

CLASS 12

MATHEMATICS

NCERT SOLUTIONS

NCERT Solutions for Class 12 Mathematics Chapter 12: Linear Programming – Free PDF Download

Chapter 12 of Class 12 Maths is Linear Programming. It covers formulating real-world optimization problems as linear programming problems (LPPs) and solving them graphically.

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Class 12 Mathematics Chapter 12 – Notes and Extra Questions

Chapter 12 of Class 12 Maths is Linear Programming. It covers formulating real-world optimization problems as linear programming problems (LPPs) and solving them graphically.

Linear Programming Problem (LPP)

An LPP involves optimizing (maximizing or minimizing) a **linear objective function** $Z=ax+by$, subject to a set of **linear constraints** (inequalities) and non-negativity restrictions ($x \geq 0, y \geq 0$).

Feasible Region

The **feasible region** is the common region satisfying all constraints simultaneously, represented graphically. It is **bounded** if enclosed within a finite area, or **unbounded** otherwise. Points within/on the boundary are **feasible solutions**.

Corner Point Method

The optimal value of Z (if it exists) occurs at a **corner point (vertex)** of the feasible region. Method: identify all corner points, evaluate Z at each, and select the maximum/minimum value.

Types of LPP

Common real-world applications: **diet problems** (minimize cost subject to nutritional constraints), **manufacturing problems** (maximize profit subject to resource constraints), **transportation problems** (minimize transportation cost).

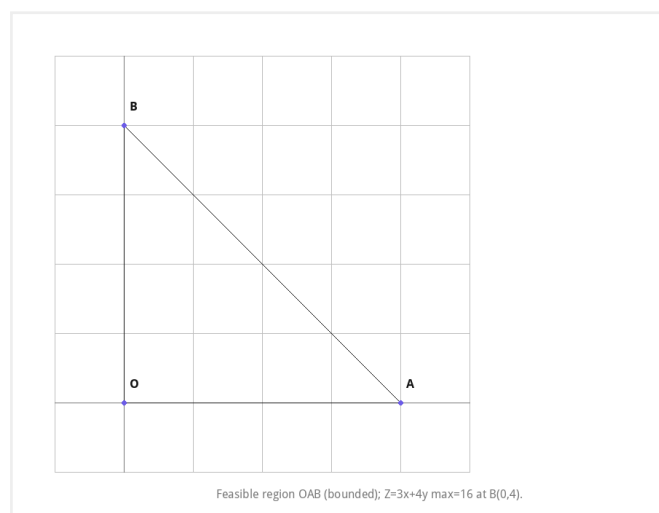
Special Cases

If the feasible region is unbounded, a maximum may not exist even if Z appears large at corner points — must verify by checking if the constraint half-plane intersects the region. **Multiple optimal solutions** occur when Z is constant along an entire edge of the feasible region.

Exercise 12.1 Solutions (All 10 Questions)

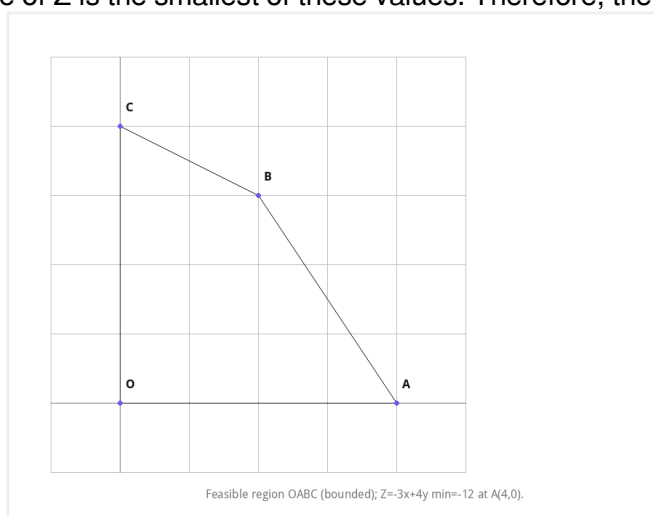
1. Maximise $Z = 3x + 4y$ subject to the constraints $x + y \leq 4, x \geq 0, y \geq 0$.

Ans: The feasible region is bounded by the lines $x + y = 4, x = 0$ and $y = 0$. The corner points of the feasible region are $O(0,0)$, $A(4,0)$ and $B(0,4)$. The value of Z at each corner point is: at $O(0,0)$, $Z = 0$; at $A(4,0)$, $Z = 3(4)+4(0) = 12$; at $B(0,4)$, $Z = 3(0)+4(4) = 16$. Since the feasible region is bounded, the maximum value of Z is the largest of these values. Therefore, the maximum value of Z is 16, occurring at the point $(0,4)$.



