bottom management.
ii. **Flow of the existing system:** It describes the input, processing and output of the data that flows at various levels of organisation's structure.
iii. **Outputs of the existing system:** The documents produced by existing system are listed.
iv. **General description of the new system:** A brief justification for the changes is specified.
v. **Flow of the new system:** It defines the flow of the system from and to the computer operation and within the computer department.
vi. **Output Layouts:** It describes the user interface or layouts for the user that is used for better communication in near future.
vii. **Output distribution:** The output distribution is summarized.
viii. **Input layouts:** The inputs to the new system are described as well as a complete layout of the input documents , input disks or tapes are described.
ix. **Input responsibility:** The source of each input document is indicated. The user department is responsible for each item on the input documents.

x. **Macro Logic:** It defines the logic of the internal flows as to be defined by system analysts.

xi. **Controls:** This shall include type of controls, and the method in which it will be operated.

(c) Once the proposals are received from various vendors for the system, it is the responsibility of the IT Incharge or the committee to select the best product relevant to the requirements/needs of the organization. In order to facilitate the process, following are the factors contributing to evaluation and validation process of vendors' proposals:

i. **Performance Rating of the proposed system in relation to its cost:** In this , the vendors are provided with the sample data and the task is performed by each vendor. Subsequently representatives of the organization examine the outputs for accuracy, consistency as well as processing efficiency, so, operational efficiency is judged.

ii. **Cost Benefits Analysis of the proposed system:** In this process, the cost benefit analysis is conducted in relation to the performance benefits against the Total Cost of Operations.

iii. **Judging the maintainability of the proposed system:** It refers to the flexibility and customization scope inbuilt in the pr posed system for effective use in the organization. If the changes occurring due to the federal tax laws and statutory legal requirements, it should be analysed that whether it can be incorporated in the package easily or not.

iv. **Compatibility with Existing Systems:** The proposed system has to be operated in integration with other existing systems in the organization so that it forms a part of the Integrated Enterprise System.

Vendor Support : Support of vendors must be provided at the time of training, implementation, testing and back-up systems.

26. (a) What are the duties of certifying authorities with respect to digital signature?
(b) State the Importance of Marketing Information System.
(c) What is Data Dictionary?

Solution:

(a) Every Certifying Authority shall-

(i) make use of hardware, software and procedures that are secure intrusion and misuse;
(ii) ensure a reasonable level of reliability in its services and performing the functions;
(iii) adhere to security procedures to ensure that the secrecy and privacy of the electronic signature are assured;
(iv) be the repository of all electronic Signature Certificates (that is issued under this Act);
(v) publish information regarding its practices ,electronic signature certificates and current status of such certificates;
(vi) observe such other standards as may be specified by regulation; and
(vii) complies with the provisions of this Act , rules, regulations and orders made there under.

Display of license: Every Certifying Authority shall display its license at a conspicuous place of the premises in which it carries on its business.

Surrender of license:

(i) Every Certifying Authority after the suspension or revocation of license shall immediately surrender the license to the Controller.

Disclosure:

I. Every Certifying Authority shall disclose in the manner specified by regulations
   - **(i)** Its Electronic signature Certificate.
   - **(ii)** Any certification practice statement
   - **(iii)** Notice of revocation or suspension of its Certifying Authority Certificate.
   - **(iv)** Any other fact.

II. Where in the opinion of the Certifying Authority any situation has arisen which may materially and adversely affect the integrity of its computer system or the conditions subject to which a Electronic Signature Certificate was granted, then, the Certifying Authority shall-
   - **(i)** use reasonable efforts to notify any person who is likely to be affected by that occurrence or
   - **(ii)** act in accordance with the procedure specified in its certification practice statement.

