MATHS

NCERT - NCERT MATHEMATICS(ENGLISH)

LINEAR PROGRAMMING

Exercise 12 2

1. There are two types of fertilizers F_1 and F_2. F_1 consists of 10% nitrogen and 6% phosphoric acid and F_2 contains 5% nitrogen and 10% phosphoric acid. After testing the soil condition a farmer finds that he needs at least 14 kg of nitrogen and 14 kg of phosphoric acid forhis crop. If F_1 costs Rs. 6 per kg and F_2 costs Rs. 5 perkg, determine how muchofeach of fertilizers beused so that nutrient requirements are met at a minimum cost. What is the minimum cost?

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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 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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3. 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 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. Make an L.P.P. of the above and solve it graphically.

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4. 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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5. 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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6. 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 assembling. There are 3 hours 20 minutes available for cutting and 4 hours for assembling. The profit is Rs 5 each for type A and Rs 6 each for type B souvenirs. How many souvenirs of each type should the company manufacture m order to maximise the profit?

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7. 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 machine A and 1 hour on machine B to produce a package of bolts. He earns a profit of Rs 17.50 per package on nuts and Rs 7.00 per package on bolts. How many packages of each should be

produced each day so as to maximise his profit, if he operates his machine for at most 12 hours a day?

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8. 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 sc

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9. 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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10. A diet is to contain at least 80 units of vitamin A and 100 units of minerals. Two foods $F_1$and F_2, are available. Food F_1costs Rs 4 per unit food and F, costs Rs 6 per unit. One unit of food F_1, contains 3 units of vitamin A and 4 units of minerals.One unit of foodF_2, contains 6 units of vitamin A and 3 units of minerals.Formulate a LPP. find the minimum cost of diet which matches the minimal requirement

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11. The corner points of the feasible region determined by the following system of linear inequalities: $2x + y \leq 10,\ x + 3y \leq 15,\ x,\ y \geq 0\, are\, (0, 0),\ (5, 0), (3,\ 4) and\, (0, 5) \dot{L}et$. Condition on $p\, and\, q$ so that the maximum of Z occurs at both (3,4) and (0,5) is $p = q$ b. $p = 2q$ c. $p = 3q$ d. $q = 3p$

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Exercise 12 1

1. Maximise $Z = x + y$

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

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2. Solve the Following Linear Programming Problem graphically : Maximise $Z = 3x + 2y$subject to $x + 2y \leq 10, 3x + y \leq 15, x, y \geq 0.$

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3. Solve the Following Linear Programming Problem graphically : Minimise $Z = 3x + 5y$ such that $x + 3y \geq 3, x + y \geq 2, x, y \geq 0x + 3y$.

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4. Show that the minimum of Z occurs at more than two points : Minimise and Maximise $Z = 5x + 10y$subject to

$x + 2y \leq 20, x + y \geq 60, x - 2y \geq 0, x, y \geq 0.$

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5. Solve the Following Linear Programming Problem graphically : Minimise $Z = x + 2y$subject to $3x + y \geq 3, x + 2y \geq 6. x, y \geq 0.$

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6. Solve the Following Linear Programming Problem graphically : Maximise $Z = 3x + 4y$subject to the constraints : $x + y \leq 4, x \geq 0, y \geq 0.$

A. 14

B. 15

C. 16

D. 17

Answer: C

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7. Solve the Following Linear Programming Problem graphically : Maximise

$Z = 5x + 3y$ subject to

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

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8. Solve the Following Linear Programming Problem graphically : Minimise

$Z = 3x + 4y$ Subject to

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

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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. 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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Miscellaneous Exercise

1. A dietician wishes to mix two types of food in such a way that the vitamin contents of the mixture contain at least 8 units f Vitamin A and 10 units of vitamin C, Food I contains 2 units per kg of vitamin A and 1 unit per kg of vitamin C while food II contains 1 unit per kg of vitamin A and 2 units per kg of vitamin C. It costs Rs 50.00 per kg to purchase food I and Rs. 70.00 per kg to produce food II. Formulate the above linear programming problem to minimize the minimize the cost of such a mixture.

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2. A toy manufacturer produces two types of dolls; a basic version doll A and a deluxe version doll B. Each doll of type B takes twice as long to produce as one doll of type A. The company have time to make a maximum of 2000 dolls of type A per day, the supply of plastic is sufficient to produce 1500 dolls per day and each type requires equal amount of it. The deluxe version i.e. type B requires a fancy dress of which there are only 600 per day available. If the company makes a profit of RLs. 3 and Rs. 5 per doll, respectively, on doll A and B; how many of each should be produced per day in order to maximize profit? Solve it by graphical method.

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3. 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 element A, 11.25 units of element B, and 3

units of element C. The minimum requirements of nutrients A, B and C are 18 units, 45 units and 24 units respectively. Determine the number of bags of each brand which should be mixed in order to produce a mixture having a minimum cost per bag? What is the minimum cost of the mixture per bag?