2. Minimise $Z = -3x + 4y$ subject to $x + 2y \leq 8$, $3x + 2y \leq 12$, $x \geq 0$, $y \geq 0$.

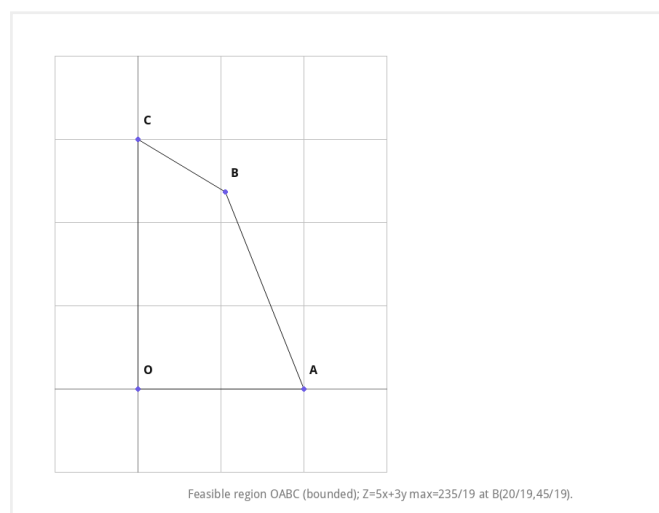
Ans: The feasible region is bounded by $x + 2y = 8$, $3x + 2y = 12$, $x = 0$ and $y = 0$. Solving $x + 2y = 8$ and $3x + 2y = 12$ simultaneously gives $x = 2$, $y = 3$. The corner points of the feasible region are $O(0,0)$, $A(4,0)$, $B(2,3)$ and $C(0,4)$. The value of Z at each corner point is: at $O(0,0)$, $Z = 0$; at $A(4,0)$, $Z = -3(4)+4(0) = -12$; at $B(2,3)$, $Z = -3(2)+4(3) = 6$; at $C(0,4)$, $Z = -3(0)+4(4) = 16$. Since the feasible region is bounded, the minimum value of Z is the smallest of these values. Therefore, the minimum value of Z is -12, occurring at



the point (4,0).

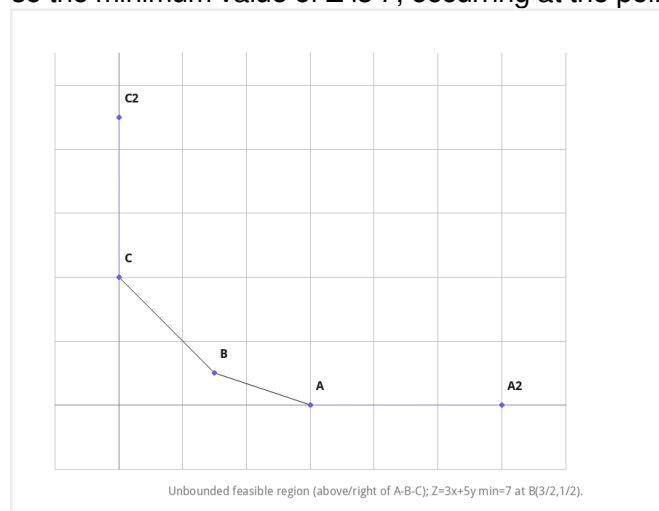
3. Maximise $Z = 5x + 3y$ subject to $3x + 5y \leq 15$, $5x + 2y \leq 10$, $x \geq 0$, $y \geq 0$.

Ans: The feasible region is bounded by $3x + 5y = 15$, $5x + 2y = 10$, $x = 0$ and $y = 0$. Solving $3x + 5y = 15$ and $5x + 2y = 10$ simultaneously: multiplying the first by 2 and the second by 5 gives $6x+10y=30$ and $25x+10y=50$; subtracting gives $19x = 20$, so $x = 20/19$, and then $y = 45/19$. The corner points of the feasible region are $O(0,0)$, $A(2,0)$, $B(20/19, 45/19)$ and $C(0,3)$. The value of Z at each corner point is: at $O(0,0)$, $Z = 0$; at $A(2,0)$, $Z = 5(2)+3(0) = 10$; at $B(20/19, 45/19)$, $Z = 5(20/19)+3(45/19) = 100/19+135/19 = 235/19$; at $C(0,3)$, $Z = 5(0)+3(3) = 9$. Since the feasible region is bounded, the maximum value of Z is the largest of these values. Therefore, the maximum value of Z is $235/19$, occurring at the point $(20/19, 45/19)$.