(b) Importance of Marketing Information System

i. **Anticipation Of Customer Demand**-Every marketer needs up-to-date knowledge about consumer needs and wants.
ii. **Systematic Approach**-Expanding markets and competitive marketing environment require adequate market intelligence system.
iii. **Economic indicator**-Marketers must have latest information on the changing trends of supply, demand and prices
iv. **Significance of Analysing Competition**-Marketer cannot survive without having information regarding nature , character and size of competition to be met.
v. **Development of Technology**-Marketers must have latest information regarding technological development.
vi. **Understanding the Consumer**-Information system can establish proper two way flow of information and understanding between marketers and consumer.
vii. **Marketing Planning**-Marketing plans and programmes are based upon information supplied by economic forecasts and market research.

(c) Data Dictionary: Each computer record of a data dictionary contains information about a single data item used in a business information system. The information in each record of a Data Dictionary may include the following:

(i) Codes describing the data item's length, data type and range.
(ii) Identity of the source documents used to create the data.
(iii) Names of the computer files storing the data item.
(iv) Identity of individuals/programs permitted to access the data item.
(v) Identity of programs/individuals not permitted to access the data item.
(vi) Names of the computer programs that modify the data item.

For an Auditor, A data dictionary can also help to establish an audit trial because it can identify the input sources of data items, the computer programs that modify particular data items, and the managerial reports on which data items are output.

For the accountants, a data dictionary can also be used to plan the flow of transaction data through the system.

27. (a) Write a note on - Database Administrator.
(b) List the main inputs, processes and output involved in Share Accounting in a Management Information System (MIS) environment.
(c) Write a note on - Maintenance of Master Data in an ERP system.

Solution:

(a) Database Administrators

In any organization where many persons use the same resources, there is a need for a chief administrator to oversee and manage these resources. In a database environment, the primary resource is the database itself and the secondary resource is the Database Management System and related software. Administering these resources is the responsibility of the Database Administrator (DBA).

The Database Administrator is responsible for
- Authorizing access to the database,
- coordinating and monitoring its use, and
- acquiring software and hardware resources as needed.

The Database Administrator is accountable for problems such as
- breach-of security or
- poor system response time.

In large organizations, the DBA is assisted by a staff that helps carry out these functions.

(b) Share is an investment option used by many persons. A person may purchase shares either from the company (at the time of a public or a rights issue) or from the share market.
A share accounting system needs to maintain an updated list of shareholders. For each shareholder, the main information held is the name and address, names of joint holders (if any) the number of shares held, and the identification of the certificates through which these shares are held.
When a person purchases shares from a share holder, a share transfer form along with the certificates is sent by the buyer to the company for incorporating the transfer. The system records a change in ownership for the shares from the seller to the buyer.
Periodically, the company declares a dividend. Dividend warrants (cheques) need to be mailed on a particular day to the various shareholders who hold shares. Calculation of income tax to be deducted at source is also done before the printing and mailing dividend warrants.

Other facilities usually provided in share accounting system are:

- Bank mandate facility, where the shareholder's dividend warrant is sent to a bank account at the shareholder's request
- Splitting of share certificates, where a single certificate containing a large number of shares is replaced with a number of certificates containing a smaller number of shares
- Consolidation of shares, where many certificates belonging to a single shareholder are combined into one share certificate.
- Mailing annual reports and invitations to various meetings.

Main inputs in a share accounting system are:

- Shareholding data from a fresh issue-this is usually supplied by the issue agency on electronic media.
- Share transfer request
- Split request
- Consolidation request
- Request for bank mandate
- Tax exemption forms
- Request for duplicate certificates
- Request for duplicate dividend warrants
- Change in shareholder's address.

Processing involves:

- Updating shareholders master file
- Recording the transfer of shares
- Handling splitting, consolidation and duplicate requests and printing new certificates
- Calculation of dividend and income tax to be deducted.

Main outputs are :

- Transferred share certificates
- New share certificates in case of consolidation, splitting and duplicates
- Dividend warrants and counterfoils
- Statement of Tax deductions.

