K26U 1305

Reg. No. : .....

Name : .....

IV Semester B.Sc. Honours in Mathematics Degree (CBCSS – OBE – Supplementary/Improvement) Examination, April 2026
(2021 to 2023 Admissions)
4B18 BMH : OPERATIONS RESEARCH

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **any 4** questions out of 5 questions. **Each** question carries **1** mark.

1. Define vertex of a convex set.
2. Define objective function.
3. The number of basic (decision) variables of the general transportation problem at any stage of feasible solution must be _____
4. What is the relation between the number of resources and the number of activities in an assignment problem ?
5. Define pure strategy. **(4×1=4)**

SECTION – B

Answer **any 6** questions out of 9 questions. **Each** question carries **2** marks.

6. Differentiate between convex function and concave function.
7. A company has 3 operational departments (weaving, processing and packing) with capacity to produce 3 different types of clothes namely suiting, shirting and woollen yielding a profit of Rs. 2, Rs. 4 and Rs. 3 per metre respectively. One metre of suiting requires 3 minutes in weaving, 2 minutes in processing and 1 minute in packing. Similarly, one metre of shirting requires 4 minutes in weaving, 1 minutes in processing and 3 minutes in packing. One metre of woollen requires 3 minutes in each department. In a week, total run time of each department is 60, 40 and 80 hours for weaving, processing and packing respectively. Formulate the linear programming problem to find the product mix to maximize the profit.
8. Define slack variable and surplus variable.
9. Determine an initial basic feasible solution to the following transportation problem using North-West Corner method.

	D_1	D_2	D_3	D_4	Availability
O_1	5	3	6	2	19
O_2	4	7	9	1	37
O_3	3	4	7	5	34
Demand	16	18	31	25	

Where O_i and D_j denote i^{th} origin and j^{th} destination respectively.

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10. Define loop in transportation table.
11. Give the mathematical formulation of the assignment problem.
12. Define the following terms in sequencing problem :
    i) Total elapsed time
    ii) Idle time on a machine.
13. Determine whether the following two person zero sum game is strictly determinable :

	Player B	
Player A	5	0
	0	2

14. State the rules for determining the saddle point of a payoff matrix. **(6×2=12)**

SECTION – C

Answer **any 8** questions out of 12 questions. **Each** question carries **4** marks.

15. Prove that the set of all convex combinations of a finite number of points of $S \subseteq R^n$ is a convex set.
16. Use the graphical method to solve the following LPP.
    Minimize $z = -x_1 + 2x_2$ subject to the constraints :
    $-x_1 + 3x_2 \le 10$, $x_1 + x_2 \le 6$, $x_1 - x_2 \le 2$ and $x_1 \ge 0$, $x_2 \ge 0$.
17. a) From simplex table how can we predict the effect of changes in the resources and the profit margins ?
    b) Formulate the dual of the following linear programming problem :
    Maximize $z = 5x_1 + 3x_2$ subject to the constraints :
    $3x_1 + 5x_2 \le 15$, $5x_1 + 2x_2 \le 10$, and $x_1 \ge 0$, $x_2 \ge 0$.
18. Use Vogel's approximation method to obtain an initial basic feasible solution of the transportation problem.

	D	E	F	G	Available
A	11	13	17	14	250
B	16	18	14	10	300
C	21	24	13	10	400
Demand	200	225	275	250	

19. Explain various steps involved in MODI Method.
20. Obtain an initial basic feasible solution to the following transportation problem using Least Cost method.

	D_1	D_2	D_3	D_4	Capacity
O_1	1	2	3	4	6
O_2	4	3	2	0	8
O_3	0	2	2	1	10
Demand	4	6	8	6	

Where O_i and D_j denote i^{th} origin and j^{th} destination respectively.

21. In a factory, there are six jobs to perform, each of which should go through two machines A and B, in the order A, B. The processing timings (in hours) for the jobs are given here. Determine the sequence for performing the jobs that would minimize the total elapsed time T. What is the value of T ?

Job	J_1	J_2	J_3	J_4	J_5	J_6
Machine A	1	3	8	5	6	3
Machine B	5	6	3	2	2	10

22. Explain optimal sequence algorithm for n jobs on k machines.
23. The maintenance crew of a company is divided in two groups, C_1 and C_2, which cares for the maintenance of the machines. Crew C_1 is responsible for replacement of parts which are worn out while Crew C_2 oils and resets the machines back for operation. The times (in hours) required by crews C_1 and C_2 on different machines which need working on them are as follows :

Machine	M_1	M_2	M_3	M_4	M_5	M_6	M_7
Crew C_1	8	6	10	11	10	14	4
Crew C_2	5	3	7	12	8	6	7

In what order should the machines be handled by crews C_1 and C_2 so that the total time taken is minimized ?

24. Explain the Maximin-Minimax Principle for the selection of the optimal strategies by the two players.
25. Consider a "modified" form of "matching biased coins" game problem. The five agencies located in different cities. All of a sudden, there is a demand for the product in another five cities not having any agency of the company. The company is faced with the problem of deciding on how to assign the existing agencies to despatch the product to needy cities in such a way that the travelling distance is minimised. The distance between the surplus and deficit cities (in km) is given in the following table.

		Deficit cities				
		a	b	c	d	e
Surplus Cities	A	85	75	65	125	75
	B	90	78	66	132	78
	C	75	66	57	114	69
	D	80	72	60	120	72
	E	76	64	56	112	68

Determine the optimum assignment schedule.

26. Use matrix oddment method to solve the 3×3 game $\begin{bmatrix} 0 & 1 & 2 \\ 2 & 0 & 1 \\ 1 & 2 & 0 \end{bmatrix}$. **(8×4=32)**

SECTION – D

Answer **any 2** questions out of 4 questions. **Each** question carries **6** marks.

27. Use simplex method to solve the following LPP :
    Maximize $z = 4x_1 + 10x_2$ subject to the constraints :
    $2x_1 + x_2 \le 50$, $2x_1 + 5x_2 \le 100$, $2x_1 + 3x_2 \le 90$; $x_1 \ge 0$, $x_2 \ge 0$.
28. Find the starting solution in the following transportation problem by VAM. Also obtain optimum solution.

	D_1	D_2	D_3	D_4	Supply
S_1	3	7	6	4	5
S_2	2	4	3	2	2
S_3	4	3	8	5	3
Demand	3	3	2	2	

29. A pharmaceutical company is producing a single product and is selling it through five agencies located in different cities. All of a sudden, there is a demand for the product in another five cities not having any agency of the company. The company is faced with the problem of deciding on how to assign the existing agencies to despatch the product to needy cities in such a way that the travelling distance is minimised. The distance between the surplus and deficit cities (in km) is given in the following table.

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	E	76	64	56	112	68

Determine the optimum assignment schedule.

30. Solve the game whose payoff matrix is given by

		Player A		
		A_1	A_2	A_3
Player B	B_1	1	3	1
	B_2	0	–4	–3
	B_3	1	5	–1

(2×6=12)