MATHS

BOOKS - ML KHANNA

LINEAR PROGRAMMING

Examples

1. The set $\{(x, y) \mid x^2 + y^2 \leq 2\}$ is a convex set. True or False

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2. The set $\{(x, y) \mid 3 \leq x^2 + y^2 \leq 4\}$ is not a convex set. True or false

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3. Find the solution set of the following system of linear inequations.

$5x + 12y \geq 20$

$3x + 8y \leq 40$

$x \geq 0$

$y \geq 0$

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4. Maximize

$X = 8x + 9y$

Subject to $2x + 3y \leq 6$

$3x - 2y \leq 6$

$y \leq 1$

$x, y \geq 0$

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Practice Exercises

1. Find graphically the solution sets of each of the following systems of inequalities :

$3x_1 + x_2 \leq 66$

$x_1 + x_2 \leq 45$

$x_1 \leq 20$

$x_2 \leq 40$

and $x_1, x_2 \geq 10$

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2. Find graphically the solution sets of each of the following systems of inequalities :

$x_1 - x_2 \leq 1$

$x_1 + x_2 \geq 3$

$x_1, x_2 \geq 0$

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3. Find graphically the solution sets of each of the following systems of inequalities :

$2x_1 + 5x_2 \leq 80$

$x_1 + x_2 \leq 20$

$x_1, x_2 \geq 0$

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4. Find graphically the solution sets of each of the following systems of inequalities :

$x_1 + x_2 \leq 6$

$x_1 \geq 3$

$2x_1 + 3x_2 \geq 3$

$x_1 \geq 0, x_2 \geq 0$

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5. Find graphically the solution sets of each of the following systems of inequalities :

$x + y \leq 6$

$2x + 5y \geq -8$

$3x + 8y \leq 9$

$10x + 12y \leq 7$

$8x + 7y \leq 14$

$x, y \geq 10$

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6. A convex polygon has the points (-1,0), (3,4), (0,-3) and (1, 6) as its vertices. Find a set of inequalities which defines the convex polygon having these vertices.

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7. Maximize $z = 3x + 2y$ by graphical method Subject to

$x + 2y \geq 2$

$x + 2y \leq 8$

$x, y \geq 0$

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8. Minimize $z = -x + 2y$

$x + y \leq 6$

$x - y \leq 2$

and $x, y \geq 0$

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9. Minimize and Maximize $Z = 5x + 2y$, subject to the following constraints:

$x - 2y \leq 2, 3x + 2y \leq 12, -3x + 2y \leq 3, x \geq 0, y \geq 0$

.

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10. Minimize $z = x + 3y$

Subject to

$x + y \leq 5$

$2x + y \geq 4$

$x + 5y \geq 5$

$x \geq 3$

$y \leq 3$

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11. Maximize $z = -x_1 + 2x_2$

Subject to

$-x_1 + x_2 \leq 1$

$-x_1 + 2x_2 \leq 4$

$x_1, x_2 \leq 0$

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12. Maximize $z = 5x_1 + 3x_2$

Subject to

$3x_1 + 5x_2 \leq 15$

$5x_1 + 2x_2 \leq 10$

$x_1, x_2 \geq 0$

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13. Maximize $z = 7x_1 + 3x_2$ by graphical method

Subjecto to

$x_1 + 2x_2 \geq 3$

$x_1 + x_2 \leq 4$

$0 \leq x_1 \leq \frac{5}{2}$

and $0 \leq x_2 \leq \frac{3}{2}$

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14. Maximize $z = x_1 + 3x_2$

Subject to

$3x_1 + 6x_2 \leq 8$

$5x_1 + 2x_2 \leq 10$

and $x_1, x_2 \geq 0$

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15. Minimize $z = -x_1 + 2x_2$

Subject to

$-x_1 + 3x_2 \leq 10$

$x_1 + x_2 \leq 6$

$x_1 - x_2 \leq 2$

and $x_1, x_2 \geq 0$

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16. The objective function $z = 4x + 3y$ can be maximized subjected to the constraints $3x + y = \ \leq 24, 8x + 6y \leq 48, x \leq 5, y \leq 6, x, y \geq 0$ at an infinite number of points.

