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Question Bank

MODULE 1: Introduction, Linear Programming

1. List the different phases of OR and explain them briefly.

2. Give any four definitions and impact of OR. Also Define feasible region, unbounded solution & feasible solution.

3. What is the historical development of OR? What are the advantages and limitations of OR studies? Also name few organizations that are taking the advantage of OR.

4. A company makes two kinds of leather belts. Belt A is a high quality belt, and belt B is of low quality. The respective profits are Rs.4 and Rs.3 per belt. Each belt of type A requires twice as much time as a belt of type B and if all belts were of type B, the company could make 1000 per day. The supply of leather is sufficient for only 800 belts per day (A & B combined). Belt A requires a fancy buckle and only 400 per day are available. There are only 700 buckles in a day available for belt B. Formulate it as LPP and solve it by graphical method

5. Old hens can be bought at Rs. 2 each and young ones at Rs. 5 each. The old hens lay 3 eggs per week and the young ones lay 5 eggs per week, each egg being worth 30 paise. A hen (young or old) costs Re. 1 per week to feed. I have only Rs. 80 to spend for hens, how many of each kind should I buy to give a profit of more than Rs. 6 per week, assuming that I cannot house more than 20 hens. Use graphical method to solve.

6. A marketing manager wishes to allocate his annual advertising budget of Rs. 20,000 in two media groups M&N. The unit cost of the message in the media M is Rs.200 & N is Rs.300. The media M is monthly magazine & not more than two insertions are desired in one issue. At least five messages should appear in the media N. The expected effective audience per unit message for media M is 4000 & for N is 5000. Formulate the LPP.

7. A retailer deals in two only A & B. he has 50000 to invest and a space to store at most 60 pieces. An item A costs him 2500 and B costs 500. A net profit to him on item A is 500 and B is 150. If he can sell the entire item he purchases, how should he invest his amount to have max profit? Solve graphically.

8. A company has 3 operational departments (weaving processing & packing) with capacity to produce 3 different types of cloths namely suiting, shirting & woolen yielding the profit of Rs.2, Rs.4 & Rs.3 per meter respectively. 1 meter suiting requires 3 minutes in weaving, 2 min processing & 1 min in packing, 1 meter of shirting requires 4 min in weaving, 1 min in processing & 3 min in packing. While 1 meter woolen requires 3 min in each department. In a week total run time of each dept. is 60,40 & 80 hr of weaving, processing & packing the dept. respectively. Formulate the LPP to find the product mix to max the profit.

9. Solve the following LPP by Graphically
   $z_{max} = 8000x_1 + 7000x_2$ *subjected to* $3x_1 + x_2 \le 6$, $x_1 + x_2 \le 45$, $x_1 \le 20$, $x_2 \le 40$, $x_1, x_2 \ge 0$.

10. Solve the following LPP by Graphically
    $z_{min} = -6x_1 - 4x_2$ *STC* $2x_1 + 3x_2 \ge 30$, $3x_1 + 2x_2 \le 24$, $x_1 + x_2 \ge 3$ $x_1, x_2 \ge 0$.

MODULE 2: Simplex Method – 1

11. Define feasible solution, basic feasible solution, slack variable, surplus variable and optimal solution.

12. Explain the concept of tie breaking and degeneracy in simplex method.

13. Briefly explain assumptions required in linear programming models? Why is simplex method a better technique than graphical for most real case? Explain.

14. Explain the special cases that arise in the use of the simplex method.

15. ABC firm manufactures 3 products p1, p2, p3. The profits are 30, 20 & 40 respectively. The firm has 2 machines m1 and m2 and requires processing time in minutes for each machine on each product and total machine available minutes on each machine are given below.

Machine	Machine minutes required			Total machine minutes available
	P1	P2	P3	
M1	4	3	5	2000
M2	2	2	4	2500

The firm must manufacture at least 100 p1 and 200 p2 and 50 p3 but not more than 150 p1's.solve by simplex method.

