MATHS

BOOKS - ARIHANT MATHS (HINGLISH)

LINEAR PROGRAMMING

Illustrative Examples

1. Draw the graph of the following LPP: $5x + 2y \geq 10, x \leq 0, y \leq 0.$

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2. Solve the system of linear inequations: $x + 2y \leq 10, 2x + y \leq 8.$

A. Lines meet at E(2,4)

B. Lines meet at E(-2,4)

C. Lines meet at E(2,-4)

D. Lines meet at E(-2,-4)

Answer: A

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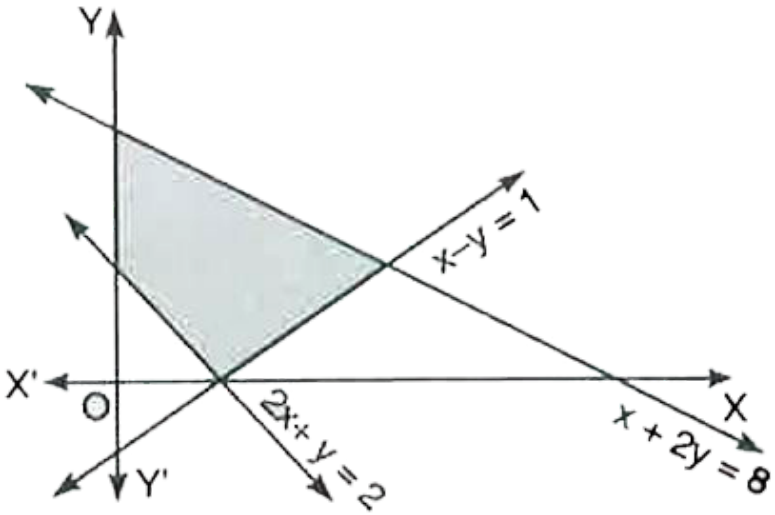
3. Find the linear constraints for which the shaded area in the figure below is the solution set:



A.

$$2x + y \geq 2, x - y \leq 1, x + 2y \leq 8, x \geq 0, y \geq 0.$$

B.

$$2x - y \geq 2, x - y \leq 1, x + 2y \leq 8, x \geq 0, y \geq 0.$$

C.

$$2x + y \leq 2, x - y \leq 1, x + 2y \leq 8, x \geq 0, y \geq 0.$$

D.

$$2x + y \geq 2, x - y \geq 1, x + 2y \leq 8, x \geq 0, y \geq 0.$$

Answer: A

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4. A faniture dealer deals in only two itmes - tables and chairs. He has 'Rs. 50000 invest and has storage place of at most 60 pieces. A table costs Rs. 2500 and chair Rs. 500. He estimates that from the sale of one table, he can make a perfect Rs. 250 and that from the sale of one chair a profit of

Rs. 75. How many table and chair he should buy from the available money so as to maximise his total profit assuming that he can sell all the items which he buys.

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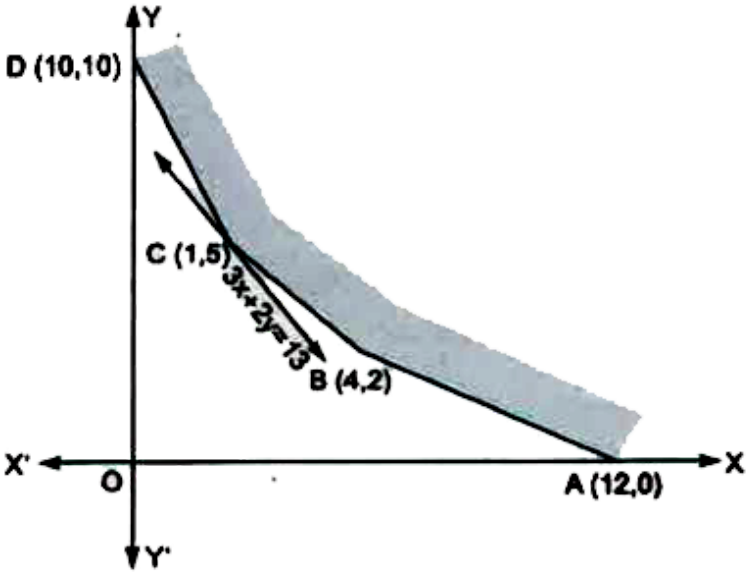
5. Determine the minimum value of $Z = 3x + 2y$ (if any), if the feasible region for an LPP is shown in figure:



A. Minimum value of Z = 11.

B. Minimum value of Z = 14.

C. Minimum value of Z = 12.

D. Minimum value of Z = 13.

Answer: D

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Faqs

1. A small firm manufactures neclaces and bracelets.The total number of neclaces and bracelets that it can handle per day is at most 24.It takes one hour to make a bracelet and half an hour to make a neclace.The maxium number of hours available per day is 16. If the profit on a neclace is ₹ 100 and that on a braclet is ₹ 300. Formulate an LLP for finding how many of each should be produced daily to maximize the profit? It is being given that at least one of ecah must be produced.

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2. Old hens can be bought for ₹ 2.00 each and young ones at ₹. 5.00 each.The old hens lay 3 eggs per week and the young hens 5 eggs per week, each egg being worth 30 paise.A hen costs ₹ 1.00 per week to feed.A man has only ₹ 80 to spend for hens.Formulate the problem for maximum profit per week, assuming that he cannot house more than 20 hens.

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3. Maximize $Z = 5x + 3y$ subject to the constraints: $3x + 5y \leq 15, 5x + 2y \leq 10, x \geq 0, y \geq 0$

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4. Graphically maximise $Z = 9x + 10y$ subject to constraints :

$9x + 2y \geq 20, x - 2y \geq 0, x + y \leq 9, x \geq 0, y \geq 0.$

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5. Solve the following LPP graphically:

Maximise : Z = 4x + y

Subject to following constraints:

$x + y \leq 50$

$3x + y \leq 90$

$x \geq 10$

and $y \geq 0$.

A. $Z_{\max} = 110$ at the point (30,0).

B. $Z_{\max} = 120$ at the point (30,0).

C. $Z_{\max} = 120$ at the point (20,0).

D. $Z_{\max} = 110$ at the point (20,0).

Answer: B

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6. Minimize $Z = 3x + 2y$ subject to the constraints :

$x + y \geq 8, 3x + 5y \leq 15, x \geq 0, y \geq 0.$

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7. Maximise and Minimise :

$Z = 4x + 3y - 7$ subject to the constraints:

$x + y \leq 10, x + y \geq 3, x \leq 8, y \leq 9, x, y \geq 0$

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8. Determine graphically the minimum value of the objective function:

$Z = -50x + 20y$ subject to the constraints:

$2x - y \geq -5, 3x + y \geq 3, 2x - 3y \leq 12, x, y \geq 0.$

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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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Faq

1. A dealer in rural area wishes to purchase a number of sewing machines. He has only Rs. 5,760 to invest and has space for at most 20 items for storage. An electronic sewing machine cost him Rs. 360 and a manually operated sewing machine Rs. 240. He can sell an electronic sewing machine at a profit of Rs. 22 and a manually operated sewing machine at a profit of Rs. 18. Assuming that he can sell all the items that he can buy, how should he invest his money in order to maximize his profit? Make it as a LPP and solve it graphically.

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2. If a young man rides his motorcycle at 25 km/hr, he has to spend 2 per kilometer on petrol if per he rides it at a faster speed of 40 km/hr the petrol cost increases to 5 per kilometer.He has 100 to spend on petrol and wishes to find the maximum distance he can travel within one hours. Express this as a linear programming problem and then solve it.

