Reg. No. : ....

Name : ....

IV Semester B.Sc. Honours in Mathematics Degree (C.B.C.S.S.-OBE – Regular/Supplementary/Improvement) Examination, April 2025
(2021 – 2023 Admissions)
4B18 BMH : OPERATIONS RESEARCH

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **any four** questions out of five questions. **Each** question carries **1** mark. **(4×1=4)**

1. Give an example of a convex set.
2. When can you say that a function f(x) is strictly convex ?
3. Define a transportation problem.
4. What is an assignment problem ?
5. What is pure strategy in game theory ?

SECTION – B

Answer **any six** questions out of nine questions. **Each** question carries **2** marks. **(6×2=12)**

6. Show that the function $f(x) = 3x^2$ is convex over R^1.
7. Explain the linear programming problem giving two examples.
8. Define dual. Give any two relationships between a primal and a duel.
9. Write a necessary and sufficient condition for the existence of a feasible solution to a m × n transportation problem.

P.T.O.

10. Write a note on loops in transportation tables.
11. Given below is an assignment problem, write it as a transportation problem.

	A_1	A_2	A_3
R_1	1	2	3
R_2	4	5	1
R_3	2	1	4

12. What is 'no passing' rule in a sequencing algorithm ?
13. Explain the term, 'payoff matrix' in game theory.
14. Explain the maximin principle used in game theory.

SECTION – C

Answer **any 8** questions out of 12 questions. **Each** question carries **4** marks. **(8×4=32)**

15. Prove that the set of all convex combinations of a finite number of points of $S \subset R^n$ is a convex set.
16. Use graphical method to solve the LPP.
Minimize $z = -x_1 + 2x_2$; Subject to the constraints :
$-x_1 + 3x_2 \leq 10, x_1 + x_2 \leq 6, x_1 - x_2, \leq 2, x_1 \geq 0, x_2 \geq 0.$
17. Discuss the various steps involved in the formulation of a primal-dual pair.
18. Obtain an initial basic feasible solution to the following transportation problem using the north-west corner rule :

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

19. Explain MODI method for solving transportation problem.
20. Obtain an initial basic feasible solution to the following transportation problem using the matrix minima method :

Source	1	2	3	4	Availability
1	20	22	17	4	120
2	24	37	9	7	70
3	32	37	20	15	50
Requirement	60	40	30	110	240

21. Explain Hungarian assignment method for solving assignment problem.
22. We have 4 jobs each of which has to go through the machines M_j, j = 1, 2, ...,6 in the order $M_1, M_2, ..., M_6$. Processing time is given below :

	M_1	M_2	M_3	M_4	M_5	M_6
Job A	18	8	7	2	10	25
Job B	17	6	9	6	8	19
Job C	11	5	8	5	7	15
Job D	20	4	3	4	8	12

Determine a sequence of these 4 jobs that minimized the total elapsed time.

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 crew 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

24. Determine whether the following two-person zero sum is strictly determinable and fair. Give optimum strategies for each player in the case of strictly determinable game.

Player B

Player A $\begin{pmatrix} 0 & 2 \\ -1 & 4 \end{pmatrix}$.

25. Determine the range of value of p and q that will make the payoff element a_{22}, a saddle point for the game whose payoff matrix (a_{ij}) is given below.

Player B

Player A $\begin{pmatrix} 2 & 4 & 7 \\ 10 & 7 & q \\ 4 & p & 8 \end{pmatrix}$.

26. In a game of matching coins with two players, suppose A wins one unit of value, when there are two heads, wins nothing when there are two tails and loses $\frac{1}{2}$ unit of value when there are one head and one tail. Determine the payoff matrix, the best strategies for each player and the value of the game to A.

SECTION – D

Answer **any 2** questions out of four questions. **Each** question carries **6** marks. **(2×6=12)**

27. Find the maximum value of $z = 107x_1 + x_2 + 2x_3$ subject to the constraints :
$14x_1 + x_2 - 6x_3 + 3x_4 = 7, 16x_1 + x_2 - 6x_3 \leq 5, 3x_1 - x_2 - x_3 \leq 0,$
$x_1, x_2, x_3, x_4 \geq 0.$
28. Find the starting solution in the following transportation problem by Vogel's Approximation method. Also obtain the 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 departmental head has four subordinates and four tasks to be performed. The subordinates differ in efficiency and tasks differ in their intrinsic difficulty. His estimate of the time each man would take to perform each task is given in the matrix below :

Tasks	Man 1	Man 2	Man 3	Man 4
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

How should the tasks be allocated, one to a man, so as to minimize the total man-hours ?

30. Solve the following 2 × 2 game graphically.

Payer B

Player A $\begin{pmatrix} 2 & 1 & 0 & -2 \\ 1 & 0 & 3 & 2 \end{pmatrix}$.