16. solve by simplex method also write the type of solution

$$\text{Max } Z = 4x_1 + x_2 + 3x_3 + 5x_4$$

$$\text{STC} \quad 4x_1 - 6x_2 - 5x_3 - 4x_4 \geq -20$$
$$-3x_1 - 2x_2 + 4x_3 + x_4 \leq 10$$
$$-8x_1 - 3x_2 + 3x_3 + 2x_4 \leq 20$$
$$x_1, x_2, x_3, x_4, \geq 0$$

17. Find all the basic solutions of the following system of equations identifying in each case the basic and non basic variables.

$2x_1 + x_2 + 4x_3 = 11,\ 3x_1 + x_2 + 5x_3 = 14$

18. Solve the LPP, Maximize $Z = 2x_1 + 2x_2$

$$\text{STC} \quad 5x_1 + 3x_2 \leq 8$$
$$2x_1 + 4x_2 \leq 8$$
$$x_1, x_2 \geq 0$$

19. Solve the LPP, Maximize $Z = 3x_1 + 2x_2$

$$\text{STC} \quad 4x_1 + 3x_2 \leq 12$$
$$4x_1 + x_2 \leq 8,\ 4x_1 - x_2 \leq 8$$
$$x_1, x_2 \geq 0$$

20. Determine all Alternate solution of the LPP

Solve the LPP, Maximize $Z = 2x_1 + 4x_2$

$$\text{STC} \quad x_1 + 2x_2 \leq 5$$
$$x_1 + x_2 \leq 4$$
$$x_1, x_2 \geq 0$$

21. Check for Unbounded solution in the LPP

Solve the LPP, Maximize $Z = 4x_1 + x_2 + 3x_3 + 5x_4$

$$\text{STC} \quad 4x_1 - 6x_2 - 5x_3 - 4x_4 \geq -20$$
$$-3x_1 - 2x_2 + 4x_3 + x_4 \leq 10$$
$$-8x_1 - 3x_2 + 3x_3 + 2x_4 \leq 20$$
$$x_1, x_2, x_3, x_4 \geq 0.$$

22. Solve by Two Phase Method

$$\text{Minimize} \quad Z = x_1 - 2x_2 - 3x_3$$

$$\text{STC} \quad -2x_1 + 3x_2 + 3x_3 = 2$$
$$2x_1 + 3x_2 + 4x_3 = 1$$
$$x_1, x_2, x_3 \geq 0$$

23. Use two-phase simplex method to solve the problem:
    Minimize $Z = 7.5x_1 - 3x_2$,
    Subject to the constraints:
    $3x_1 - x_2 - x_3 \geq 3$,
    $x_1 - x_2 + x_3 \geq 2$ and
    $x_1, x_2, x_3 \geq 0$

24. Solve by Big M Method

$$\text{Minimize} \quad Z = 4x_1 + x_2$$
$$\text{STC} \quad 3x_1 + 4x_2 \geq 20$$
$$-x_1 - 5x_2 \leq -15$$
$$x_1, x_2 \geq 0$$

25. Solve by Big M Method Max Z = 6x+4y
    S.T.C $2x+3y \leq 30$
    $3x+2y \leq 24$
    $x+y \geq 3$
    $x, y \geq 0$.
    Does this problem have an alternate solution? If so, give the alternate solution.
26. Explain in detail the computer implementation of simplex method and available software option for linear programming.
27. Explain the two phase technique procedure for solving an LPP in simplex method.
28. Explain the Big M technique procedure for solving an LPP in simplex method.
29. Write a note on artificial variables.
30. Check for infeasible solution , Solve by two phase method
    Max Z = 5x+3y
    S.T.C $2x+y \leq 1$
    $x+4y \geq 6$
    $x, y \geq 0$.

MODULE 3:- Simplex Method – 2 Duality Theory

31. Obtain the dual of the primal problem
    Minimize $Z = x_1 - 3x_2 + x_3$
    S.T.C $3x_1 - x_2 + 2x_3 \leq 7$, $2x_1 - 4x_2 \geq 12$, $-4x_1 + 3x_2 + 8x_3 = 10$
    $x_1, x_2 \geq 0$ and x_3 is unrestricted.
32. Obtain the dual problem of the primal L.P.P

$$\text{Max} \quad Z = x_1 + x_2$$
$$\text{STC} \quad 2x_1 + x_2 = 5$$
$$3x_1 - x_2 = 6$$
$$x_1, x_2 \text{ Unrestricted}$$