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3. (Diet Problem)Every gram of wheat provides 0.1 g of protein and 0.25 g of carbohydrates. The corresponding values for rice are 0.05 g and 0.5 g respectively.Wheat costs₹ 4 per/kg and rice ₹ 6 per/kg.The minimum daily requirements of protein and carbohydrates for an average child are 50 g and 200 g respectively.In what quantities should wheat and rice be mixed in the daily diet so as to provide the maximu, daily requirements of protein and carbohydrates at minimum cost?Frame an L.P.P and solve it graphically.

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4. A small firm manufactures gold rings and chains. The total number of rings and chains manufactured per day is atmost 24. It takes 1 hour to make a ring and 30 minutes to make a chain. The maximum number of hours available per day is 16. If the profit on a ring is Rs. 300 and that on a chain is Rs 190, find the number of rings and chains that should be manufactured per day, so as to earn the maximum profit. Make it as an L.P.P. and solve it graphically.

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5. A manufacturer produces two products A and B. Both the products are processed on two different machines. The available capacity of first machine is 12 hours and that of second machine is 9 hours per day. Each unit of product A requires 3 hours on both machines and each unit of product B requires 2 hours on first machine and 1 hour on second machine. Each unit of product A is sold at Rs. 7 profit and that of B at a profit of Rs. 4. Find the production level per day for maximum profit graphically.

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6. Two tailors A and B earn ₹150 and ₹200 per day respectively. A can stich 6 shirts and 4 pants per day, while B can stitch 10 shirts and 4 pants per day. Form a L.P .P to minimize the labour cost to produce (stitch) at least 60 shirts and 32 pants and solve it graphically.

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7. (Allocation Problem)A farmer has a supply of chemical fertilizer and type I which contains 10% nitrogen and 6% phospheric acid and type II fertilizer which contains 5% nitrogen and 10% phospheric acid. After testing the soil condition of a field, it is found that at least 14 kg of nitrogen and 14kg of phospheric acid are required for a good crop.The fertilizer type I costs ₹.2.00 per kg and the type II ₹ 3.00 per kg.How many kilograms of each fertilizer should be used to meet the requirements and the cost be minimum?

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8. A manufacturer makes two types of toys A and B.Three machines are needed for this purpose and the time (in minutes) required for each toy on the machines is given below:

Types of Toys	Machines		
	I	II	III
A	20	10	10
B	10	20	30

The machine I, II and III are available for a maximum of 3 hours, 2 hours and 2 hours 30 minutes respectively.The profit on each toy of type A is ₹ 50 and that of type B is ₹ 60.Formulate the above problem as a LPP and solve graphically to maximize profit.

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9. (Manufacturing Problem) A manufacturer considers that men and women workers are equally efficient and so he pays tehm at the same rate.He has 30 and 17 units of workers(male and femlae) and capital respectively, which he uses to produce two types of goods A and B.To

produe one unit of A, 2 workers and 3 units of capital are required whie 3 workers and 1 unit of capital are required to produce one unit of B. If A and B are priced at ₹. 100 and₹.120 per unit respectively, how should he use his resources to maximise the total revenue?Form the above as an LPP and solve graphically.

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10. (Allocation problem) A cooperative society of farmers has 50 hectare of land to grow two crops X and Y. The profit from crops X and Y per hectare are estimated as Rs 10,500 and Rs 9,000 respectively. To control weeds, a liquid herbicide has to be

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11. A diet for a sick person must contain at least 4000 units of vitamins, 50 units of minerals and 1400 units of calories. Two foods A and B are available at a cost of Rs. 5 and Rs. 4 per unit respectively. One unit of food A contains 200 units of vitamins, 1 unit of minerals and 40 units of

calories whereas one unit of food B contains 100 units of vitamins, 2 units of minerals and 40 units of calories. Find what combination of the food A and B should be used to have least cost but it must satisfy the requirements of the sick person.

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12. A factory manufactures two types of screws, A and B. Each type of screw requires the use of two machines, an automatic and a hand operated. It takes 4 minutes on the automatic and 6 minutes on hand operated machines to manufacture a package of screws A, while it takes 6 minutes on automatic and 3 minutes on the hand operated machines to manufacture a package of screws B. Each machine is available for at the most 4 hours on any day. The manufacturer can sell a package of screws A at a profit of 70 paise and screws B at a profit of Rs 1. Assuming that he can sell all the screws he manufactures, how many packages of each type should the factory owner produce in a day in order to maximise his profit? Formulate the above LPP and solve it graphically and determine the maximum profit.

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13. A farmer has a supply of chemical fertilizer of type A, which contains 10% nitrogen and 5% phospheric acid and type B, which contains 6% nitrogen and 10% phospheric acid.After testing the soil conditions of the field, it was found that at least 14 kg of nitrogen and 14 kg of phospheric acod are required for producing a good crop.The fertilizer of type A costs ₹ 5 per kg and type B costs ₹ 3 per kg.How many kg of each type of the fertilizer should be used to meet the requirement at minimum cost? Using LPP, solve the above problem graphically.

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14. A small manufacturer has employed 5 skilled men and 10 semi - skilled men and makes an article in two qualities-deluxe model and an ordinary model. The making of a deluxe model requires 2 hrs work by a skilled man and 2 hrs work by a semi skilled man. The ordinary model requires 1 hr by a skilled man and 3 hrs by a semi skilled man. By union rules, no man may

work more than 8 hrs per day. The manufacture's clear profit on deluxe model is Rs.15 and an ordinary model is Rs. 10. How many of each type should be made in order to maximize his total daily profit.

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15. (Diet problem): A dietician wishes to mix two types of foods in such a way that vitamin contents of the mixture contain atleast 8 units of vitamin A and 10 units of vitamin C. Food "I" contains 2 units/kg of vitamin A and 1 unit/kg of vitamin C.

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16. (Manufacturing problem) A manufacturer has three machines I, II and III installed in his factory. Machines I and II are capable of being operated for at most 12 hours whereas machine HI must be operated for atleast 5 hours a day. She produces onl

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17. A retired person wants to invest anamount of 50000. His broker recommends investing in two type of bonds $'A'$ and $'B'$ yielding 10% and 9%return respectively on the invested amount.He decides to invest at least * 20000 inbond 'A' and at least 10000 in bond 'B' He also wants to invest at least as much inbond 'A' as in bond B'. Solve this line arprogramming problem graphically tomaximise his returns.

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18. (Transportation Problem) A catering agency has two kitchens to prepare food at two places A and B. From these places 'Mid-day Meal' is to be supplied to threee different schools situated at P,Q,R. The monthly requirments of the schools are respectively 40,40 and 50 food packets.A packet contains lunch for 1000 students.Preparing capacity of kitchen A and B are 60 and 70 packets per month respectively.The transpportation cost per packet for the kitchen to schools s given below:

Transportation cost per packet (in ₹)		
To	From	
	A	B
P	5	4
Q	4	2
R	3	5

How many packets from kitechen should be transported to schools so that the cost of transportation is minimum? Also find the minimum cost.

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Exercise 12 A Short Answer Type Questions

1. (a) Draw the feasible region of inequation:

$x + y \leq 4, x \geq 0, y \geq 0$

(b) Draw the graph of the following LPP:

$3x + y \leq 17, x, y \geq 0$

(c) Shade the feasible region of LLP:

(i) $x + 3y \geq 3, x + y \geq 2, x \geq 0, y \geq 0$

(ii) $x + 2y \leq 8, 3x + 2y \leq 12, x \geq 0, y \geq 0$

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2. Find the solution set of the system of linear constraints: $x + y \leq 6, x \geq 1$ and $y < 1$ by graph.