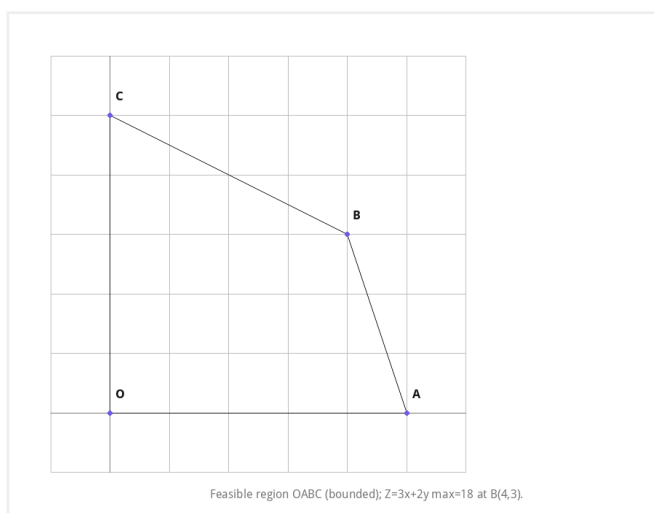
4. Minimise $Z = 3x + 5y$ subject to $x + 3y \geq 3$, $x + y \geq 2$, $x \geq 0$, $y \geq 0$.

Ans: The feasible region is unbounded, bounded below by $x + 3y = 3$, $x + y = 2$, $x = 0$ and $y = 0$. Solving $x + 3y = 3$ and $x + y = 2$ simultaneously: subtracting gives $2y = 1$, so $y = 1/2$, and then $x = 3/2$. The corner points of the feasible region are A(3,0), B(3/2, 1/2) and C(0,2). The value of Z at each corner point is: at A(3,0), $Z = 3(3)+5(0) = 9$; at B(3/2, 1/2), $Z = 3(3/2)+5(1/2) = 9/2+5/2 = 7$; at C(0,2), $Z = 3(0)+5(2) = 10$. Since the region is unbounded, we check whether $3x+5y < 7$ has any point in common with the feasible region; it does not, so the minimum value of Z is 7, occurring at the point (3/2, 1/2).



5. Maximise $Z = 3x + 2y$ subject to $x + 2y \leq 10$, $3x + y \leq 15$, $x \geq 0$, $y \geq 0$.

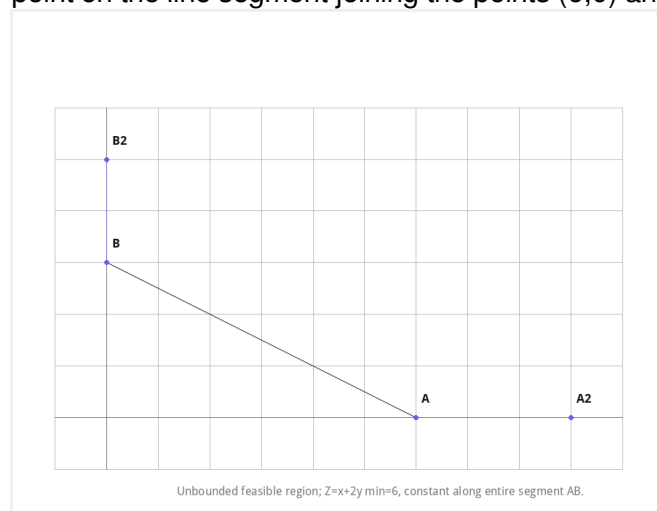
Ans: The feasible region is bounded by $x + 2y = 10$, $3x + y = 15$, $x = 0$ and $y = 0$. Solving $x + 2y = 10$ and $3x + y = 15$ simultaneously: from the second equation $y = 15-3x$; substituting gives $x+2(15-3x)=10$, so $x+30-6x=10$, giving $-5x=-20$, so $x=4$, and then $y=3$. The corner points of the feasible region are O(0,0), A(5,0), B(4,3) and C(0,5). The value of Z at each corner point is: at O(0,0), $Z = 0$; at A(5,0), $Z = 3(5)+2(0) = 15$; at B(4,3), $Z = 3(4)+2(3) = 18$; at C(0,5), $Z = 3(0)+2(5) = 10$. Since the feasible region is bounded, the maximum value of Z is the largest of these values. Therefore, the maximum value of Z is 18, occurring at



the point (4,3).