33. Write a note on relation between primal and dual and The essence of duality theory
34. Convert from Dual to Primal

$Z_{\min} = 2x_2 + 5x_3$ Subject to

$x_1 + x_2 \geq 2$, $2x_1 + x_2 + 6x_3 \leq 6$, $x_1 - x_2 + 3x_3 = 4$; $x_1, x_2, x_3 \geq 0$

35. Show that Primal of the Dual is Primal by using simplex table

$Z_{\max} = x_1 + 2x_2 + x_3$ Subject to

$2x_1 + x_2 - x_3 \leq 2$, $-2x_1 + x_2 - 5x_3 \geq -6$, $4x_1 + x_2 + x_3 \leq 6$ *where* $x_1, x_2, x_3 \geq 0$.

36. Obtain the dual solution directly, using the inverse from solution of the primal

$Z_{\max} = 5x_1 + 2x_2 + 3x_3$ Subject to

$x_1 + 5x_2 + 2x_3 = 30$, $x_1 - 5x_2 - 6x_3 \leq 40$ *where* $x_1, x_2, x_3 \geq 0$.

37. What is the important characteristic of duality? Explain weak duality property, strong duality property & complementary solutions property.

38. Solve the following problem by dual simplex method.

Minimize $Z = 2x_1 + x_2$

Subject to $3x_1 + x_2 \geq 3$

$4x_1 + 3x_2 \geq 6$

$x_1 + 2x_2 \geq 3$ and $x_1, x_2 \geq 0$

39. Obtain the optimal solution, using the dual simplex method for the dual problem of the following: Maximize $Z = 3x_1 + 5x_2$

Subject to constraints $x_1 \leq 4$; $2x_2 \leq 12$; $3x_1 + 2x_2 \leq 18$ and $x_1, x_2 \geq 0$

40. Solve the following problem by dual simplex method

Maximize $z = -4y_1 - 12y_2 - 18y_3$

Subject to constraints $y_1 + 3y_3 \geq 3$

$2y_2 + 2y_3 \geq 5$

And $y_1, y_2, y_3 \geq 0$

41. Find the maximum of $z = 6x_1 + 8x_2$

Subject to $5x_1 + 2x_2 \leq 20$

$x_1 + 2x_2 \leq 10$ and $x_1, x_2 \geq 0$

42. Use dual simplex method and solve the following

Minimize $Z = 3x_1 + x_2$

Subject to $x_1 + x_2 \geq 1$

$2x_1 + 3x_2 \geq 2$

and $x_1, x_2 \geq 0$

43. Write the working procedure of dual simplex method.

MODULE 4: Transportation and Assignment Problems

44. Write different steps in Hungarian algorithm to solve assignment problem
45. Find the initial basic feasible solution of transportation problem where cost- matrix is given below

Market

		A	B	C	D	Supply
Warehouse	I	1	5	3	3	34
	II	3	3	1	2	15
	III	0	2	2	3	12
	IV	2	7	2	4	19
	Demand	21	25	17	17	

46. A department has five employees with five jobs to be performed. The time (in hours) each men will take to perform each job is given in the effectiveness matrix.

		Employees				
		I	II	III	IV	V
Jobs	A	10	5	13	15	16
	B	3	9	18	13	6
	C	10	7	2	2	2
	D	7	11	9	7	12
	E	7	9	10	4	12

How the jobs be allocated? One per employee, so as to minimize the total man hours, use the Hungarian method.

47. The following table shows all the necessary information on the availability of supply to each warehouse, the requirement of each market and unit transport cost from each warehouse to each market

Market

		P	Q	R	S	Supply
Warehouse	A	6	3	5	4	22
	B	5	9	2	7	15
	C	5	7	8	6	8
	Demand	7	12	17	9	45

The shipping clerk has worked out the following schedule from experience, 12 units from A to Q, 1 unit from A to R, 8 units from A to S, 1.5 units from B to R, 7 units from C to P and 1 unit from C to R.

i. Check and see if the clerk has optimal schedule
ii. Find the optimal schedule and minimum total transport cost.