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3. Draw the diagrams of the solution sets of the following (3 - 6) linear constraints:

$3x + 2y \leq 8, 3x + 2y \leq 12, x, y \geq 0$

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4. $3x + 4y \leq 60, x + 3y \leq 30, x \geq 0, y \geq 0$

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5. $3x + 2y \leq 14, 3x + y \leq 9, x, y \geq 0$

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6. $x + y \leq 5, 4x + y \geq 4, x + 5y \geq 5, x \leq 4, y \leq 3.$

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7. Verify that the solution set of the following constraints is empty :

$3x + 4y \geq 12, x + 2y \leq 3, x \geq 0, y \geq 1.$

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8. Verify that the solution set of the following constraints is not empty and is unbounded :

$x - 2y \geq 0, 2x - y \leq -2$

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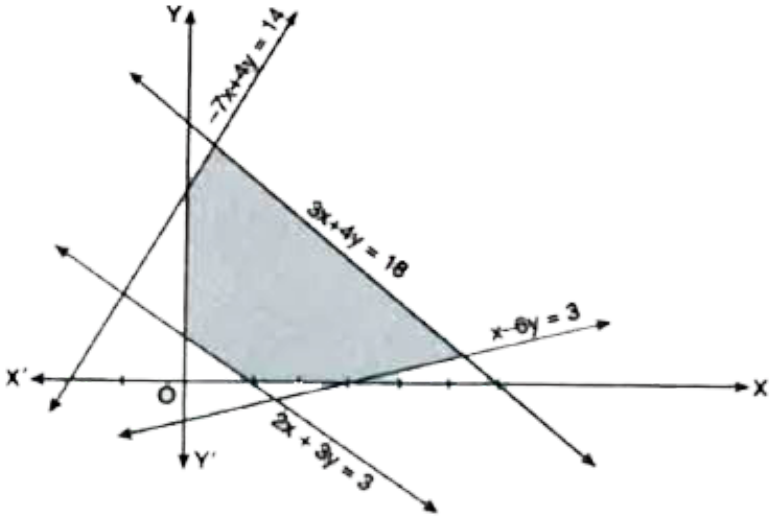
9. Find the linear constraints for which the shaded area in the following figure is the solution set:



A.

$$2x + 3y \geq 3, x - 6y \leq 3, \ -7x + 4y \leq 14, 3x + 4y \leq 18, x \geq 0, y \geq$$

B.

$$2x + 3y \leq 3, x - 6y \leq 3, \ -7x + 4y \geq 14, 3x + 4y \leq 18, x \geq 0, y \geq$$

C.

$$2x + 3y \leq 3, x - 6y \leq 3, \ -7x + 4y \leq 14, 3x + 4y \leq 18, x \geq 0, y \geq$$

D.

$$2x + 3y \leq 3, x - 6y \leq 3, -7x + 4y \leq 14, 3x + 4y \geq 18, x \geq 0, y \geq$$

Answer: C

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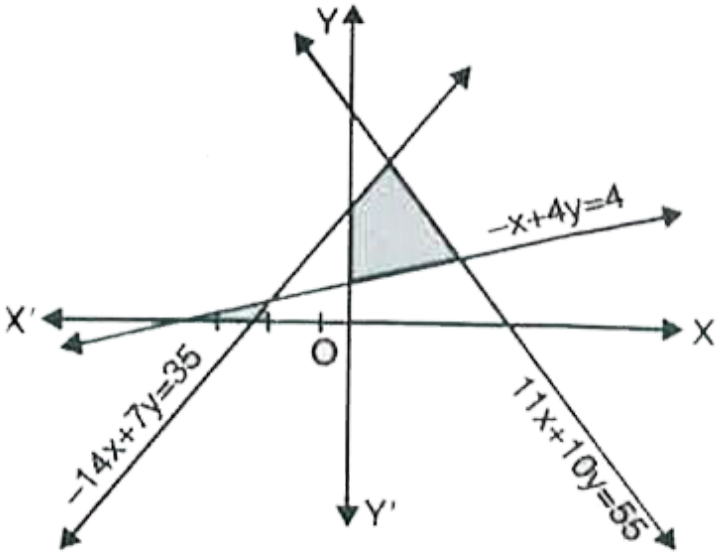
10. Find the linear constraints for which the shaded area in the following figure is the solution set:



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Exercise 12 B Short Answer Type Questions

1. (Diet problem): A dietician wishes to mix two types of foods in such a way that vitamin contents of the mixture contain atleast 8 units of vitamin A and 10 units of vitamin C. Food "I" contains 2 units/kg of vitamin A and 1 unit/kg of vitamin C.

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2. A firm can produce three types of cloth say 'A', 'B' and 'C'.Three kinds of wool are required for it, say red wool, green wool and blue wool.One unit length of type 'A' cloth needs 2 yards of red wool and 3 yards of blue wool, one unit length of type 'B' cloth needs 3 yards of red wool, 2 yards of gren wool and 2 yards of blue wool, one unit length of type 'C' cloth needs 5 yards of green wool and 4 yards of blue wool.The firm has only a stock of 8 yards of red wool, 10 yards of green wool and 15 yards of blue wool.It is assumed that the income obtained from one unit of type 'A' cloth is ₹ 3,

for type 'B' cloth is ₹ 5 and for type 'C' cloth is ₹ 4.Formulate the problem as a LPP so as to maximize the profit of the firm by using the available materials.

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3. A furniture form manufactures chairs and tables, each requiring the use of three machines A, B and C. Production of one chair requires 2 hours on machine A, 1 hour on machine B, and 1 hour on machine C. Each table requires 1 hour each on machines A and B and 3 hours on machine C. Profit realized by selling one chair is Rs. 30 while for a table the figure is Rs. 60. The total time available per week on machine A is 70 hours, on machine B is 40 hours, and on machine C is 90 hours. How many chairs and table should be made per week so as to maximize profit? Develop a mathematical formulation.

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4. (i) Maximize $Z = 2x + 3y$ subject to :

$x + 2y \leq 6, x \geq 4, y \geq 0$

(ii) Maximize $Z = 4x + y$ subject to:

$x + y \leq 50, y \geq 0$

(iii) Maximize $Z = x + 2y$ subject to:

$2x + y \leq 6, x, y \geq 0$

(iv) Maximize $Z = 3y + 5x$ subject to:

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

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5. Minimize $Z = 3x + 9y$ subject to:

$x + 3y \leq 60, x \leq y \text{ and } x, y \leq 0.$

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Exercise 12 B Long Answer Tyoe Questions I Latq

1. Solve the following Linear Programming Problems graphically:

Maximize (6-15):

OBJECTIVE FUNCTION CONSTRAINTS

6. $Z = 6x + 8y$

$x + y \leq 6, 3x + y \geq 6, x - y \geq 0, x \geq 0, y \geq 0$

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2. $Z = 4x + y$

$x + y \leq 50, 3x + y \leq 90, x \geq 0, y \geq 0$

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3. $Z = 3x + 2y$

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

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4. $Z = 13x + 3y$

$x + y \leq 6, 3x + 2y \leq 15, x \geq 0, y \geq 0.$

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5. $Z = 3x + 5y$

$x + y \geq 2, x + 3y \geq 3x \geq 0, y \geq 0$

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6. $Z = 4x + 7y$

$x + 2y \leq 20, x + y \leq 15, x \geq 0, y \geq 0.$

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7. $Z = -3x + 4y$

$x + 2y \leq 8, 3x + 2y \leq 12, x \geq 0, y \geq 0.$

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8. $Z = 6x + 11y$

$2x + y \leq 104, x + 2y \leq 76, x, y \geq 0$

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9. $Z = 7x + 4y$

$2x + y \leq 10, x + 2y \leq 12, x \geq 0, y \geq 0$

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10. (i) $Z = 20x + 10y$

$x + 2y \leq 28, 3x + y \leq 24, x \geq 2, x, y \geq 0$

(ii) $Z = 7x + 10y$

$4x + 6y \leq 240, 6x + 3y \leq 240, x \geq 10, x \geq 0, y \geq 0$

(iii) $Z = 22x + 44y$ subject to the constraints:

