C 21569 (Pages : 4)

Name..............................

Reg. No..............................

SIXTH SEMESTER B.Sc. DEGREE (SUPPLEMENTARY/IMPROVEMENT) EXAMINATION, MARCH 2017

(UG—CCSS)

Mathematics

MM 6B 13(E02)—LINEAR PROGRAMMING AND GAME THEORY

(2010 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Part I

Answer **all** *questions.*
Each question carries ¼ weightage.

1. Define optimal solution of a Linear Programming Problem.
2. Define degenerate basic feasible solution of an LPP.
3. Define basic variables for an LPP.
4. Write the Standard form of an LPP.
5. Write the Canonical form of Maximization Problem in LPP.
6. What is meant by Integer Liner Programming.
7. In a transportation problem if travelling cost for a destination is not known, it is assumed to be ————.
8. Define a Convex set K in $\mathbb{R}^n$.
9. State True *or* False "If S be convex, then all convex combinations of elements of S lie in S".
10. Define convex hull of a set S in E^n.
11. In a balanced Transportation Problem the basic variables can be at most ————.
12. When will we say that a feasible solution of a Transportation Problem is basic

(12 × ¼ = 3 weightage)

Turn over

Part II

Answer any **nine** *questions.*
Each question carries 1 *weightage.*

13. Solve graphically the LPP.

    Max $z = 5x_1 + 7x_2$, subject to $x_1 + x_2 \leq 4, 3x_1 + 8x_2 \leq 24, 10x_1 + 7x_2 \leq 35,$ Where $x_1 \geq 0, x_2 \geq 0$.

14. Reduce the problem to Canonical form

    Min $z = x_1 + x_2$, subject to $2x_1 - x_2 = 4, 3x_1 + 5x_2 = 10$ and $x_1 \geq 0, x_2 \geq 0$.

15. Verify that $A = \{(x, y) \in \mathbb{R}^2 ; x^2 + y^2 = 1\}$ is a convex set or not.

16. Prove that every hyper plane in $\mathbb{R}^n$ is convex.

17. Find the dual of :

    Max $z = x_1 - x_2 + 3x_3$, subject to $x_1 + x_2 + x_3 \leq 10, 2x_1 - x_3 \leq 2, 2x_1 - 2x_2 + 3x_3 \leq 6$, Where

    $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$.

18. Solve algebraically

    Max $z = 10x_1 + 15x_2$, subject to $x_1 + x_2 = 2, \ 3x_1 + x_2 \leq 6,$ and $x_1 \geq 0, x_2 \geq 0$.

19. Give a counter example to show that "union of two convex sets need not be convex".

20. Find the initial basic feasible solution for the transportation problem using NWCR.

Destination

	21	16	25	13	11
Source	17	18	14	23	13
	32	27	18	41	19
	6	10	12	15	

21. Write the mathematical form of the assignment problem.

22. Use simplex method to solve

    Max $z = 2x_1 + 3x_2$, subject to $x_1 + x_2 \leq 1, 3x_1 + x_2 \leq 4,$ and $x_1 \geq 0, x_2 \geq 0$.

23. Solve the Transportation problem with initial b. f. s. $x_{13} = x_{21} = x_{33} = 3, x_{32} = x_{34} = 2$.

Destination

Source	10	7	3	6	3
	1	6	8	3	5
	7	4	5	3	7
	3	2	6	4	

24. What is meant by a non-degenerate basic feasible solution of a TP.

(9 × 1 = 9 weightage)

Part III

Answer any **five** *questions.*
Each question carries 2 weightage.

25. Show that the set of all feasible solutions of an LPP is a closed convex set.

26. Solve the LPP

Min $z = x_1 - 3x_2 + 2x_3$, subject to $3x_1 - x_2 + 2x_3 \leq 7, -2x_1 + 4x_2 \leq 12, -4x_1 + 3x_2 + 8x_3 \leq 10$, Where $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$.

27. Find a basic feasible solution to the following TP by Vogels Approximation Method.

Destination

Source	5	3	6	4	30
	3	4	7	8	15
	9	6	5	8	15
	10	25	18	7	

28. Food X contains 6 units of Vitamin A and 7 units of vitamin B per gram and cost 12 paise per gram. Food Y contains 8 units and 12 units of A and B per gram respectively and costs 20 paise per gram. The daily requirements of vitamin A and B are at least 100 units and 120 units respectively. Formulate the above as an LPP.

29. Show that $H = \{(x, y) \in \mathbb{R}^2 ; a \leq x \leq b\}$ is a convex set.

30. Prove that the set of all feasible solutions of a system of equation $Ax = b$ is a closed convex set.

31. Use Charne's Method to solve

Max $z = -x_1 - x_2 - x_3$, subject to $x_1 - x_2 + 2x_3 = 2$, $x_1 + 2x_2 - x_3 = 1$,

Where $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$.

32. Solve the assignment problem

	M1	M2	M3	M4	M5
J1	9	3	4	2	10
J2	12	10	8	11	9
J3	11	2	9	0	8
J4	8	0	10	3	7
J5	7	5	6	2	9

(5 × 2 = 10 weightage)

Part IV

Answer **Both** *questions.*
Each question carries 4 *weightage.*

33. Solve the Transportation Problem

Destination

Source	6	1	9	3	70
	11	5	2	8	55
	10	12	4	7	90
	85	35	50	45	

34. Solve the Assignment problem

	M1	M2	M3	M4	M5
J1	11	17	8	16	20
J2	9	7	12	6	15
J3	13	16	15	12	16
J4	21	24	17	28	26
J5	14	10	12	11	15

(2 × 4 = 8 weightage)

C 80032 (Pages : 4) Name..............................