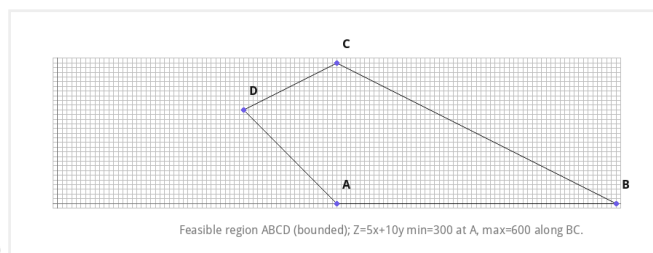
6. Minimise $Z = x + 2y$ subject to $2x + y \geq 3$, $x + 2y \geq 6$, $x \geq 0$, $y \geq 0$.

Ans: The feasible region is unbounded, bounded below by $2x + y = 3$, $x + 2y = 6$, $x = 0$ and $y = 0$. Solving $2x + y = 3$ and $x + 2y = 6$ simultaneously: from the first, $y = 3 - 2x$; substituting gives $x + 2(3 - 2x) = 6$, so $x + 6 - 4x = 6$, giving $-3x = 0$, so $x = 0$, and then $y = 3$, which is the same as the point where $x + 2y = 6$ meets $x = 0$. The corner points of the feasible region are $A(6, 0)$ and $B(0, 3)$. The value of Z at each corner point is: at $A(6, 0)$, $Z = 6 + 2(0) = 6$; at $B(0, 3)$, $Z = 0 + 2(3) = 6$. Since the region is unbounded, we check whether $x + 2y < 6$ has any point in common with the feasible region; it does not, so the minimum value of Z is 6, occurring at every point on the line segment joining the points (6, 0) and (0, 3).



7. Minimise and Maximise $Z = 5x + 10y$ subject to $x + 2y \leq 120$, $x + y \geq 60$, $x - 2y \geq 0$, $x \geq 0$, $y \geq 0$.

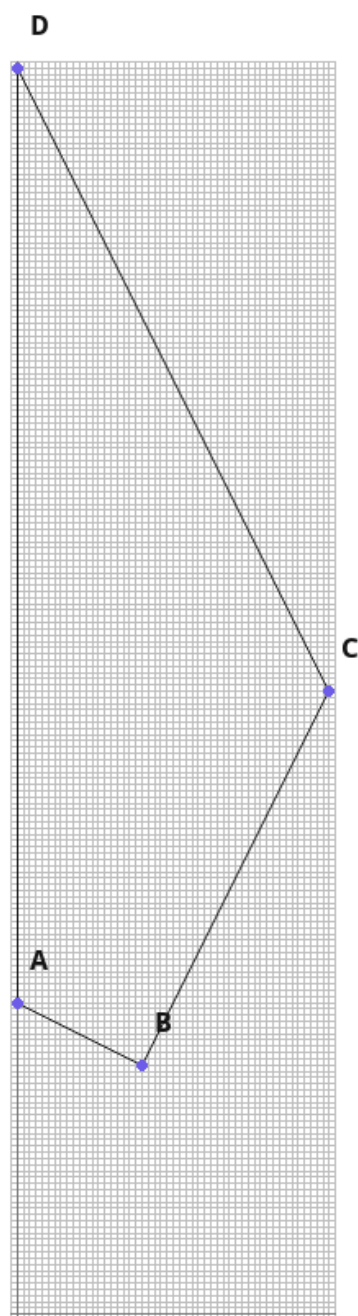
Ans: The feasible region is bounded by $x + 2y = 120$, $x + y = 60$, $x - 2y = 0$, $x = 0$ and $y = 0$. Solving $x + 2y = 120$ and $x - 2y = 0$ simultaneously gives $2x = 120$, so $x = 60$, $y = 30$. Solving $x + y = 60$ and $x - 2y = 0$ simultaneously: $x = 2y$, so $2y + y = 60$, giving $y = 20$, $x = 40$. The corner points of the feasible region are $A(60, 0)$, $B(120, 0)$, $C(60, 30)$ and $D(40, 20)$. The value of Z at each corner point is: at $A(60, 0)$, $Z = 5(60) + 10(0) = 300$; at $B(120, 0)$, $Z = 5(120) + 10(0) = 600$; at $C(60, 30)$, $Z = 5(60) + 10(30) = 300 + 300 = 600$; at $D(40, 20)$, $Z = 5(40) + 10(20) = 200 + 200 = 400$. Since the feasible region is bounded, the minimum value of Z is 300, occurring at the point (60, 0), and the maximum value of Z is 600, occurring at every point on the line



segment joining the points (120,0) and (60,30).