$x + y \geq 3, 3x + 8y \leq 24, x - y \geq 0, x, y \geq 0.$

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11. Minimize (16-21): OBJECTIVE FUNCTION CONSTRAINTS

$Z = 200x + 500y$

$x + 2y \geq 10, 3x + 4y \leq 24, x \geq 0, y \geq 0.$

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12. $Z = -3x + 4y$

$x + 2y \leq 8, 3x + 2y \leq 12, x \geq 0, y \geq 0$

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13. $Z = 3x + 5y$

$x + 3y \geq 3, x + y \geq 2, x \geq 0, y \geq 0$

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14. $Z = 2x + 3y$

$x \geq 0, y \geq 0, 1 \leq x + 2y \leq 10$

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15. $Z = 3x + 9y$

$x + 3y \leq 60, x + y \geq 10, x \leq y, x \geq 0, y \geq 0$

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16. $Z = 5x + 10y$

$x + y \geq 60, x + 2y \leq 120, x - 2y \geq 0, x, y \geq 0$

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17. Maximize if possible:

(i) $Z = 3x + 2y$ subject to the constraints:

$x - y \leq 1, x + y \geq 3, x \geq 0, y \geq 0$

(ii) $Z = 3x + 4y$ subject to the constraints :

$x - y \leq -1, -x + y \leq 0, x \geq 0, y \geq 0.$

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18. Maximize:

$Z = -x + 2y$, subject to the constraints:

$x \geq 3, x + y \geq 5, x + 2y \geq 6, y \geq 0.$

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19. Maximize :

$Z = x + y$,subject to the constraints:

$x - y \leq -1, -x + y \leq 0, x \geq 0, y \geq 0$

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20. Minimize and Maximize(25-29):

OBJECTIVE FUNCTION CONSTRAINTS

$Z = 3x + 9y$

$x + 3y \leq 60, x + y \geq 10, x \leq y, x \geq 0, y \geq 0$

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21. $Z = 5x + 10y$

$x + 2y \leq 120, x + y \geq 60, x - 2y \geq 0, x \geq 0, y \geq 0.$

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22. $Z = 15x + 30y$

$x + y \leq 8, 2x + y \geq 8, x - 2y \geq 0, x, y \geq 0$

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23. $Z = x + 2y$

$x + 2y \geq 100, x - y \leq 0, 2x + y \leq 200, x, y \geq 0$

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24. (i) $Z = 3x + 2y$

$x + 3y \leq 60, x + y \geq 10, x \leq y, x, y \geq 0$

(ii) $Z = 800x + 1200y$

$3x + 4y \geq 80, x + 3y \leq 30, x \geq 0, y \geq 0.$

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25. Consider the following LPP:

Maximize $Z = 3x + 2y$ subject to the constraints:

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

(a) Draw the feasible region.

(b)Find the corner points of the feasible region.

(c) Find the maximum value of Z.

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Exercise 12 C Long Answer Type Questions

1. (i) One kind of cake requires 200 g of flour and 25 g of fat and another kind of cake requires 100 g of flour and 50 g of fat.Find the maximum number of cakes which can be made form 5 kg of flour and 1 kg of fat assuming that there is no shortage of the other ingredients used in making the cakes.From a linear programming problem and solve it graphically.

(ii) One kind of cake requires 300 g of flour and 15 g of fat, another kind of cake requires 150 g of flour and 30 g of fat.Find the maximum number of cakes which can be made from 7.5 kg of flour and 600 g of fat assuming that there is no shortage of the other ingredients used in making the cakes. Make it as an LPP and solve it graphically.

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2. Reshma wishes to mix two types of food P and Q in such a way that the vitamin contents of the mixture contain at leat 8 units of vitamin A and 11 units of vitamin B. Food P cost Rs. 60/kg and Food Q costs Rs. 80/kg. Food P contains 3 units/kg of vitamin A and 5 units/kg of Vitamin B while food Q contains 4 units/kg of vitamin A and 2 units/kg of vitamin B. Determine the minimum cost of the mixture.

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3. A factory makes tennis rackets and cricket bats. A tennis racket takes 1.5 hours of machine time and 3 hours of craftmans time in its making while a cricket bat takes 3 hours of machine time and 1 hour of craftmans time. In a day, the factory has the availability of not more than 42 hours of machine time and 24 hours of craftsmans time. If the profit on a racket and on a bat is Rs. 20 and Rs. 10 respectively, find the number of tennis rackets and crickets bats that the factory must manufacture to earn the maximum profit. Make it as an L.P.P. and solve graphically.

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4. If a young man drives his car at 40 km per hour, he has to spend ₹ 5 per km on petrol, if he drives it at a slower speed of 25 km per hour, the petrol cost decreases to ₹ 2 per km. He has ₹ 100 to spend on petrol and wishes to find thhe maximum distance he can travel within one hour.Express this as a linear programming problem and then solve it.

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5. A dealer deals in two items A and B He has Rs. 15000 to invest and a space to store almost 80 pieces Item A costs him Rs 300 and item B costs him Rs. 150 He can sell items A and B at profits of Rs 40 and Rs 25 respectively Assuming that he can sell all that he buys formulate the above as a linear programming prioblem for maximum profit and solve it graphically

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6. A manufacture produceds two types of steel trunks. He has two machines, A and B. The second type required 3 hours on machine A and 2 hours n machine B. Machines A and B can work at most for 18 hours and 15 hours per day respectively. He earns a profit of Rs.30 and Rs.25 per trunk of the first type and second type respectively. How many trunks of each type must he make each day to make the maximum profit?

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7. A factory manufatures two types pf screws A and B, Each type of screw requires the use of two machines, an automatic and a hand operated.It takes 4 minutes on the automatic and 6 minutes on hand operated machines to manufacture a package of screws A, while it takes 6 minutes on automatic and 3 minutes on the hand operated machines to manufacture a package of screws B.Each machine is available for at the most 4 hours on any day.The manufacturer can sell a package of screws A at a profit of ₹ 7 and screws B at a profit of ₹ 10.Assuming that he can sell all the screws he amnufactures, how many packages of each type should

the factory owner produce in a day in order to maximise his profit? Determine the maximum profit.

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8. A dealer wishes to purchase a number of fans and sewing machines. He has only Rs. 5,760 to invest and has a space for at most 20 items. A fan costs him Rs. 360 and a sewing machine Rs. 240. His expectation is that he can sell a fan at a profit of Rs. 22 and a sewing machine at a profit of Rs. 18. Assuming that he can sell all the items that he can buy, how should he invest his money in order to maximize the profit? Formulate this as a linear programming problem and solve it graphically.