(c) Maintenance of Master Data in an ERP system:

ERP packages contain several modules, such as finance, sales and distribution, materials management, manufacturing and production control, human resources, plant maintenance and quality management. Main characteristics of ERP system is that all its modules function in an integrated manner. Due to integrated nature of functioning, a few master tables are referenced frequently across the system and databases, and shared by different applications, functional areas and sites. Data incorporated thereon need to be accurate, complete, timely and consistent. The quality of data that are incorporated in the master tables, is a major reason for success of an ERP system.

Collection and maintenance of master data

i. Clear cut process and procedure for maintenance of master data.
ii. Ownership of data is properly defined.
iii. In built workflow and authorization for adding and modifying data.
iv. Documentation of the process.
v. Audit trails of master tables are activated and modifications are logged in the system.
vi. Proper excel templates or data mapping with legacy system, for initial collection of data.

28. (a) List the advantages of E – commerce.
(b) What is an ERP System? Bring out the major challenges involved in implementation of ERP.
(c) Discuss the factors upon which "make or Buy" decision of application software depends.

Solution:

(a) E-commerce has several advantages:

• **Businesses without the barriers of time or distance:** E-commerce plays very important role in allowing people to carry out businesses without the barriers of time or distance.

One can log on to the Internet at any time, whether day or night and purchase or sell anything at his desires.

• **Lower cost-of-sale:** As there is no human interaction (whole seller, retailer etc.) during the on-line electronic purchase order process, therefore, the direct cost-of-sale for an order taken from a web site is lower than through traditional means. Further, electronic selling also eliminates processing errors, and is also more convenient for the visitor.

• **Cheapest means of doing business:** Another important benefit of E-commerce is that as compare to paper based commerce it is the cheapest means of doing business.

• **Advantages to buyer:** From the buyer's perspective also E-commerce offers a lot of advantages.

i. Reduction in buyer's sorting out time.
ii. Better buyer decisions;
iii. Less time is spent in resolving invoice and order discrepancies.
iv. Increased opportunities for buying alternative products.

• **Less delivery time, labour cost etc.**: A significant benefit of E-commerce is that it helps to reduce the delivery time, labour cost and the cost incurred in the following areas:

i. Document preparation;
ii. Error detection and correction;
iii. Mail preparation;
iv. Communication;
v. Data entry;
vi. Overtime for completing the work; and
vii. Supervision expenses

• **Price fixation:** The day-to-day pressures of the marketplace have played their part in reducing the opportunities for companies to invest in improving their competitive position. A matured market, increased competitions have reduced the amount of money available to invest. If the selling price cannot be increased and the manufactured cost cannot be decreased then the difference can be in the way the business is carried out. E-commerce has provided the solution by decimating the costs, which are incurred.

(b) Enterprise Resource Planning promises one database, one application and one user interface for the entire enterprise. Implementation of ERP is a risky effort since it involves considerable amount of time, efforts and valuable resources.

(i) The implementation consultants have to understand the needs of the users, understand the prevailing business realities and design the business solutions keeping in mind all these factors.
(ii) During the course of implementation the standard package may undergo changes. Implementing such changes is known as Customisation. It should be taken care that with the change in one module is not adversely affecting the other module.
(iii) The role and responsibilities of the employees have to be clearly identified, understood and configured in the system. The employee should accept new processes and procedures laid down in the ERP System.
(iv) The package should be expandable and adaptable in future to meet the changing face of the environment.
(v) An ERP package is expected to meet the objectives of the organization and also to improve the flow of information and business processes.
(vi) Required hardware, software must be installed.

