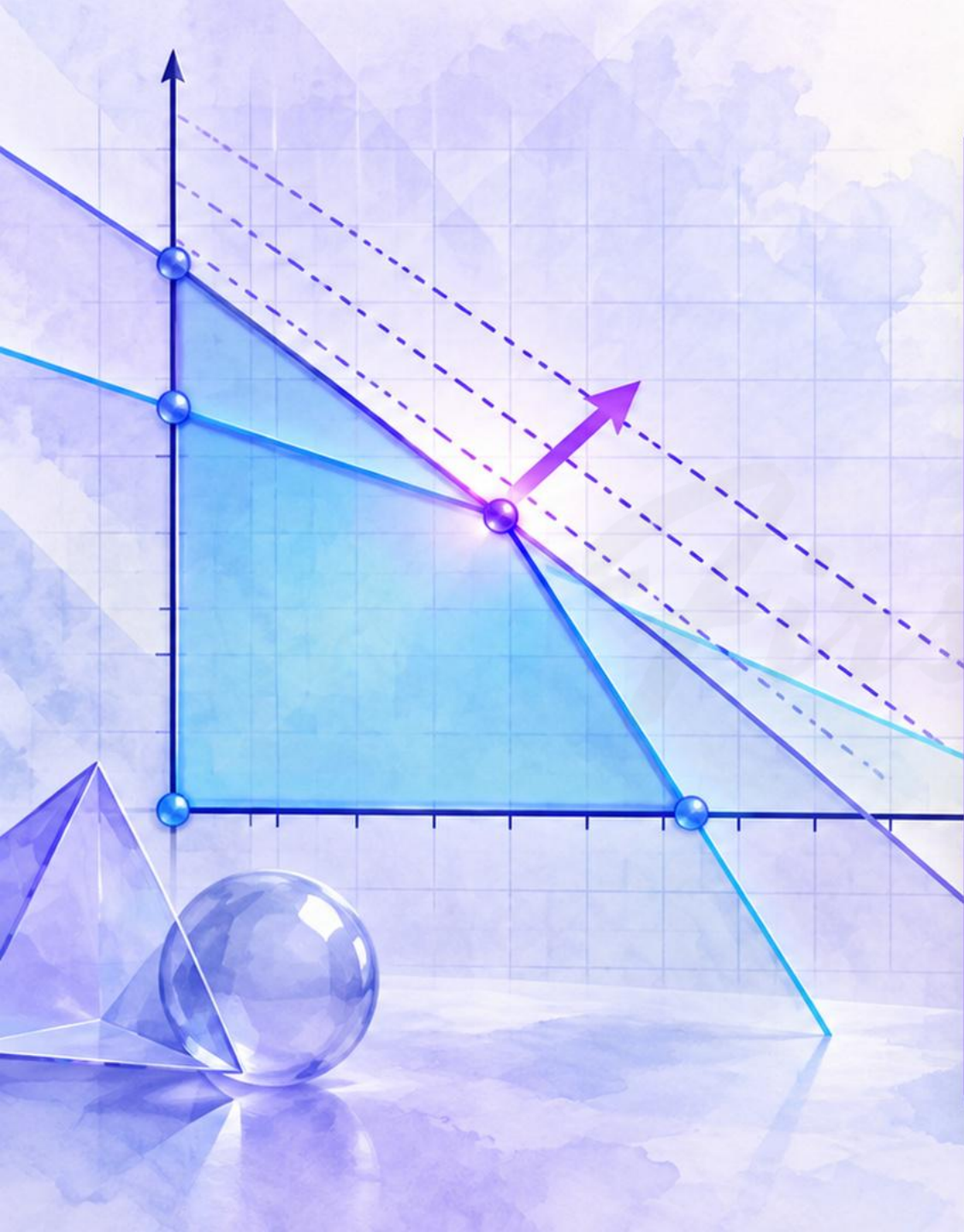




MATHEMATICS • CLASS 12

12

CHAPTER

# Linear Programming

CHAPTER NOTES

# LINEAR PROGRAMMING: MEANING AND TERMS

## Optimisation

An optimisation problem seeks the best result, such as maximum profit, minimum cost or minimum use of resources.

A linear programming problem is a special optimisation problem with a linear objective and linear constraints.

Linear means that the mathematical relations are linear. Programming means choosing a plan of action.

## The mathematical model

Decision variables represent the quantities we choose. The objective function is the linear expression to maximise or minimise.

Constraints are linear inequalities, equations or restrictions that must be satisfied.

decision variables:  $x, y$

objective function:  $Z = ax + by$

nonnegative restrictions:  $x \geq 0, y \geq 0$

The variables must be nonnegative in this chapter. Linear programming is useful in industry, commerce and management.

We use the graphical method for two variables.

# FORMULATING THE FURNITURE PROBLEM

A dealer buys tables and chairs, with limited money and storage. Assume all purchased items can be sold.

## Choose the variables

$x$  = number of tables

$y$  = number of chairs

$x \geq 0, \quad y \geq 0$

| Item  | Cost per item | Profit per item |
|-------|---------------|-----------------|
| table | Rs 2500       | Rs 250          |
| chair | Rs 500        | Rs 75           |

Counts cannot be negative.

## Write the restrictions and objective

Investment limit

Rs 50,000

$$2500x + 500y \leq 50000$$

$$5x + y \leq 100$$

Storage limit

$$x + y \leq 60$$

Maximise total profit

$$Z = 250x + 75y$$

Each inequality comes from one resource limit.

The profit expression is the objective, not a constraint.

# FEASIBLE REGION AND FEASIBLE SOLUTIONS

## Feasible

The feasible region is the common region satisfying every constraint, including the nonnegative restrictions. A feasible solution is any point within or on its allowed boundary.

The feasible region is convex: a segment joining any two feasible points stays within the region.

## Check every restriction

$$5x + y \leq 100, \quad x + y \leq 60, \quad x \geq 0, \quad y \geq 0$$

$$\begin{aligned}(10, 50): \quad 5(10) + 50 &= 100 \\ 10 + 50 &= 60\end{aligned}$$

Feasible: both limits are met.

## Infeasible and optimal

A point outside the feasible region violates at least one constraint and is an infeasible solution. An optimal feasible solution is a feasible point giving the maximum or minimum objective value.

$$\begin{aligned}(25, 40): \quad 5(25) + 40 &= 165 > 100 \\ 25 + 40 &= 65 > 60\end{aligned}$$

Infeasible: both resource limits are exceeded.

# CORNER POINTS AND OPTIMAL VALUES

## Shape of the feasible region

A corner point, or vertex, is where boundary lines meet in the feasible region.

A bounded region can be enclosed in a circle.

An unbounded region extends indefinitely in some direction.

## More than one optimum

If two corner points give the same optimal value, every point on the segment joining them gives that same value. Finding one optimum at a corner does not mean all optimal points must be corners.

$$Z = ax + by$$

The proofs of the fundamental results are outside the scope of this chapter.

## Fundamental results

- If an optimal value exists, it occurs at a corner point of the feasible region.
- A nonempty bounded feasible region has both a maximum and a minimum; each occurs at a corner point.
- For an unbounded region, a maximum or a minimum may fail to exist. Check rather than assume.

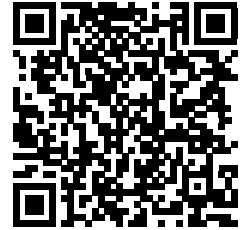


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