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9. (i) A manufacturer produces nuts and bolts for industrial machinery.It takes 1 hour of work on machine A and 3 hours on machine B to produce a package of nuts while it takes 3 hours on machine A and 1 hour on machine B to produce a package of bolts.He earns a profit og ₹ 17.50 per

package of nuts and ₹ 7.00 per package of bolts.How many packages of each should be produced each day so as to maiximise his profit, if he operate his machine for at the most 12 hous a day?Form an LPP for the problem and solve it graphically.

(ii) A manufacturer produces nuts and bolts.It takes 1 hour of work on machine A and 3 hours on machine B to produce a package of nuts. It takes 3 hours on amchine A and 1 hour on machine B to produce a package of bolts.He earns a profit ₹35 per package of nuts and ₹14 per package of bolts.How many packages of each should be produced each day so as to maximise his profit, if he operates each machine for atmost 12 hours a day? Convert it into an LPP and solve graphically.

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10. A shopkeeper manufactures gold rings and chains.The combined number of rings and chains manufactured per day is at most:(i) 16 (ii) 24 (iii)24

It takes (i) one hour (ii) half an hour (iii) one hour yo make a ring and (i) half an hour (ii) one hour (iii) half an hour for a chain.The maximum

number of hours available is (i) 12(ii)16 (iii)16.

If the profit on a ring is :

(i)₹ 300 (ii) ₹ 100 (iii) ₹ 300

and on a chain is :

(i)₹ 200 (ii)₹ 300 (iii) ₹ 190.

How many of each should be manufactured daily, so as to maximize profti?Form an LPP and solve it graphically.

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11. A man has ₹1,500 for the purchase of Rice and Wheat.A bag of rice and a bag of wheat costs ₹ 180 and ₹ 120 respectively.He has storage capacity of 10 bags only.He earns a profit of ₹ 11 and ₹ 9 per bag of Rice and Wheat respectively.Formulate the problem as an LPP to find the number of bags of each type he should buy to maximize the profit and solve it graphically.

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12. A cottage industry manufactures pedestal lamps and wooden shades, each requiring the use of grinding/cutting machine and a sprayer. It takes 2 hours on the grinding/cutting machine and 3 hours on the sprayer to manufacture a pedestal lamp. It takes one hour on the grinding/cutting machine and 2 hours on the sprayer to manufacture a shade. On any day, the sprayer is available for at the most 20 hours and the grinding/cutting machine for at the most 12 hours. The profit from the sale of a lamp is Rs. 5 and that from a shade is Rs. 3. Assuming that the manufacturer can sell all the lamps and shades that he produces, how should he schedule his daily production in order to maximise his profit? Make an L.P.P. and solve it graphically.

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13. A company manufactures two types of novelty souvenirs made of plywood. Souvenirs of type A require 5 minutes each for cutting and 10 minutes each for assembling. Souvenirs of type B require 8 minutes each for cutting and 8 minutes each for assemb

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14. A merchant plans to sell two types of personal computers - a desktop model and a portable model that will cost Rs 25000 and Rs 40000 respectively. He estimates that the total monthly demand of computers will not exceed 250 units. Determine the nu

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15. (Manufacturing problem) A manufacturing company makes two models A and B of a product. Each piece of Model A requires 9 labour hours for fabricating and 1 labour hour for finishing. Each piece of Model B requires 12 labour hours for fabricating a

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16. A manufacturing company makes two types of teaching aids A and B . Each type of A requires 9 labour hours for fabricating and 1 labour hours

for finishing.Each type of B requires 12 labour hours for fabricating and 3 labour hours for finishing.For fabricating and finishing, the maximum labour hours abailable per week are 180 and 30 respectively.The company makes a profit of ₹ 80 on each type A and ₹ 120 on each type B. How many pieces of type A and type B should be manufactured per week to get a maximum profit? Make it as an LPP and solve graphically.What is the maximum profit per week?

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17. Two tailors A and B are paid ₹ 225 and ₹ 300 per day respectively.A can stitch 9 shirts and 6 pants while B can stitch 15 shirts and 6 pants per day.Form a linear programming problem to minimize the labour cost to produce at least 90 shirts and 48 pants.Solve the problem graphically.

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18. (Allocation problem) A cooperative society of farmers has 50 hectare of land to grow two crops X and Y. The profit from crops X and Y per

hectare are estimated as Rs 10,500 and Rs 9,000 respectively. To control weeds, a liquid herbicide has to be

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19. A diet for a sick person must contain at least 4000 units of vitamins, 50 units of minerals and 1400 units of calories. Two foods A and B are available at a cost of Rs. 5 and Rs. 4 per unit respectively. One unit of food A contains 200 units of vitamins, 1 unit of minerals and 40 units of calories whereas one unit of food B contains 100 units of vitamins, 2 units of minerals and 40 units of calories. Find what combination of the food A and B should be used to have least cost but it must satisfy the requirements of the sick person.

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20. Food X contains 6 units of vitamin A per gm and 7 units of vitamin B per gm and costs ₹ 2.00 per gm.Food Y contains 8 units of Vitamin A per gm and 12 units of vitamin B per gm and costs ₹ 2.50 per gm.The daily

minimum requirement of vitamin A and vitamin V are 100 units and 120 units respectively.Formulate the above as a linear programming problem to minimize the cost.

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21. A diet is to contain at least 80 units of Vitamin A and 100 units of minerals. Two foods F1 and F2 are available. Food F1 costs Rs. 4 per unit and F2 costs Rs. 6 per unit. One unit of food F1 contains 3 units of Vitamin A and 4 units of minerals. One unit of food F2 contains 6 units of Vitamin A and 3 units of minerals. Formulate this as a linear programming problem and find graphically the minimum cost for diet that consists of mixture of these two foods and also meets the minimal nutritional requirements.

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22. (Diet problem): A dietician wishes to mix two types of foods in such a way that vitamin contents of the mixture contain atleast 8 units of

vitamin A and 10 units of vitamin C. Food "I" contains 2 units/kg of vitamin A and 1 unit/kg of vitamin C.

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23. There are two factories located one at place P and the other at place Q.From these locations, a certain commodity is to be delivered to each of the three depots situated at A, B and C. The weekly requirments of the depots are respectively 5,5 and 4 units of the commodity while the production capacity of the factories at P and Q are respectively 8 and 6 units. The cost of transportation per unit is given below:

From/To	Cost (in ₹)		
	A	B	C
P	160	100	150
Q	100	120	100

How many units should be transported from each factory to each depot in order that the transportable cost is minimum? When will be the minimum transportation cost?

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Exercise 12 C Multiple Choice Questions

1. The point which does not lie in the half plane

$2x + 3y - 12 \leq 0$ is

A. (1,2)

B. (2,1)

C. (2,3)

D. (-3,2)

Answer: C

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2. The point, which does not lie in the half-plane $3x + 4y - 15 \leq 0$ is:

A. (1,2)

B. (2,1)

C. (2,2)

D. (3,2)

Answer: D

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3. The point, which lies in the half-plane $2x + 3y - 12 \geq 0$ is :

A. (1,2)

B. (2,1)

C. (2,2)

D. (2,3)

Answer: D

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4. Maximize $Z = x + 2y$ subject to $x + y \geq 5, x \geq 0, y \geq 0$ is :

A. 5 at (0,5)

B. 10 at (0,5)

C. 5 at (5,0)

D. 10 at (5,10)

Answer: B

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5. Maximize $Z = 3x + 2y$ subject $x + y \geq 8, x \geq 0, y \geq 0$ is :

A. 16 at (0,8)

B. 16 at(8,0)

C. 8 at (16,0)

D. 8 at (0,16)

Answer: A

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6. Maximize $Z = 2x + 3y$ subject to $x + 2y \leq 6, x \geq 4, y \geq 0$ is :