(c) Factors affecting the "make or buy" decision of application software are discussed below:

i. **Availability of skilled programmers:** If sufficient number of programmers is not available, the organization may purchase packages.

ii. **Cost of programming:** If the cost of developing the software is more than the price of pre-written software, the organization may decide to buy the software.

iii. **Suitability of software:** Many times the available software may not be suitable for the particular needs of the organization. Hence, it may be better to develop software in such instances.

iv. **Time available for implementation:** If the time available for implementation of the new computerized system is very short, the organization may go for buying the software.

v. **Availability of sophisticated software:** In many instances, the programs available for purchase are more sophisticated than the organization would probably develop. For example, many of the applications programs are fully integrated with other application programs. This integration forces for purchasing rather than developing programs.

29. (a) File and Smile Online asks you to draw a flowchart for calculation of income tax as per slabs prescribed which are as below:

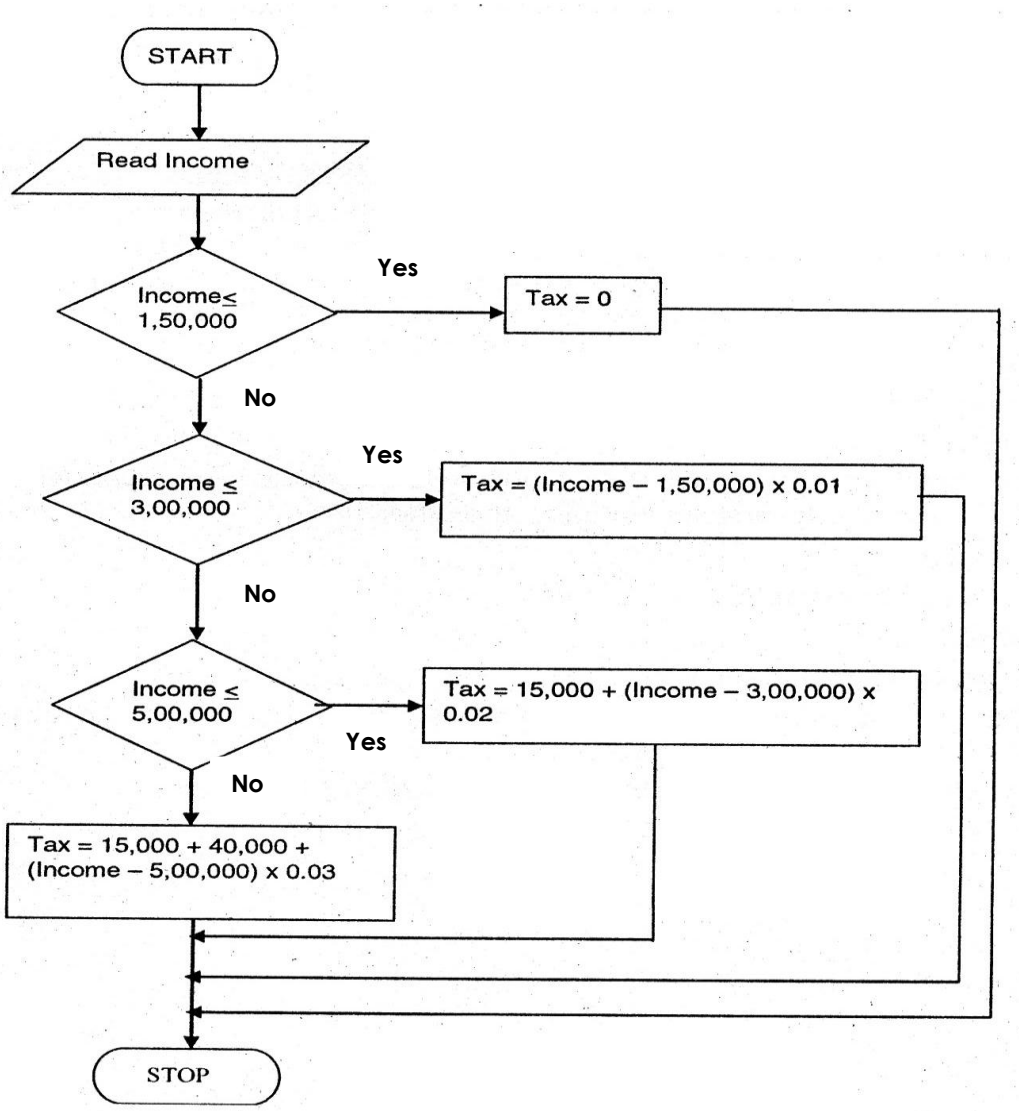
Salary in currency limit	**Rate %**
Upto 1,50,000	**NIL**
1,50,001 to 3,00,000	**10**
3,00,001 to 5,00,000	**20**
5,00,001 and above	**30**