48. The transportation costs per truck load of cement (in hundreds of rupees) from each plant to each project site are as follows:

		Project Sites				
		P	Q	R	S	Supply
Warehouse	1	2	3	11	7	6
	2	1	0	6	1	1
	3	5	8	15	9	10
	Demand	7	5	3	2	17

Determine the optimal distribution for the company so as to minimize the total transportation cost.

49. Four jobs are to be done on four different machines. The cost (in rupees) of producing i^{th} job in the j^{th} machine is given below:

		Machines			
		M1	M2	M3	M4
Jobs	J1	15	11	13	15
	J2	17	12	12	13
	J3	14	15	10	14
	J4	16	13	11	17

Assign the jobs to different machines so as to minimize the total cost.

50. Define feasible solution, basic feasible solution, non degenerate solution and optimal solution in a Transportation problem.
51. A product is produced in 4 factories F1, F2, F3 and F4. Their unit production costs are Rs 2, 3, 1 and 5 respectively. The product is supplied to 4 stores S1, S2, S3 and S4 the requirements of which are 25, 35,105 and 20 respectively. Unit costs of transportation are given below:

Stores / Factories	S1	S2	S3	S4
F1	2	4	6	11
F2	10	8	7	5
F3	13	3	9	12
F4	4	6	8	3

Find the transportation plan such that the total production and transportation cost is minimum.

52. Find the initial solution to the following transportation problem

		Destination					
		D1	D2	D3	D4	D5	Supply
Origin	O1	7	6	4	5	9	40
	O2	8	5	6	7	8	30
	O3	6	8	9	6	5	20
	O4	5	2	7	8	6	10
	Demand	30	30	15	20	5	10

53. The owner of a small machine shop has four machines available to assign for the jobs. Five jobs are offered to assign, with the expected profits in hundreds of rupees for each machine on each job being as follows:

	Job				
Machines	1	2	3	4	5
A	6.2	7.8	*	10.1	8.2
B	7.0	8.4	6.5	7.5	6.0
C	8.7	9.2	11.1	7.0	8.2
D	*	6.4	8.7	7.7	8.0

*indicates that machine A and D cannot perform the jobs 3 and 1 respectively. Find the assignment of jobs to machines that will result in the maximum profit.

54. Solve the assignment problem represented by the following matrix using column reduction.

	A	B	C	D
1	2	3	4	5
2	4	5	6	7
3	7	8	9	8
4	3	5	8	4

55. Solve the following assignment problem. If it is treated as a salesman problem and the cell entries represent cost in rupees, find the least cost route such that salesman does not visit any city twice.

	A	B	C	D	E
A	-	2	5	7	1
B	6	-	3	8	2
C	8	7	-	4	7
D	12	4	6	-	5
E	1	3	2	8	-

MODULE 5: Game Theory, Decision Analysis and Metaheuristics

56. Explain basic characteristics of two person, zero sum game. For the game having following payoff table, determine the optimal strategy for each player by successively eliminating dominated strategies. Indicate the order in which you eliminate strategies.

		Player -2		
		1	2	3
Player-1	1	1	2	0
	2	2	-3	-2
	3	0	3	-1

57. Explain the details of solving simple games in game theory.

58. Solve the game whose payoff matrix for the player A is given below:

	I	II	III
I	1	7	2
II	6	2	7
III	5	2	6

59. Solve the following (2 x 3) game graphically.

		Y_1	Y_2	Y_3
		I	II	III
X_1	I	1	3	11
X_2	II	8	5	2

60. Solve the following game graphically:

		Player B		
		B1	B2	B3
Player A	A1	2	6	22
	A2	16	10	4

61. Explain the following
   i. Minimax and Maximum principles
   ii. Pure and Mixed strategies
   iii. Two persons zero sum game

62. Solve the game whose pay off matrix is given below.

	B1	B2	B3	B4
A1	-5	2	0	7
A2	5	6	4	8
A3	4	0	2	-3

Give the value of game and strategies adopted by A and B.

63. Find out the value of game, given the following pay off matrix

	B1	B2
A1	4	-4
A2	-4	4

Metaheuristics

64. Explain briefly Metaheuristics.
65. Explain briefly Tabu search algorithm.
66. Explain briefly Genetic algorithm.
67. Write a short note on simulated annealing technique.