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17. The constraints $-x_1 + x_2 < 1, \ -x_1 + 3x_2 \leq 9, x_1, x_2 > , 0$ difines on

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18. The maximum value of z = 4x +2y subject to the constraints $2x + 3y \leq 18, x + y \geq 10, x, y \geq 0$ is

A. 40

B. 20

C. 35

D. none of these

Answer: D

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19. A firm manufactures two products A and B on which the profit earned per unit are Rs. 3 and Rs. 4 respectively. Each product is processed on two machines M_1 and M_2. Product A requires one minute of processing time on M_1 and two minutes on M_2 while B requires one minute on M_1 and one minute on M_2. Machine M_1 is available for not more than 7 hours 30 minutes, while machine M_2 is available for 10 hrs during any working day. Find the number of units of products A and B to manufactured to get maximum profit.

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20. A factory makes cricket bats and tennis rackets. A cricket bat takes 1.5 hours of machine time and 2 hours of craftsman's time, while a tennis racket takes 2.5 hours of machine time and 1.5 hours of craftsman's time. In aday the factory has available upto 80 hours of machine time and 70 hours of craftsman's time.

What is the largest number of (i) bats, (ii) rackets which could be made in a day in the factory ?

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21. A factory makes cricket bats and tennis rackets. A cricket bat takes 1.5 hours of machine time and 2 hours of craftsman's time, while a tennis racket takes 2.5

hours of machine time and 1.5 hours of craftsman's time. In aday the factory has available upto 80 hours of machine time and 70 hours of craftsman's time.

What number of bats and rackets must be made if the factory is to work at full capacity ?

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22. A factory makes cricket bats and tennis rackets. A cricket bat takes 1.5 hours of machine time and 2 hours of craftsman's time, while a tennis racket takes 2.5 hours of machine time and 1.5 hours of craftsman's time. In aday the factory has available upto 80 hours of machine time and 70 hours of craftsman's time.

The profit on a bat and on a racket is Rs. 5 and Rs. 3.50 respectively. Find the maximum profit to the factory on a day when it produces (i) only bats, (ii) only rackets and (iii) works at full capacity.

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23. Solve the problem graphically

Maximize $8000x + 7000y$

Subject to $3x + y \leq 66$

$x + y \leq 45$

$x \leq 20$

$y \leq 40$

and $x, y \geq 0$

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24. A transport company has offices in five localities A, B, C, D and E. Some day the offices located at A and B had 10 and 15 spare trucks whereas offices at C, D and E required 8, 10 and 7 trucks respectively. The distances in kilometres between the five localities are given below :

From ↓	To →	C	D	E
A		20	60	40
B		15	25	80

How should the trucks from A and B be sent to C, D and E so that the total distance covered by the trucks is minimum ?

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25. A company owns two coal mines, A and B say. The production in these mines and the total requirement are given in the table below :

	Production in A (quintals/day)	Production in B (quintals/day)	Requirements (quintals)
High grade	100	200	8000
Medium grade	300	200	15,000
Low grade	500	200	20,000

How many days should each mine be operated if it costs Rs. 500 per day to work each mine so that the total cost incurred is minimized when the requirements are satisfied ?

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26. A company owns two coal mines, A and B say. The production in these mines and the total requirement are given in the table below :

	Production in A (quintals/day)	Production in B (quintals/day)	Requirements (quintals)
High grade	100	200	8000
Medium grade	300	200	15,000
Low grade	500	200	20,000

If the production cost at A is Rs. 700 per day and at B is Rs. 400 day, how will the solution change ?

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Fill In The Blanks

1. A mathematical technique for finding the optimal use to an organization's scarce resources is called ..... .

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2. The ultimate goal of the organization is called .....