A. 6 at (6,0)

B. 6 at (0,6)

C. 12 at (6,0)

D. 12 at (0,6)

Answer: C

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7. The maximum value of $Z = 3x + 4y$ subject to the constraints:

$x + y \leq 4, x \geq 0, y \geq 0$ is :

A. 0

B. 12

C. 16

D. 18

Answer: C

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8. The corner points of the feasible region determined by the system of linear constraints are (0, 10), (5, 5) (15, 15), (0, 20). Let Z = px + qy , where $p, q > 0$. Then, the condition on p and q so that the maximum of Z occurs at both the points (15, 15) and (0, 20), is

A. p = q

B. $p = 2q$

C. $q = 2p$

D. $q = 3p$

Answer: D

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9. A linear function, which is minimzed or maximized is called:

A. An objective function

B. An optimal function

C. A feasible function

D. None of these.

Answer: A

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10. Objective function of an LPP is

A. a function to be optimized

B. a constraint

C. a relation between the variables

D. None of these.

Answer: A

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11. The optimal value of the objective function is attained at the points

A. the points given by the corners of feasible region

B. the points given by the intersection of inequalities with x - axis only

C. the points given by the intersection of inequalities with y-axis only.

D. none of these

Answer: A

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12. The value of an objective function is maximum under linear constraints:

A. at (0,0)

B. at any vertex of feasible region

C. at the centre of feasible region

D. at the vertex which is at maximum distance from (0,0)

Answer: B

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Exercise 12 C B Fill In The Blanks

1. B.Fill in the Blanks

1. Maximum of $Z = x + 2y$ subject to: $x + y \geq 5, x \geq 0, y \geq 0$ is .....at .....

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2. Maximum of $Z = 3x + 2y$ subject to:

$x + y \geq 88, x, y \geq 0$ is .....at .....

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3. Maximum of $Z = 4x + y$ subject to:

$x + y \leq 50, 3x + y \leq 90, x \geq 0, y \geq 0$ is .....at .....

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4. Minimum of $Z = x + y$ subject to :

$2x + y \geq 3, x + 2y \geq 6, x \geq 0, y \geq 0$ is .....at .....

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5. Maximum and Minimum of $Z = 3x + 4y$ subject to

$3x + 4y \leq 80, x + 3y \leq 30, x \geq 0, y \geq 0$ are .....and .....

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Exercise 12 C True False Questions

1. A linear function, which is minimized or maximized is called an optimal point.

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2. The point (7,8) lies in the half-plane $2x + 3y - 12 \geq 0$.

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3. Optimal function of a LPP is a function to be optimised.

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4. Any feasible solution,which maximizes or minimizes the objective function is called an optimal feasible solution.

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5. Maximum value of $Z = 3x + 4y$ subject to the constraints $x + y \leq 4, x \geq 0, y \geq 0$ is 16.

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Exercise 12 C Very Short Answer Type Questions

1. Answer the following questions:

1. Define Constraints of LPP.

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2. Define the feasible region.

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3. Objective function of an LPP is

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4. Define Optimal Solution of LPP.

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5. Define the feasible region.

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6. Define the feasible region.

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7. Define a corner point of a feasible region.

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8. Two tailors, A and B, earn < 300 and < 400 per day respectively. A can stitch 6 shirts and 4 pairs of trousers while B can stitch 10 shirts and 4 pairs of trousers per day. To find how many days should each of them work and if it is desired to produce at least 60 shirts and 32 pairs of trousers at a minimum labour cost, formulate this as an LPP.

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9. Maximize $Z = x + 2y$ subject to $x + y \geq 5, x \geq 0, y \geq 0.$

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

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11. Minimize $Z = 3x + 2y$ subject to $x + y \leq 8, x, y \geq 0.$

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12. Maximize $Z = 4x + 45y$ subject to :

$x + y \leq 300, 2x + 3y \leq 7, x, y \geq 0.$

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13. Maximize $Z = x + 2y$ subject to:

$2x + y \geq 3, x + 2y \geq 6, x, y \geq 0.$

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14. Maximize $Z = 5x + 3y$ subject to $3x + 5y \leq 10, x, y \geq 10.$

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15. Minimize $Z = 3x + 9y$ subject to $x + 3y \leq 60, x \leq y$and $x, y \geq 0.$

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Exercise 12 1

1. Solve the Following Linear Programming Problem graphically : Maximise

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

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2. Minimise $Z = -3x + 4y$

subject to $x + 2y \leq 8, 3x + 2y \leq 12, x \geq 0, y \geq 0.$

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3. Maximise $Z = 5x + 3y$

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

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4. Minimise $Z = 3x + 5y$

such that $x + 3y \geq 3, x + y \geq 12, x, y \geq 0$

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

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6. Minimise $Z = x + 2y$

Subject to $2x + y \geq 3, x + 2y \geq 6, x, y \geq 0.$

Show that the minimum of Z occurs at more than two points.

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

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8. Minimise and Maximise $Z = x + 2y$

Subject to $x + 2y \geq 100, 2x - y \leq 0, 2x + y \leq 200, x, y \geq 0.$

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

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

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Exercise 12 2

1. Reshma wishes to mix two types of food P and Q in such a way that the vitamin contents of the mixture contain at least 8 units of vitamin A and 11 units of vitamin B. Food P costs Rs 60 / kg and Food Q costs Rs 80 / kg. Food P contains 3 units/kg

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2. One kind of cake requires 200 g of flour and 25 g of fat, and another kind of cake requires 100 g of flour and 50 g of fat. Find the maximum number of cakes which an be made from 5 kg of flour and 1 kg of fat assuming that there is no shortage of the other ingredients used in making the cakes.

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3. A factory makes tennis rackets and cricket bats. A tennis racket takes 1.5 hours of machine time and 3 hours of craftman"s time m its making while a cricket bat takes 3 hour of machine time and 1 hour of craftman"s time. In a day, the factory has

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4. (i) A manufacturer produces nuts and bolts.It takes 1 hour of work on machine A and 3 hours on machine B to produce a package of nuts while

it takes 3 hours on machine A and 1 hour on machine B to produce a package of bolts.He earns a profit og ₹ 17.50 per package of nuts and ₹ 7.00 per package of bolts.How many packages of each should be produced each day so as to maiximise his profit, if he operate his machine for at the most 12 hous a day?Form an LPP for the problem and solve it graphically.

(ii) A manufacturer produces nuts and bolts.It takes 1 hour of work on machine A and 3 hours on machine B to produce a package of nuts. It takes 3 hours on amchine A and 1 hour on machine B to produce a package of bolts.He earns a profit ₹35 per package of nuts and ₹14 per package of bolts.How many packages of each should be produced each day so as to maximise his profit, if he operates each machine for atmost 12 hours a day?

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5. A factory manufactures two types of screws, A and B. Each type of screw requires the use of two machines, an automatic and a hand operated. It takes 4 minutes on the automatic and 6 minutes on hand operated

machines to manufacture a package of screws A, while it takes 6 minutes on automatic and 3 minutes on the hand operated machines to manufacture a package of screws B. Each machine is available for at the most 4 hours on any day. The manufacturer can sell a package of screws A at a profit of 70 paise and screws B at a profit of Rs 1. Assuming that he can sell all the screws he manufactures, how many packages of each type should the factory owner produce in a day in order to maximise his profit? Formulate the above LPP and solve it graphically and determine the maximum profit.

