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OPTION—B

Course No. : MTMDSE-601T (B)

(Linear Programming)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

SECTION—A

Answer any *twenty* of the following questions : 1×20=20

1. What type of LPP can be solved using graphical method?

2. What is a convex set in $\mathbb{E}^n$?

3. Introduce slack variable in the inequality

$$x_1 + 2x_2 + x_3 \leq 7$$

and rewrite it accordingly.

4. What are surplus variables?

5. What is a convex polyhedron?

Find an initial basic feasible solution of the LPP :

$$\text{Max } Z = x+2y+3z$$

subject to

$$x-3y+z \leq 8$$

$$2x+y+3z \leq 7$$

$$x, y, z \geq 0$$

How should you modify the objective function of a minimization LPP in order to apply Simplex method?

Mention two methods to solve LPP using artificial variables.

9. What is the objective function in the first phase of the two-phase method?

10. In solving an LPP by Big-M method, state the condition under which it can be concluded that the LPP has no feasible solution.

11. Mention three types of primal-dual problem.

12. If the 4th variable in primal is unrestricted in sign, then what can you say about the 4th constraint in its dual?

13. If the dual has unbounded solution, then what can you conclude about the solution of the primal?

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14. What is an unbalanced transportation problem?

15. Which cell gets the first allocation in North-West corner rule?

16. When is the solution of a transportation problem called degenerate?

17. What is the relation between c_{ij}, u_i and v_j for occupied cells?

18. Mention one basic assumption of an assignment problem.

19. Write True or False :

Assignment problem is a special type of transportation problem.

20. When is an assignment problem called unbalanced?

21. What is a payoff matrix?

22. What is a two-person zero-sum game?

23. State the minimax principle.

24. What is a symmetric game?

25. What is saddle point?

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SECTION—B

Answer any *five* of the following questions : $2 \times 5 = 10$

26. Justify with example that the union of two convex sets may not be convex.

27. Write the LPP in the standard form :

$$\text{Max } Z = 3x + 4y - z$$

subject to

$$x - 2y + 3z \leq 4$$
$$2x + 3y + z \geq 5$$
$$x, y, z \geq 0$$

28. Write a short note on Big-M method.

29. Construct the auxiliary LPP of two-phase method for the LPP

$$\text{Max } Z = 5x_1 + 8x_2$$

subject to

$$3x_1 + 2x_2 \geq 3$$
$$x_1 + 4x_2 \geq 4$$
$$x_1, x_2 \geq 0$$

30. Write the dual of

$$\text{Max } Z = 3x + 4y + z$$

subject to

$$4x + 2y + z \leq 3$$
$$2x + y + 3z \leq 5$$
$$x, y, z \geq 0$$

31. Write a short note on North-West corner rule.

32. Explain loop in a transportation table.

33. State the assignment problem mathematically.

34. Write the analytical definition of saddle point.

35. Two boys *A* and *B* simultaneously draw either one or two ball(s) which they have in their bags. If the number of balls drawn by *B* be the same as the number of balls drawn by *A*, then *A* wins and gets one rupee from *B*. If the number of balls is not same, then *B* wins and gets one rupee from *A*. Write the payoff matrix of this game.

SECTION—C

Answer any *five* of the following questions : 8×5=40

36. *(a)* A manufacturing company produces two types of products *A* and *B*. The profit on each product is ₹ 5 and ₹ 7 respectively. The company must produce at least a total of 1000 products per month. However, the raw materials are sufficient for at most 400 products of type *A* per month. Each product of type *A* requires 2 hours and each product of type *B* requires 3 hours to

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manufacture and the company has 25 working days each of 10 hours work time. Formulate the problem as an LPP so as to maximize profit. 3

5

(b) Solve graphically :

$$\text{Max } Z = 3x + 5y$$

subject to the constraints

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

(a) Show that a convex polyhedron is a convex set. 5

(b) Explain the standard form of an LPP. Give an example to illustrate the same. 3

(a) Solve using Simplex method : 5

$$\text{Max } Z = 2x_1 + 5x_2 + 7x_3$$

subject to

$$3x_1 + 2x_2 + 4x_3 \leq 100$$
$$x_1 + 4x_2 + 2x_3 \leq 100$$
$$x_1 + x_2 + 3x_3 \leq 100$$
$$x_1, x_2, x_3 \geq 0$$

(b) Write a note on two-phase method. 3

39. *(a)* Solve using Big-M method : 6

$$\text{Max } Z = -2x_1 - x_2$$

subject to

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

(b) In the Big-M method, what conclusions can be drawn if some artificial variables are present in the basis but optimality conditions are satisfied? 2

40. *(a)* Write the dual of the following LPP : 4

$$\text{Max } Z = x + 2y + 3z$$

subject to

$$x + 3y - z \geq 8$$
$$2x + y \leq 5$$

where $x \geq 0$, y is unrestricted in sign.

(b) Find an initial basic feasible solution of the following transportation problem by matrix minima method : 4

		Destination			
Source	D_1	D_2	D_3	
S_1	2	3	1	10
S_2	4	1	5	10
S_3	6	2	7	15
S_4	1	4	3	5
Requirement →	15	10	15	

(Continued)

State and prove a necessary and sufficient condition for a transportation problem to have a feasible solution. 4

Find an initial basic feasible solution of the following transportation problem using Vogel's approximation method : 4

	M_1	M_2	M_3	
O_1	2	7	4	5
O_2	3	3	1	8
O_3	5	4	7	7
O_4	1	6	2	14
	7	9	18	

Solve the following transportation problem so as to find its optimal solution : 6

	D_1	D_2	D_3	D_4	
S_1	2	3	11	7	6
S_2	1	0	6	1	1
S_3	5	8	15	9	10
	7	5	3	2	

Write how you can resolve degeneracy in a transportation problem. 2

Solve using Hungarian method : 6

Man →	*I*	*II*	*III*	*IV*
1	15	13	14	17
2	11	12	15	13
3	13	12	10	11
4	15	17	14	16

(b) How do you solve an unbalanced assignment problem? 2

44. (a) Solve the following game whose payoff matrix is given by

	B_1	B_2	B_3	B_4
A_1	-5	2	1	6
A_2	5	6	4	8
A_3	4	0	1	-3

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(b) Show that the following payoff matrix has no saddle point : 3

		B		
		B_1	B_2	B_3
	A_1	1	3	6
A	A_2	2	1	3
	A_3	6	2	1

45. (a) Solve graphically the game whose payoff matrix is

	B_1	B_2	B_3	B_4
A_1	2	2	3	-1
A_2	4	3	2	6

(b) Transform to LPP :

	B		
	1	-1	-1
A	-1	-1	3
	-1	2	-1