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4. 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 pumps D,E,F whose requirements are 4500 L, 3000 L and 3500 L respectively. The distance (in Km) between the depots and the petrol pumps are given in the following table :

From / To	Distance (in Km)	
	A	B
D	7	3
E	6	4
F	3	2

Assuming that the transportation cost of10 litres of oil is ₹ 1 per km , how

should the delivery be scheduled in order that the transportation cost is minimum ?

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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 the shops are given in the following table:How should the supplies be transported in order that the transportation cost is minimum? What is the minimum cost?

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6. An aeroplane can carry a maximum of 200 passengers. A profit of Rs. 800 is made on each first class ticket and a profit of Rs. 500 is made on each second class ticket. The airline reserves at least 20 seats for first class. However, at least 4 times as many passengers prefer to travel by second class than by first class. Determine how many tickets of each type

must be sold in order to maximize the profit of airline? Also find the maximum profit.

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7. 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 on each toy of type A is Rs 7.50 and that on each toy of type B is Rs 5. show that 15 toys of type A and 30 of the B should be manufactured m a day to get maximum profit.

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8. 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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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 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 240 kg of phosphoric acid, at least 270 kg of potash and at most 310 kg of chlorine. If the grower wants to minimise the amount of nitrogen added to the garden, how many bags of each brand should be used? What is the minimum amount of nitrogen added in the garden?

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Solved Examples

1. (Transportation problem) 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 requirements 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 : How many units should be transported from each factory to each depot in order that the transportation cost is minimum. What will be the minimum transportation cost?

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2. (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 only two items M and N each requiring the use of all the three machines. The number of hours required for producing 1

unit of each of M and N on the three machines are given m the following table:She makes a profit of Rs 600 and Rs 400 on items M and N respectively. How many of each item should she produce so as to maximise her profit assuming that she can sell all the items that she produced? What will be the maximum profit?

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3. A manufacturing company makes two models A and B of a product. Each piece of mode a requires 9 labour hours for fabricating and 1 labour hour for finishing. Each piece of Mode B requires 12 labour hours for fabricating and 3 labour hours for finishing. For fabricati2 and finishing, the maximum labour hours available are 180 and 30 respectively. The company makes a profit of Rs. 8000 on each piece of model A and Rs. 12000 on each piece of Model B. How many pieces of Model A and Model B should be manufactured per week to realise a maximum profit? What is the maximum profit per week?

A. 150000

B. 168000

C. 180000

D. 190000

Answer: B

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4. A dietician has to develop a social diet using two foods P and Q. Each packet (containing 30 g) 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 calcium, 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?

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5. Solve the following linear programming problem graphically :Minimise $Z = 200x + 500y$. . . (1)subject to the constraints:$x + 2y \geq 10$ . . .(2) $3x + 4y \leq 24 \ldots$.(3)$x \geq 0, y \geq 0 \ldots$.(4)

A. $(Z) = (4, 3) = 2300$

B. $(Z) = (5, 4) = 2400$

C. $(Z) = (6, 2) = 2500$

D. $(Z) = (5, 3) = 2550$

Answer: A

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6. Solve the following problem graphically:Minimise and Maximise $Z = 3x + 9y$ . . . (1)subject to the constraints: $x + 3y \leq 60$ . . . (2) $x + y \geq 10 \ldots$ (3) $x \leq y \ldots$ (4) $x \geq 0, y \geq 0 \ldots$ (5)

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7. Solve the following linear programming problem graphically: Maximise $Z = 4x + y \ldots$ (1) subject to the constraints: $x + y \leq 50 \ldots$.(2) $3x + y \leq 90 \ldots$.(3) $x \geq 0, y \geq 0 \ldots$.(4)

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8. A dietician wishes to mix two types of food in such a way that the vitamin contents of the mixture contain at least 8 units f Vitamin A and 10 units of vitamin C, Food I contains 2 units per kg of vitamin A and 1 unit per kg of vitamin C while food II contains 1 unit per kg of vitamin A and 2 units per kg of vitamin C. It costs Rs 50.00 per kg to purchase food I and Rs. 70.00 per kg to produce food II. Formulate the above linear programming problem to minimize the minimize the cost of such a mixture.

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9. A cooperative society of farmers has 50 hectares of land to grow two crops A and B.The profit from crops A and B per hectare are Rs. 10500 and Rs. 9000 respectively. A liquid herbicide has to be used for crops A and B at rates 20 litres and 10 litres per hectares respectively, but it cannot be more than 800 litres. How much land should be allocated to each crop so as to maximize the total profit of the society?

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10. Determine graphically the minimum value of the objective function $Z = -50x + 20y$ subject to the constraints: $2x - y \geq -5$, $3x + y \geq 3$, $2x - 3y \leq 12$, $x \geq 0, y \geq 0$.

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11. Minimise $Z = 3x + 2y$ subject to the constraints:

$x + y \geq 8 \ldots$(1)

$3x + 5y \leq 15 \ldots$.(2)

$x \geq 0, y \geq 0 \ldots$.(3)

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