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6. A cottage industry manufactures pedestal lamps and wooden shades, each requiring the use of a grinding/cutting machine and 2 hours on the sprayer to manufacture a shade.On any day, the sprayer is available for at the most 12 hours and the grinding/cutting machine for at the most 12 hours.The profit from the sale of a lamp is ₹ 5 and that from a shade is ₹ 3.Assuming that manufacturer can sell all the lamps and shades that he

produces, how should he schedule his daily production in order to maximise his profit?

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7. A company manufactures two types of novelty souvenirs made of plywood. Souvenirs of type A require 5 minutes each for cutting and 10 minutes each for assembling. Souvenirs of type B require 8 minutes each for cutting and 8 minutes each for assemb

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8. A merchant plans to sell two types of personal computers a desktop model and a portable model that will cost Rs. 25,000 and Rs. 40,000 respectively. He estimates that the total monthly demand of computers will not exceed 250 units. Determine the number of units of each type of computers which the merchant should stock to get maximum profit if he does not want to invest more than Rs. 70 lakhs and his profit on the

desktop model is Rs. 4,500 and on the portable model is Rs. 5,000. Make an L.P.P. and solve it graphically.

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9. A diet is to contain at least 80 units of Vitamin A and 100 units of minerals. Two foods F1 and F2 are available. Food F1 costs Rs. 4 per unit and F2 costs Rs. 6 per unit. One unit of food F1 contains 3 units of Vitamin A and 4 units of minerals. One unit of food F2 contains 6 units of Vitamin A and 3 units of minerals. Formulate this as a linear programming problem and find graphically the minimum cost for diet that consists of mixture of these two foods and also meets the minimal nutritional requirements.

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10. There are two types of fertilisers F_1 and F_2.F_1 consists of 10% nitrogen and 6% phosphoric acid and F_2 consists of 5% nitrogen and 10% phosphoric acid. After testing he soil conditions a farmer finds that

she needs at least 14 kg of nitrogen and 14 kg of phosphoric acid for her crop. If F_1 costs Rs. 6/kg and F_2 costs Rs. 5/kg, determine how much of each type of fertiliser should be used to that nutrient requirements are met at a minimum cost. What is the minimum cost?

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11. The corner points of the feasible region determined by the following system of linear inequalities:

$2x + y \geq 10, x + 3y \leq 15, x, y \geq 0$ are $(0, 0), (5, 0), (3, 4)$ and $(0, 5)$. Let $Z = px + qy$, where $p, q \geq 0$. Condition on p and q so that the maximum of Z occurs at both $(3, 4)$ and $(0, 5)$ is:

A. p = q

B. p = 2q

C. p = 3q

D. q = 3p

Answer: D

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Miscellaneous Exercise

1. Refer to Example 9. How many packets of each food should be used to maximise the amount of vitamin A in the diet? What is the maximum amount of vitamin A in the diet?

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2. A fanner mixes two brands P and Q of cattle feed. Brand P, costing Rs 250 per bag, contains 3 units of nutritional element A, 2.5 units of element B and 2 units of element C. Brand Q costing Rs 200 per bag contains 1.5 units of nutritional el

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3. A dietician wishes to mix together two kinds of food X and Y in such a way that the mixture contains at least 10 units of vitamin A, 12 units of vitamin B and 8 units of vitamin C. The vitamin contents of 1 kg food is given below:

Food	Vitamin A	Vitamin B	Vitamin C
X	1	2	3
Y	2	2	1

1 kg of food X costs Rs. 16 and 1 kg of food Y costs Rs. 20. Find the least cost of the mixture which will produce the required diet?

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4. A manufacturer makes two types of toys A and B. Three machines are needed for this purpose and the tune (in minutes) required for each toy on the machines is given below: Each machine is available for a maximum of 6 hours per day. If the profit

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5. An aeroplane can carry a maximum of 200 passengers. A profit of Rs 1000 is made on each executive class ticket and a profit of Rs 600 is made on each economy class ticket. The airline reserves at least 20 seats for executive class. However, at le

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6. Two godowns A and B have gram capacity of 100 quintals and 50 quintals respectively. They supply to 3 ration shops, D. E and F whose requirements are 60, 50 and 40 quintals respectively. The cost of transportation per quintal from the godowns to

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7. An oil company has two depots A and B with capacities of 7000 L and 4000 L respectively. The company is to supply oil to three petrol pumps,

D, E and F whose requirements are 4500L, 3000L and 3500L respectively. The distances (in km) between the

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8. A fruit grower can use two types of fertilizer in his garden, brand P and brand Q. The amounts (in kg) of nitrogen, phosphoric acid, potash, and chlorine m a bag of each brand are given m the table. Tests indicate that the garden needs at least 2

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9. Refer to Question 8. If the grower wants to maximise the amount of nitrogen added to the garden, how many bags of each brand should be added? What is the maximum amount of nitrogen added?

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10. A toy company manufactures two types of dolls, A and B. Market tests and available resources have indicated that the combined production level should not exceed 1200 dolls per week and the demand for dolls of type B is at most half of that for do

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Exercise

1. Solve the following LPP graphically :

Maximise $Z = 2x + 3y$, subject to:

$x + y \leq 4, x \geq 0, y \geq 0.$

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

$x + 2y \geq 10, x + y \geq 6, 3x + y \geq 8, x \geq 0, y \geq 0.$

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Revision Exercise

1. Find the maximum and minimum values of $f: 2x + y$ subject to the constraints :

$x + 3y \geq 6, x - 3y \leq 3, 3x + 4y \leq 24,$

$-3x + 2y \leq 6, 5x + y \geq 5, x, y \geq 0.$

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2. An aeroplane can carry a maximum of 200 passengers. A profit of Rs 1000 is made on each executive class ticket and a profit of Rs 600 is made on each economy class ticket. The airline reserves at least 20 seats for executive class. However, at le

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3. A manufacturer of a line of patent medicines is preparing a production plane on medicines A and B. There are sufficient ingredients available to make 20,000 bottles of A and 40, 000 bottles of B but there are only 45, 000 bottles into which either of the medicines can be put. Further more, it takes 3 hours to prepare enough material to fill 100 bottles of A, it takes on hours to prepare enough material to fill 1000 bottles of B and there are 66 hours available for this operation. Te profit is Rs. 8 per bottle for A and Rs. 7 per bottle for B. Formulate this problem as a linear programming problem.

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4. A medical company has factories at two places, A and B.From these places, supply is made to each of its three agencies situated at P,Q, and R.The monthly requirements of the agencies are respectively 40,40 and 50 packets of the medicines, while the production capacity of the factories A and B, are 60 and 60 packets respectively.The transportation cost per packet from the factories to the agencies are given below:

Transportation cost per packet (in ₹)

To \ From	A	B
P	5	4
Q	4	2
R	3	5

How many packets from each factory be transported to each agency so that the cost of transportation is minimum? Also find the minimum cost.

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5. Two godowns A and B have gram capacity of 100 quintals and 50 quintals respectively. They supply to 3 ration shops, D. E and F whose requirements are 60, 50 and 40 quintals respectively. The cost of transportation per quintal from the godowns to

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6. An oil company has two depots A and B with capacities of 7000 L and 4000 L respectively. The company is to supply oil to three petrol pumps,

D, E and F whose requirements are 4500L, 3000L and 3500L respectively. The distances (in km) between the

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7. A soft drinks firm has two bottling plants, one located at P and the other located at Q.Each plant produces three different soft drinks A, B and C.The capacities of two plants in number of bottles per day, are as follows:

Product	Plant P	Plant Q
A	3000	1000
B	1000	1000
C	2000	6000

A market survey indicates that during the month of April, there will be a demand for 24,000 bottles of A, 16,000 bottles of B and 48,000 bottles of C.The cost of running the two plants P and Q are respectively ₹6,000 and ₹ 4,000 per day.Find graphically, the number of days for which either of the two plants P and Q should be run in the month of April so as to minimise production cost while still meeting the market demand.

