(b) A car hire company has one car at each of the five depots *a*, *b*, *c*, *d* and *e*. A customer requires a car in each town A, B, C, D and E. Distance (in km.) between depots (origins) and towns (destinations) are given in the following distance matrix :

	a	b	c	d	e
A	160	130	175	190	200
B	135	120	130	160	175
C	140	110	155	170	185
D	50	50	80	80	110
E	55	35	70	80	105

How should cars be assigned to customers so as to minimize the distance travelled? (8)

7. (a) Determine an initial basic feasible solution to the following transportation problem using North-West corner rule :

Origin \ Destination	A_1	B_1	C_1	D_1	E_1	Supply
A	2	11	10	3	7	4
B	1	4	7	2	1	8
C	3	9	4	8	12	9
Demand	3	3	4	5	6	21

(7)

(b) Solve the following (2 × 3) game graphically :

A \ B	I	II	III
I	1	3	11
II	8	5	2

(8)

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May-2026

B.Sc. Mathematics/B.Sc. Mathematics and Computing 6th Semester

Linear Programming Problems

(BMH24-604/MTU-308-V)

Time : 3 Hours] [Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART–A

1. (a) Consider the following LPP :

Maximize $z = 3x_1 + 2x_2$

subject to

$2x_1 + x_2 \leq 2$

$3x_1 + 4x_2 \geq 12$

$x_1, x_2 \geq 0.$

Convert the constraints into equations by introducing slack or surplus variables. (1.5)

(b) Define optimum solution of a linear programming problem. (1.5)

(c) Determine the dual of the following LPP :

Maximize $z = 5x_1 + 12x_2 + 4x_3$

subject to

$$x_1 + 2x_2 + x_3 \leq 10$$
$$2x_1 - x_2 + 3x_3 = 8$$
$$x_1, x_2, x_3 \geq 0.$$

(1.5)

(d) What is the relation between the primal anddual of the dual of a given primal problem? (1.5)

(e) Determine the dual of the following LPP :

Minimize $z = 15x_1 + 12x_2$

subject to

$$x_1 + 2x_2 \geq 3$$
$$2x_1 - 4x_2 \leq 5$$
$$x_1, x_2 \geq 0.$$

(1.5)

(f) Define assignment problem. Give an example. (1.5)

(g) State a necessary and sufficient condition for the existence of a feasible solution of a transportation problem. (1.5)

(h) Define feasible solution and basic feasible solution with reference to the transportation problem. (1.5)

(i) Define two-person zero-sum game. (1.5)

(j) Define saddle point of a payoff matrix. (1.5)

PART–B

2. (a) Solve the following LPP graphically :

Maximize $z = 5x_1 + 4x_2$

subject to

$$6x_1 + 4x_2 \leq 24$$
$$x_1 + 2x_2 \leq 6$$
$$-x_1 + x_2 \leq 1$$
$$x_2 \leq 2$$
$$x_1, x_2 \geq 0.$$

(7)

(b) Solve the following LPP using two-phase method :

Minimize $z = 4x_1 + x_2$

subject to

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

(8)

3. (a) A company makes three products X, Y and Z out of three raw materials A, B and C. The number of units of raw materials required to produce one unit of product is given in the following table :

	X	Y	Z
A	1	2	1
B	2	1	4
C	2	5	1

The unit profit contribution of the products X, Y and Z are Rs. 40, Rs. 25 and Rs. 50, respectively. The number of units of raw materials available are 36, 60 and 45, respectively. Determine the product mix that will maximize the total profit. Through the final simplex table, find the solution to the dual problem. (7)

(b) A department head has four subordinates and four tasks have to be performed. Subordinates differ in efficiency and tasks differ in intrinsic difficulty. Time each man would take to perform each task is given in the effectiveness matrix. How the tasks should be allocated to each person so as to minimize total man hours? (8)

Subordinates

Tasks	I	II	III	IV
A	8	26	17	11
B	13	28	4	26
C	38	19	18	15
D	19	26	24	10

4. (a) Obtain an initial basic feasible solution to the following transportation problem by using Vogel's approximation method : (5)

Store → / Warehouses ↓	I	II	III	IV	Availability
A	7	3	5	5	34
B	5	5	7	6	15
C	8	6	6	5	12
D	6	1	6	4	19
Demand	21	25	17	17	80

(b) Find the initial feasible solution of the following transportation problem :

Warehouse → / Factory ↓	W_1	W_2	W_3	W_4	Factory Capacity
F_1	19	30	50	10	7
F_2	70	30	40	60	9
F_3	40	8	70	20	18
Warehouse Requirement	5	8	7	14	34

Is the solution optimal? If not, obtain the optimal solution. (10)

5. (a) The payoff matrix of a game is given below.

A \ B	I	II	III	IV	V
I	–2	0	0	5	3
II	3	2	1	2	2
III	–4	–3	0	–2	6
IV	5	3	–4	2	–6

Find the solution of the game to the player A and player B. (7)

(b) Two competitors A and B are competing for the same product. Their different strategies are given in the following payoff matrix :

Company B

Company A	I	II	III	IV
I	3	2	4	0
II	3	4	2	4
III	4	2	4	0
IV	0	4	0	8

Use dominance principle to find the optimal strategies. (8)

6. (a) Solve the following LPP : (7)

Maximize $z = 4x_1 + 3x_2 + 6x_3$

subject to

$$2x_1 + 3x_2 + 2x_3 \leq 440$$
$$4x_1 + 3x_3 \leq 470$$
$$2x_1 + 5x_2 \leq 430$$
$$x_1, x_2, x_3 \geq 0.$$ (7)