Q1 : There are five jobs, each of which must go through the three machines A, B and C in the order ABC. Processing time are given in the table below:

Determine a sequence for the given jobs and determine the value of T and idle time on machine A, B and C.

Job No.	J1	J2	J3	J4	J5
Processing time A	4	9	8	6	5
Processing time B	5	6	2	3	4
Processing time C	8	10	6	7	11

Q2 : There are seven jobs, each of which must go through the three machines A, B and C in the order ABC. Processing time are given in the table below:

Determine a sequence for the given jobs and determine the value of T and idle time on machine A, B and C.

Job No.	J1	J2	J3	J4	J5	J6	J7
Processing time A	30	80	70	40	90	80	70
Processing time B	40	30	20	50	10	40	30
Processing time C	60	70	50	110	50	60	120

Processing "N" jobs through 3 Machines (when initial conditions are not satisfied)

If the initial conditions are not satisfied, we will change the conditions as follows:

(a) The minimum time on machine A is greater than or equal to the maximum time on machine C.

(a) The minimum time on machine B is greater than or equal to the maximum time on machine C.

i.e. if either minimum of A ≥ maximum of C, or

minimum of B ≥ maximum of C, then the following can be applied:

- Replace the problem with an equivalent problem involving n jobs and two machines. Denote the fictitious machines by G and H and define the processing time **Gi** and **Hi** by:

$$\mathbf{Gi} = \mathbf{Ai} + \mathbf{Ci}\ , \qquad \mathbf{Hi} = \mathbf{Bi} + \mathbf{Ci}$$

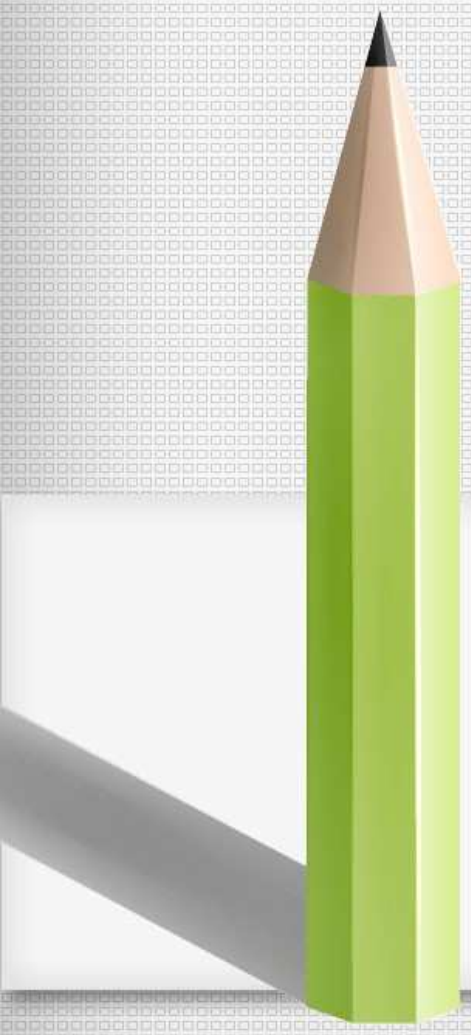
- Now, workout the new problem, two machines and n jobs, with the prescribed order GH, by the same method of processing “n” jobs through 2 machines.

- Now, the sequence of machine will be changed to ACB.

Q23: There are seven jobs, each of which must go through the three machines A, B and C in the order ABC. Processing time are given in the table below:

Determine a sequence for the given jobs and determine the value of T and idle time on machine A, B and C.

Job No.	J1	J2	J3	J4	J5	J6
Processing time A	12	8	7	11	10	5
Processing time B	7	10	9	6	10	4
Processing time C	3	4	2	5	1.5	4



LINEAR PROGRAMMING

Meaning:

Linear programming is a technique for choosing the best alternative from a set of feasible alternatives, in situation in which the objective function as well as the constraints can be expressed as linear mathematical functions.

Applications of Linear Programming Problems:

(a) Optimal Product Line problems

(b) Product mix problem

(c) Diet planning problems

(d) Transportation problems.

Basic Requirements of a Linear Programming Problem:

(a) **Objective Function:** A function of certain variables which is to be optimized subject to given conditions on the variables of the function is called objective function of the problem. If it is profit then it will be maximization type and if it is cost then it will be minimization type.

(b) **Non-negative restrictions:** Non-negative restriction indicates that all decision variables must take on values equal to or greater than zero.

(c) **Constraints:** The constraints indicate limitations on the resources which are to be allocated among various decision variables. These resources may be production capacity, man power, time or machinery, etc.

Assumptions of Linear Programming:

(a) **Linearity:** The term linearity means straight line among the relevant variables. It is the amount of resource required for a given activity level is directly proportional to the level of that activity.

(b) **Divisibility:** It means that fractional values of the decision variables are permitted.

(c) **Certainty:** The various parameters, i.e. the objective function coefficients, the coefficients of equations and the constraint are known with certainty.

(d) **Non-Negativity:** It means that the decision variables are permitted to have only the values which are greater than or equal to zero.