(b) Can a web server act as a Permanent Establishment?

(c) "A decision support system supports the human decision-making process rather than providing a means to replace it". Justify the above statement by stating the characteristics of decision support system.

Solution:

(a) Flowchart for calculation of Income Tax :



(b) Earlier it was a controversial issue that whether in cyber space the web server act as Permanent Establishment. However, this controversy was solved in 2001 when the working party of Organisation for Economic Co-operation and Development (OECD) had agreed upon considering the server as Permanent Establishment for taxing e-transactions. According to OECD the server on which website is stored and through which it is accessible is a piece of, equipment having a physical location which constitute a fixed place of business of the entity that operates that server. However, for the server or other computer equipment to constitute a Permanent Establishment following conditions must be fulfilled:

- **i.** It must be owned or leased by that entity.
- **ii.** It must be in a fixed location.
- **iii.** Business must be wholly or partly carried on in the jurisdiction where that server or other equipment is located and the activities carried on through the server must be core and not merely preparatory or auxiliary.

Therefore, now it is settled law that existence of a web server in a country is enough to act as Permanent Establishment.

(c) A Decision Support System (DSS) is defined as a system that provides tools to managers to assist them in solving semi-structured and unstructured problems in their own way. A DSS is not intended to make decisions for managers, but rather to

provide managers with a set of capabilities that enables them to generate the information required by them in making decisions. The DSS are characterized by following three properties:

(i) Semi-structured / Unstructured decisions **–** Structured decisions are those that are easily made from a given set of inputs. Unstructured decisions and semi-structured decisions are decisions for which information obtained from a computer system and those are only a portion of the total knowledge needed to make the decision. The DSS is particularly well adapted to help with semi-structured / unstructured decisions. In DSS, the problem is first defined and formulated. It is then modeled with DSS software. The model is run on the computer to provide results. The modeler, in reviewing these results, might decide to completely reformulate the problem, refine the model, or use the model to obtain other results.

(ii) Ability to adapt to changing need **–** Semi-structured / unstructured decisions often do not conform to a predefined set of decisions-making rules. Because of this, their decision support system must provide for enough flexibility to enable users to model their own information needs. The DSS designer understands that managers usually do not know in advance what information they need and, even if they do, those information needs keep changing constantly. Thus, rather than locking the system into rigid information producing requirements, capabilities and tools are provided by DSS to enable users to meet their own output needs.

(iii) Ease of Learning and use **-** Since decision support systems are often built and operated by users rather than by computer professionals, the tools that company possesses should be relatively easy to learn and use. Such software tools employ user-oriented interfaces such as grid, graphics, non-procedural 4GL and easily read documentation. These interfaces make it easier for user to conceptualize and perform the decision making process.

30. (a) Write a note on Digital Signature Certificate.
(b) List the objectives of Information Technology Act 2000.
(c) Discuss the effect of applying computer technology to Management Information System.

Solution:

(a) Digital Signature Certificate: A digital signature certificate is a mechanism for authenticating and securing the information that is transmitted between the two parties. It is an authoritative identification about a person or a company. It is simply a public key, along with some identifying information, that has been digitally signed by a certifying authority. It identifies the subscriber, certification authority, and its operational period and contains the subscriber public key. The certificate is thus protected so that it cannot be altered without detection. It is like an electronic passport that authenticates identity of an entity. The identifying information in the certificate can be trusted because the digital signature is cryptically strong.