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8. A toy company manufactures two types of dolls, A and B. Market tests and available resources have indicated that the combined production level should not exceed 1200 dolls per week and the demand for dolls of type B is at most half of that for do

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9. A dietician wishes to mix together two kinds of food X and Y in such a way that the mixture contains at least 10 units of vitamin A, 12 units of vitamin B and 8 units of vitamin C. The vitamin contents of 1 kg food is given below:

Food	Vitamin A	Vitamin B	Vitamin C
X	1	2	3
Y	2	2	1

1 kg of food X costs Rs. 16 and 1 kg of food Y costs Rs. 20. Find the least cost of the mixture which will produce the required diet?

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10. (Diet problem) A dietician has to develop a special diet using two foods P and Q. Each packet (containing $30g$) of food P contains 12 units of calcium, 4 units of iron, 6 units of cholesterol and 6 units of vitamin A. Each packet of the same quantity of food Q contains 3 units of calcium, 20 units of iron, 4 units of cholesterol and 3 units of vitamin A. The diet requires atleast 240 units of calciums atleast 460 units of iron and at most 300 units of cholesterol. How many packets of each food should be used to minimise the amount of vitamin A in the diet? What is the minimum amount of vitamin A? How many packets of each food should be used to maximise the amount of vitamin A in the diet? What is the maximum amount of vitamin A in the diet?

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11. A fruit grower can use two types of fertilizer in his garden, brand P and brand Q. The amounts (in kg) of nitrogen, phosphoric acid, potash, and

chlorine m a bag of each brand are given m the table. Tests indicate that the garden needs at least 2

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12. A factory owner purchases two types of machines, A and B for his factory. The requirements and the limitations for the machines are as follows: Machine Area occupied Labour force Daily output (in units) A $1000\,m^2$ $12\,men$ 60 B $1200\,m^2$ $8\,men$ 40 He has maximum area of $9000\,m^2$ available, and 72 skilled labourers who can operate both the machines. How many machines of each type should he buy to maximise the daily output?

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13. (Manufacturing problem) A manufacturer has three machines I, II and III installed in his factory. Machines I and II are capable of being operated for at most 12 hours whereas machine HI must be operated for atleast 5 hours a day. She produces onl

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14. A manufacturer makes two types of toys A and B. Three machines are needed for this purpose and the tune (in minutes) required for each toy on the machines is given below: Each machine is available for a maximum of 6 hours per day. If the profit

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15. A fanner mixes two brands P and Q of cattle feed. Brand P, costing Rs 250 per bag, contains 3 units of nutritional element A, 2.5 units of element B and 2 units of element C. Brand Q costing Rs 200 per bag contains 1.5 units of nutritional el

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16. A packet of plain biscuits costs ₹ 6 and that of choloate biscuits costs ₹ 9 . A house-wife has ₹ 72 and wants to buy at least three packets of

plain biscuits and at least four of choloate biscuits.How many of each type should she buy so that she can have maximum number of packets? Make it as an LPP and solve it graphically.

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17. A manufacturer produces two products A and B. Both the products are processed on two different machines. The available capacity of first machine is 12 hours and that of second machine is 9 hours per day. Each unit of product A requires 3 hours on both machines and each unit of product B requires 2 hours on first machine and 1 hour on second machine. Each unit of product A is sold at Rs. 7 profit and that of B at a profit of Rs. 4. Find the production level per day for maximum profit graphically.

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Check Your Understanding

1. The graph of the ineequation $2x + 3y \geq 6$ does not lie in the first quadrant.(True/False)

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2. The graph of the inequation $3x + 2y > 6$ does not lie in the fourth quadrant.

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3. The, objective function is maximum or minimum at a point, which lies on the boundary of the feasible region.

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4. Maximize $Z = x + 2y$ subject to :

$x + y \geq 5, x \geq 0, y \geq 0.$

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5. Maximize $Z = 4x + y$ subject to : $x + y \leq 50, x, y \geq 0.$

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6. What is the optimum solution?

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7. What is the objective solution?

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8. Feasible solution In feasible solution Feasible region in feasible region

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9. Define the feasible region.

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10. What is optimal solution?

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Chapter Test

1. The point, which does not lie in the half-plane $3x + 4y - 15 \leq 0$ is:

A. (1, 2)

B. (2, 1)

C. (2, 2)

D. (3, 2)

Answer: D

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2. A linear function, which is maximized or minimized is called:

A. An objective function

B. An optimal function

C. A feasible function

D. None of these.

Answer: A

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3. The graph of the inequation $3x + 2y > 6$ does not lie in the 4th quadrant.(True/False)

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4. Draw the graph of the following LPP: $3x + y \leq 17, x, y \geq 0.$

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5. Maximize $Z = 4x + y$ subject to : $x + y \leq 30, x, y \geq 0.$

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6. Maximize $Z = 4x + y$ subject to : $x + y \leq 50, x, y \geq 0.$

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7. Minimize $Z = -3x + 4y$ subject ot constraints : $x + 2y \leq 8, 3x + 2y \leq 12, x \geq 0, y \geq 0.$

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8. If a young man rides his motorcycle at 25 km/hr, he has to spend 2 per kilometer on petrol if per he rides it at a faster speed of 40 km/hr the petrol cost increases to 5 per kilometer.He has 100 to spend on petrol and wishes to find the maximum distance he can travel within one hours. Express this as a linear programming problem and then solve it.

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9. A manfufacturer produces two products A and B.Both the products are processed on two different machines.The available capacity of the first machines is 12 hours and that of second machine is 9 hours.Each unit of product A require 3 hours on both machines and each unit of product B requires 2 hours on first machine and 1 hour on the second machine.Each unit of product A is sold at a profit of ₹ 5 and B at a profit ₹ 6. Find the productive level for maximum profit graphically.

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10. Two tailors A and B earn ₹150 and ₹200 per day respectively. A can stich 6 shirts and 4 pants per day, while B can stitch 10 shirts and 4 pants per day. Form a L.P .P to minimize the labour cost to produce (stitch) at least 60 shirts and 32 pants and solve it graphically.

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11. A cooperative society oof farmer has 50 hectares of land to grow crops A and B.The profits from crops A and B per hectare are estimated as ₹.10,500 and ₹. 9,000 respectively.To control weeds, a liquid pesticide has to be used for crops A and B at the rate of 20 litres and 10 litres per hectare,respectively.Further not more than 800 litres of pesticide should be used in order to protect fish and wildlife using a pond which collects drainage from this land.Keeping in mind that the protection of fish and other wildlife is more important than earning profit, how much land should be allocated to each crop so as to maximize the total profit?Form an LPP from the above and solve it graphically.Do you agree with the

message that the protection of wildlife is utmost necessary to preserve the balance in environment?

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12. A dietician wishes to mix two types of foods in such a way that the vitamin contents of the mixture contains at least 8 units of vitamin A and 10 units of vitamin C. Food I contains 2 units/kg of vitamin A and 1 units/kg of vitamin C while Food II contains 1 unit/kg of vitamin A and 2 units/kg of vitamin C. It costs Rs.5 per kg to purchase Food I and Rs.7 per kg to purchase Food II. Determine the minimum cost of such a mixture. Formulate the above as a LPP and solve it graphically.

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