(e) **Additivity:** Total output for a given combination of activity levels is the algebric sum of the output for each individual process.

(f) **Continuity:** It means that the decision variables are continuous.

Limitations of Linear Programming:

(a) The basic assumption that objective function and constraints are linear may not hold good in many practical situations.

(b) This technique does not consider the problems related to uncertainty.

(c) When the number of variables involved in the problem are quite large, then the procedure become complex and is difficult to handle manually.

(d) Parameters appearing in L.P. model are assumed to be constant but in reality they are frequently neither known or constant.

Q: S company is producing two products A and B. The processing times are 3 and 4 hours per unit for A on operation one and two and 4 hours and 5 hours per unit for B on operation one and two respectively. The available time is 18 hours and 21 hours for operation one and two respectively. The product A can be sold for Rs 3 profit per unit and B of Rs 8 per unit. Solve for maximum profit program. Only formulate the problem.

Q: A dietician mixes two types of food in such a way that the vitamin contents of the mixture contain at least 8 units of vitamin A and 10 units of Vitamin C. Food X contains 2 units/kg of vitamin A and 1 unit/kg of vitamin C while food Y contains 1 unit/kg of vitamin A and 2 units/kg of vitamin C . One kg of food X costs Rs 5 whereas one kg of food Y costs Rs. 7. Determine the minimum cost of such a mixture. Formulate the above as a linear programming problem.

Q: An animal feed company must produce 200 kgs of a mixture consisting of ingredients A and B daily. A costs Rs. 3 per kg and B costs Rs. 8 per kg. No more than 80 kgs of A can be used and at least 60 kgs of B must be used. Find how much of each ingredient should be used if the company wants to minimize cost?

Q: A producer has 30 and 17 units of labour and capital respectively which he can use to produce two types of goods X and Y. To produce one unit of X, 2 units of labour and 3 units of capital are required. Similarly, 3 units of labour and 1 unit of capital is required to produce one unit of Y. If X and Y are priced Rs. 100 and Rs. 120 per unit respectively, how should the producer use his resources to maximise the total revenue. Use LPP.

Q: A manufacturer has three machines I, II and III installed in his factory. Machine I and II are capable of being operated for at the most 12 hours, whereas machine III must be operated at least for 5 hours a day. He produces only two items, each requiring the use of three machines. One unit of A requires 1 hour on machine I, 2 hours on machine II and 1 hour on machine III. Whereas, one unit of B requires 2 hours on machine I, 1 hour on machine II and 5/4 hours on machine III. He makes a profit of Rs. 60 on item A and Rs. 40 on item B. Assuming that he can sell all that he produces, how many of each item should be produced so as to maximise his profit? Formulate the above problem as LPP.

Q: A company manufactures two types of dolls A and B. Type A requires 5 minutes each for cutting and 10 minutes each for assembling. Type B requires 8 minutes each for cutting and 8 minutes each for assembling. There are 3 hours available for cutting and 4 hours for assembling in a day. The profit is Rs. 50 each on type A and Rs. 60 each on type B. How many dolls of each type should the company manufacture in a day to maximise the profit? Formulate L.P.P

Q: A producer has 30 and 17 units of labour and capital respectively which he can use to produce two types of goods X and Y. To produce one unit of X, 2 units of labour and 3 units of capital are required. Similarly, 3 units of labour and 1 unit of capital is required to produce one unit of Y. If X and Y are prices at Rs. 100 and Rs 120 per unit respectively, how should the producer use his resources to maximise the total revenue? Formulate LPP.

Q: A firm manufactures two types of products A and B and sells them at a profit of Rs. 5 per unit of type A and Rs. 3 per unit of type B. Each product is processed on two machines M1 and M2. One unit of type A requires one minute of processing time on M1 and two minutes of processing time on M2; whereas one unit of type B requires one minute of processing time on M1 and one minute on M2. Machines M1 and M2 are respectively available for at most 5 hours and 6 hours in a day. Find out how many units of each type of product should the firm should produce in a day in order to maximise the profit. Formulate LPP.

Methods of Linear Programming:

(a) Graphic Method.

(b) Simplex Method.

GRAPHIC METHOD:

There are two techniques of solving an LPP by graphical method:

(c) Corner Point Method

(d) Iso-profit or Iso-cost method.

(A) Corner Point Method:

The maximum/minimum value of a linear objective function over a convex polygon bounded by a number of lines, occurs at some vertex or the other. Following is the procedure to solve a LPP graphically:

(i) Consider each constraint as an equation.

(ii) Plot each equation on graph, as each one will geometrically represent a straight line.

(iii)The common region obtained satisfying all the constraints and the non-negative restrictions is called the feasible region.

(iv) Determine the co-ordinates of the corner points of the convex polygon.

(v) Find the values of the objective function at each of the extreme points. The point at which the value of the objective function is maximum or minimum is the optimal solution of the given LPP.

Special Cases in Linear Programming:

(a) Multiple Optimal Solution: Sometimes a LPP may yield more than one optimal solution. It happens only when the objective function is parallel to one of the constraint.

