Summary

- Linear programming is the general technique of optimum allocation of 'scarce' or 'limited' resources, such as labour, material, machine ,capital, energy, etc. to several competing activities, such as products, services, jobs, new equipment's, projects etc. on the basis of a given criterion of optimality
    - The term 'limited' here is used to describe availability of scarce resources during planning period
    - The 'criterion of optimality', generally is either performance, return on investment, utility, time distance, etc

- The word linear is used to describe the proportionate relationship of two or more variables in a model. Thus a given change in one variable will always cause a resulting proportional change in another variable
  For example: Doubling the investment on a certain project will exactly double the rate of return. The word programming here is used to specify a sort of planning that involves the economic allocation of limited resources by adopting a particular course of action or strategy amongst various alternative strategies to achieve the desired objective

- Out of several courses of action available, the best or optimal is selected. A course of action is said to be most desirable or optimal if it optimizes (maximizes or minimizes) some measure of criterion of optimally such as profit, cost, rate of return, time, distance, utility, etc

Structure of Linear Programming
The general structure of any linear programming model consists essentially of three components.

- **The activities (variables) and their relationships:** the activity values represent the extent to which each activity is performed. These are represented by X_1, X_2, X_3, ……X_n
    - **For example:** In a product- mix problem the activities of interest are the production of several products under considerations. These activities are also known as decision variables because they are under the decision maker's control. These decision variables, usually interrelated in terms of consumption of limited resources, require simultaneous solutions. All decisions variables are continuous, controllable and non-negative. That is $X_1 \geq 0$, $X_2 \geq 0$, …..$X_n \geq 0$

- **The objective function:** The objective function of each Linear programming problem is a mathematical representation of the objective in terms of a measurable quantity such as profit, cost, revenue, distance, etc. it is represented in one of two forms: Optimize (Maximize or Minimize) $Z = c_1X_1 + c_2X_2 + \ldots. + c_nX_n$ where Z is the measure of performance variable, which is a function of X_1, X_2, X_3, ……X_n to the measure of performance of Z. the optimal value of a given objective function is obtained by the graphical method or simplex method

- **The constraints:** There are always certain limitations (or constraints) on the use of limited resources, e.g. labour, machine, raw material, space, money, etc. such constraints must be expressed as linear equalities or inequalities in terms of decision variables. The solution of an Linear Programming model must satisfy these constraints

Basic assumptions of Linear Programming

- **Certainty:** In all Linear programming model it is assumed that all model parameters such as availability of resources, profit contribution of a unit of decision variable and resource consumption by a unit of decision variable must be known and constant. In some cases there may be either random variables represented by a known distribution which can be either general distribution or statistical distribution methods. Using the given parameters the problem can be solved by a stochaistic Linear Programming model or parametric programming

- **Divisibility:** The solution values of decision variables and resources are assumed to have either whole number, which are integers or mixed numbers which can be either integer or fractional. If only integer variables are desired like number of employees, types or number of machines used, then the integer programming method may be applied to get the desired values

- **Additivity:** The value of the objective function for the given values of decision variables and the total sum of resources used, must be equal to the sum of the contributions, be it profit or cost, earned from each decision variable and the sum of the resources used by each decision variable respectively. For example, if the total profit earned by sale of two products A and B must be equal to the sum of the profits earned separately from A and B. In the same way, the amount of a resources consumed by A and B must be equal to the sum of the resources used for A and B individually

- **Linearity:** All relationships in the Linear Programming model are linear. This is applicable in both objective function and in case of constraints. Ideally in Linear programming given a decision variable, the amount of particular resource (i) and its contribution to the cost in objective function must be directly proportional to its amount (i). If the decision variable x is equal to 5, then the resource consumed (i) is 5 into ‘a’ of ‘ij’ and if the value of x is equal to 10, then the consumption would be 10 into a of ‘ij’. Here ‘a of ‘ij’ represents the amount of resource I used for an activity ‘j’ where ‘j’ becomes the decision variable