8. Minimise and Maximise $Z = x + 2y$ subject to $x + 2y \geq 100$, $2x - y \leq 0$, $2x + y \leq 200$, $x \geq 0$, $y \geq 0$.

Ans: The feasible region is bounded by $x + 2y = 100$, $2x - y = 0$, $2x + y = 200$, $x = 0$ and $y = 0$. Solving $x + 2y = 100$ and $2x - y = 0$ simultaneously: $y = 2x$, so $x + 2(2x) = 100$, giving $5x = 100$, so $x = 20$, $y = 40$. Solving $2x - y = 0$ and $2x + y = 200$ simultaneously: adding gives $4x = 200$, so $x = 50$, $y = 100$. The corner points of the feasible region are A(0,50), B(20,40), C(50,100) and D(0,200). The value of Z at each corner point is: at A(0,50), $Z = 0 + 2(50) = 100$; at B(20,40), $Z = 20 + 2(40) = 100$; at C(50,100), $Z = 50 + 2(100) = 250$; at D(0,200), $Z = 0 + 2(200) = 400$. Since the feasible region is bounded, the minimum value of Z is 100, occurring at every point on the line segment joining the points (0,50) and (20,40), and the maximum value

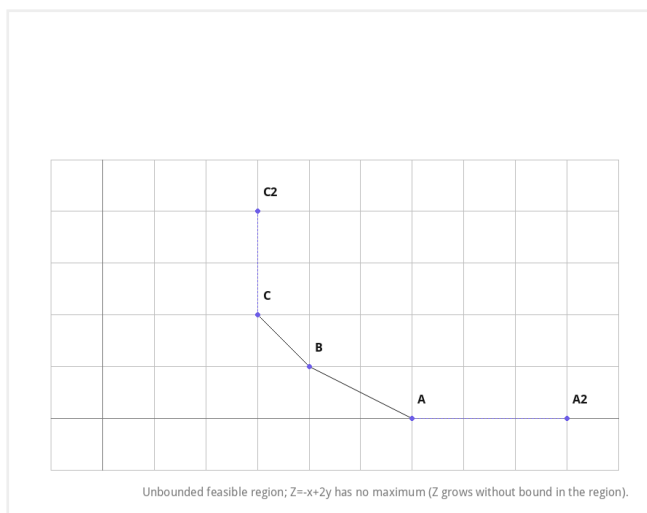


$Z = x + 2y$ min=100 (on AB), max=400 at D(0,200)

of Z is 400, occurring at the point (0,200).

9. Maximise $Z = -x + 2y$ subject to $x \geq 3$, $x + y \geq 5$, $x + 2y \geq 6$, $y \geq 0$.

Ans: The feasible region is unbounded, bounded below by $x = 3$, $x + y = 5$, $x + 2y = 6$ and $y = 0$. Solving $x + y = 5$ and $x + 2y = 6$ simultaneously: subtracting gives $y = 1$, so $x = 4$. Solving $x = 3$ and $x + y = 5$ simultaneously gives $y = 2$. The corner points of the feasible region are A(6,0), B(4,1) and C(3,2). The value of Z at each corner point is: at A(6,0), $Z = -6 + 2(0) = -6$; at B(4,1), $Z = -4 + 2(1) = -2$; at C(3,2), $Z = -3 + 2(2) = 1$. Since the feasible region is unbounded, these values may not give the maximum value of Z . To check, we plot the region $-x + 2y > 1$ and see that it has points in common with the feasible region (for instance, taking $x=3$ and letting y increase without bound keeps every constraint satisfied while $-x + 2y$ grows arbitrarily



large). Therefore, Z has no maximum value.

10. Maximise $Z = x + y$ subject to $x - y \leq -1$, $-x + y \leq 0$, $x \geq 0$, $y \geq 0$.

Ans: The constraint $x - y \leq -1$ means $y \geq x + 1$, while the constraint $-x + y \leq 0$ means $y \leq x$. There is no point (x, y) that can simultaneously satisfy $y \geq x + 1$ and $y \leq x$, since $x + 1$ is always greater than x . Hence there is no point satisfying all the given constraints, so there is no feasible region. Therefore, Z has no maximum



value.

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