(b) Unbounded Solution: An unbounded solution is a solution whose objective function is infinite. The objective function can also be increased infinitely.

(c) Infeasible solution: When it is not possible to find a feasible region that satisfies all the constraints then LPP is said to have an infeasible solution.

INVENTOR Y CONTROL

- Inventories refers to any kind of resource that has economic value and is maintained to fulfill the present and future needs of an organization.

- **Inventories may be classified as:**

(a) Physical resources such as raw materials, semi-finished & finished goods

(b) Human resources such as unused labour.

(c) Financial resources such as working capital.

Inventory Control:

- Inventory control is the function of directing the movement of goods through the entire manufacturing cycle from the requisitioning of raw materials to the inventory of finished goods in orderly manner to meet the objectives of maximum customer service with minimum investment and low-cost plant operation.
- To determine what to order? When to order? How much to order? And how much to carry in stock.
- To minimize shortage, holding and replacement costs of inventories leading to maximum efficiency in production and distribution.
- To maintain waste, surplus, scrap and obsolete items at the minimum.

Functional Classification of Inventory:

Inventory can be defined as the stock of goods or any other resources that are stored at any given period for future production or for meeting future demand.

(a) Direct Inventories: It includes those items which play a direct role in the manufacture and become an integral part of finished goods. It includes raw materials, semi-finished goods and finished goods.

(b) Indirect Inventories: It includes those items which are necessary for manufacturing but do not become component of the finished goods. It includes oil, office materials, maintenance materials etc. It may also includes the following:

(i) Pipeline or Transit Inventories: This includes maintenance of optimal inventory level for shipment to distribution centres and customers from production centres. It is essential to keep extra stock of inventory items at various work places to meet the demand while the supply is in transit. The amount of pipeline inventory depend on the time required for shipment and the nature of demand.

(ii) Buffer Inventories or Safety Stock: It is the specific level of extra stock of inventory that is maintained for protection against uncertainties of demand and the lead time necessary for delivery of goods. It is determined by trade-off between protection against demand and supply uncertainties and the level of investment in additional stock.

(iii) Lot Size or Cycle Inventories: These inventories are held due to the fact that orders are placed in lots rather than purchasing the exact amount of inventory which may be needed at a point of time. It is more economical to order inventories in lots to achieve reduced ordering cost or to obtain quantity discounts.

(iv) Decoupling Inventories: These inventories serve the function of decoupling operations in a production system. These permit the various production activities to operate more independently, they do not have to rely completely on the schedule of output of prior activities in the production process.

(v) Seasonal Inventories: These inventories are required the seasonal fluctuations in demand. These inventories are used to smooth out the level of production so that workers do not have to be frequently hired to meet such demand fluctuations.

(vi) Fluctuation Inventories: These inventories are required because sales and production time of a product cannot always be predicted accurately.

Inventory Decisions:

There are three types of decisions to be made in managing inventories:

(a) How much is to order for each replenishment?

(b) When it is necessary to place an order to replenish inventory?

(c) How much safety stock should be kept?

Decisions regarding the size and timing of replenishment orders are influenced by:

(a)Forecast of demand for an item.

(b)Its replenishment lead time.

(c)Inventory related cost and management policies.

Objectives of Inventory Control:

(a) To reduce the financial investment in inventories.

(b) To ensure that the value of materials consumed is minimum: It involves efficient purchasing, storage, consumption and accounting for materials from the time orders are placed with the suppliers till the materials have been utilized in production.

(c) To maintain timely records of inventories of all items and to maintain the stock within the desired limits.

(d)To ensure timely action for replenishment.

(e) To avoid losses from inventory obsolescence.

(f) To improve customer service: Carrying of raw materials and finished products reduces lead time for deliveries.

(g) To allow flexibility in production scheduling: It relieves the pressure on production system and gives them scheduling flexibility that can reduce unit production costs.

(h) To reduce surplus stock.

(i) To protect the inventories from pilferage, theft, waste, loss and damage.

(j) Helps in tiding over the demand fluctuations.

Benefits of Inventory Management:

(a)Ensures an adequate supply of items to the customers and avoid shortages.

(b)Use of available capital in a most effective way and avoids unnecessary on high inventories.

(c)Reduces the risk of loss due to the changes in price of items.

(d)Takes advantages of quantity discounts on bulk purchases.

(e)Services as a buffer stock in case of delayed deliveries by the suppliers.

(f)Helps in minimizing the loss due to obsolescence, damages.

(g)Ensures smooth functioning of its various departments by maintaining reasonable stocks.

Basic Characteristics of an Inventory Control System:

(1) Relevant Inventory Costs: The costs that are affected by the firm's decision to maintain a particular level of stock are called relevant costs. It includes the following:

(a) Purchase Cost: It is the actual price paid for the procurement of items and includes direct material, direct labour and direct expenses.

(b) Ordering Costs/Acquisition/Replenishing or Set-up Costs: It is the cost of placing an order and it varies with individual organization. This cost is independent of the size of the order, but varies with the number of orders placed during a given period of time.

Ordering Cost = Cost per order * Number of orders placed during a period.