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3. Organizational resources which are in limited quantities are called .....

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4. A limitation on the availability of resources is called .....

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5. Expression showing the relationship between the variables in the problem and the organization's goal is called .....

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6. The common region determined by all the linear constraints of a LPP is called the ..... region.

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7. The area containing all the possible solutions to the problem which are feasible is called .....

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8. A corner point of the area of feasible solutions is called .....

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9. The condition in linear programming where the objective function is not constrained is called .....

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Question

1. A whole-sale dealer deals in two kinds, A and B say, of mixture of nuts. Each kg of mixture A contains 60 gms of almonds, 30 gms of cashew nuts, and 30 gms of hazel nuts. Each kg of mixture B contains 30 gms of almonds, 60 gms of cashew nuts, and 180 gms of hazel

nuts. The remainder of both mixtures is pea nuts. The dealer is contemplating to use mixtures A and B to make a bag which will contain at least 240 gms of almonds, 300 gms of cashew nuts, and 540 gms of hazel nuts. Mixture A costs Rs. 8 per kg. And mixture B costs Rs. 12.00 per kg. Assuming that mixture A and V are uniform :

How many kgs of each should he use to minimize the cost of the bag ?

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2. A whole-sale dealer deals in two kinds, A and B say, of mixture of nuts. Each kg of mixture A contains 60 gms

of almonds, 30 gms of cashew nuts, and 30 gms of hazel nuts. Each kg of mixture B contains 30 gms of almonds, 60 gms of cashew nuts, and 180 gms of hazel nuts. The remainder of both mixtures is pea nuts. The dealer is contemplating to use mixtures A and B to make a bag which will contain at least 240 gms of almonds, 300 gms of cashew nuts, and 540 gms of hazel nuts. Mixture A costs Rs. 8 per kg. And mixture B costs Rs. 12.00 per kg. Assuming that mixture A and V are uniform :

If there is no market for nut mixtures prices at Rs. 15 pr kg, will you advise the dealer to introduce the type of mixture he is contemplating ?

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Self Assessment Test

1. Maximum value of Z = 12x + 3y subject to constraints

$x \geq 0, y \geq 0, x + y \leq 5$ and $3x + y \leq 9$ is

A. 15

B. 36

C. 60

D. 40

Answer: B

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2. The point at which , the maximum value of (3x+2y) subject to the constraints $x + y \leq 2, x \geq 0, y \geq 0$ obtained , is

A. (0, 0)

B. (1.5, 1.5)

C. (2, 0)

D. (0, 2)

Answer: C

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3. Maximize $Z = 5x + 3y$ subject to the constraints:

$3x + 5y \leq 15, 5x + 2y \leq 10, x \geq 0, y \geq 0$

A. $\frac{235}{19}$

B. $\frac{325}{19}$

C. $\frac{523}{19}$

D. $\frac{532}{19}$

Answer: A

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4. The maximum value of $z = 3x + 4y$ subject to the conditions $x + y \leq 40, x + 2y \leq 10, x, y \geq 0$ is

A. 130

B. 120

C. 40

D. 30

Answer: D

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5. All points lying inside the triangle formed by the points (1,3) ,(5,0) and $(-1, 2)$ satisfy

A. $3x + 2y \geq 0$

B. $2x + y - 13 \leq 0$

C. $2x - 3y - 12 \leq 0$

D. All the above

Answer: D

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6. In L.P.P., x_j for all basic variable is equal to

A. 1

B. -1

C. 0

D. none of these

Answer: D

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7. The minimum value of the objective function $z = 2x + 10y$ for linear constraints $x \geq 0, y \geq 0, x - y \geq 0, x - 5y \leq -5$ is

A. 10

B. 15

C. 12

D. 8

Answer: B

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8. Variables of the objective function of the linear programming problem are

A. 0

B. ≥ 0

C. < 0

D. ≤ 0

Answer: B

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