Legal recognition of digital signature, electronic records and authentication is necessary in an electronically formed contract. The Information Technology Act provides legal status on the use of the electronic records and signatures. Authentication and non - repudiation are secured through the mechanism of digital signature. The digital signature certificate ensures that the purported sender is in fact the person who sent the message. By certifying that a particular public key does indeed belong to a specific person, it authenticates and makes digital signature conclusive. For verification of such signature, the verifier must have the signer's public key and have an assurance that it corresponds to his private key. Digital

certificate associates a particular person to that pair. Its basic purpose is to serve the need of the person seeking to verify a digital signature who would want to know that:

- The public key corresponds to the private key used to create the digital signature;
- Whether the public key is identified with the signer.

Section 35 of the Act deals with the issues of the certificate by the Certifying Authority, on an application being made in the prescribed form.

(b) The objectives of Information technology Act, 2000 Act are:

- To grant legal recognition to transactions carried out through electronic data interchange and other means of electronic communication commonly referred to as "electronic commerce" replacing the paper-based communication;
- To give legal recognition to Digital Signature for authentication of any information or matter which requires authentication under any law;
- To facilitate electronic filing of documents with Government Departments;
- To facilitate electronic data storage;
- To facilitate and give legal sanction to electronic funds transfers between banks and financial institutions;
- To give legal recognition for keeping of books of account by bankers in electronic form;
- To amend the Indian Penal Code, the Indian Evidence Act, 1872; the Banker's Book Evidence Act, 1891 and the Reserve Bank of India Act, 1934.

(c) The effects of applying computer technology to Management Information System are discussed below:

(i) Speed of processing and retrieval of data has increased: Modern business situations invariably call for systems capable of providing relevant information with minimal loss of time. Manual system, howsoever well organized, often fails to match the demand for information for decision-making. Computer with its unbelievably fast computational capability and systematic storage of information with random access facility has emerged as an answer to the problems faced in modern days management. The speed of computer processing is in new range i.e. an operation takes only billionths of a second. This characteristic of computer has accounted for as a major factor in inducing MIS development.

(ii) Scope of use of information system has expanded: The importance and utility of information systems was realized by most of the business organizations after the induction of computers for Management Information System (MIS) development. System experts in business organizations developed areas and functions, where computerized MIS could be used to improve the working of the concern.
These types of applications are not feasible under the manual system. For example, online systems can provide information to various users sitting at a remote distance from a centrally located computer system.

(iii) Scope of analysis is widened: The use of computer can provide multiple type of information accurately and in no time to decision makers. Such information equips an executive to carry out a thorough analysis of the problems and to arrive at the final decision. Computer is capable of providing various types of sales reports, which are useful in analyzing the sales department working and to ascertain their weakness so that adequate measures may be taken in time.

(iv) Complexity of system design and operation has increased: After the inclusion of computer for MIS development, system experts faced problems in designing system and their operations because of the non availability of experts in the initial stage. But in

the present situation, the computer manufacturers have developed some important programs (software) to help their users. Also, private agencies are there to develop programs to cater to the specified needs of their customers either on consultancy basis or on contract.

(v) Integrates the working of different information subsystem : There are number of subsystems like production, material, marketing, finance, engineering and personnel which constitute MIS. Each of these sub systems are required to provide information to support operational control, management control and strategic planning. Such information may be available from a common data base which meets the information requirements of different information sub system by utilizing the services of computers for storage, processing, analyzing and providing such information as and when required.

(vi) Increases the effectiveness of Information Systems : Before the existence of computer technology, it was difficult to provide the relevant information to business executives in time even after incurring huge expenses. The use of computer technology has overcome this problem, by providing timely, accurate and desired information for the purpose of decision-making.