Reg. No..............................

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH/APRIL 2015

(U.G.–CCSS)

Elective Course—Mathematics

MM 6B 13 (E02)—LINEAR PROGRAMMING AND GAME THEORY

(2010 Admission onwards)

Time : Three Hours | Maximum : 30 Weightage

Section A

Answer **all** *questions.*
Each question carries weight ¼.

1. Give the canonical form of a maximization LPP.
2. Is " Maximize $z = 2x_1 + 3x_2$

   subject to $x_1 + x_2 = 5$
   $5x_1 - 2x_2 \geq 3$
   $x_1, x_2 \geq 0$

   in the standard form.
3. State True *or* False : The singleton set is convex.
4. What is the maximum number of basic solutions in a system of 'm' linear non-homogenous equations with 'n' variables ?
5. Define a surplus variable.
6. State the optimality criterion for a basic feasible solution of a Linear Programming Problem.
7. If the primal problem has an unbounded objective function, then the dual has no feasible solution—True *or* False ?
8. Define "penalty" in Cham's method.
9. What is the maximum number of basic variables in a balanced Transportation problem with 'm' rows and 'n' columns ?
10. Consider a 4×4 Transportation Problem. Does the set of cells $\{(1,1),(1,2),(3,2),(3,4),(4,4),(4,1)\}$ form a loop in it.
11. State True *or* False : An Assignment Problem is a special types of Transportation Problem.
12. A non-degenerate basic feasible solution of a Transportation Problem with 'm' rows and 'n' columns has how many zeros.

(12 × ¼ = 3 weightage)

Turn over

Section B

Answer **all** *questions.*
Each question carries weight 1.

13. Reduce to the standard form :

    Minimize $z = x_1 + x_2$

    subject to $2x_1 - x_2 \le 4$
    $3x_1 + 5x_2 \ge 10$
    $x_1 \ge 0, x_2 \ge 0.$

14. Define a hyperplane in the Euclidean plane.
15. State a necessary and sufficient condition for a set S to be convex in E^n.
16. State the Fundamental Theorem of linear programming.
17. Find the dual of

    Minimize $z = 2x_1 + 3x_2 + 4x_3$

    subject to $2x_1 + 3x_2 + 5x_3 \ge 2$
    $3x_1 + x_2 + 7x_3 = 3$
    $x_1 + 4x_2 + 6x_3 \le 5$
    $x_1, x_2 \ge 0, x_3$ unrestricted.

18. Name the method used to solve an LPP when surplus variables arise. Also define 'penalty'.
19. Give the matrix notation of a transportation problem.
20. Find an initial basic feasible solution by NWCR :

	D_1	D_2	D_3	D_4	Supply
O_1	11	13	17	14	250
O_2	16	18	14	10	300
O_3	21	24	13	10	400
Demand	200	225	275	250	

21. Show that a balanced Transportation problem possesses a finite feasible solution and an optimal solution always.

(9 × 1 = 9 weightage)

Section C

Answer any **five** *questions.*
Each question carries weight 2.

22. Solve graphically :

    Maximize $z = x_1 + x_2$

    subject to $2x_1 + 3x_2 \le 6$
    $x_1 - x_2 \le 1$
    $x_1, x_2 \ge 0.$

23. Show that the set of all feasible solutions of a system of equations $A_x = b$ is a closed convex set.

24. Solve by simplex method :

    Maximize $z = x_1 + 5x_2$

    subject to $x_1 + 10x_2 \le 20$
    $x_1 \le 2$
    $x_1, x_2 \ge 0.$

25. Solve

    Maximize $z = 3x_1 + 2x_2 + 3x_3$

    subject to $2x_1 + x_2 + x_3 \le 2$
    $3x_1 + 4x_2 + 2x_3 \ge 8$
    $x_1, x_2, x_3 \ge 0.$

26. Show that the dual of the dual is the primal itself.

27. Find an initial basic feasible solution by VAM :

	D_1	D_2	D_3	Supply
O_1	3	5	7	150
O_2	6	4	10	200
O_3	8	10	3	100
Demand	100	300	50	

28. Solve the following AP to minimize cost :

	I	II	III	IV	V
A	9	8	7	6	4
B	5	7	5	6	8
C	8	7	6	3	5
D	8	5	4	9	3
E	6	7	6	8	5

(5 × 2 = 10 weightage)

Section C

Answer any **two** *questions.*
Each question carries weight 4.

29. Formulate as an LPP and solve : Two types of cloth X and Y are made by a company. Each has to go through processes A and B. Time in hours per unit and total time available are :

	X	Y	Total hours
Process A ..	3	4	24
Process B ..	9	4	36

Profit per unit of X and Y are Rs. 5 and Rs. 6 respectively how many units of X and Y should be produced to maximize profit ?

30. Use Principle of Duality to solve :

Maximize $z = 3x_1 + 2x_2$

subject to $x_1 + x_2 \geq 1$

$x_1 + x_2 \leq 7$

$x_1 + 2x_2 \leq 10$

$x_2 \leq 3$

$x_1, x_2, x_3, x_4 \geq 0.$

31. Solve the following minimization Transportation Problem :

	D_1	D_2	D_3	Supply
O_1	2	7	4	5
O_2	3	3	1	8
O_3	5	4	7	7
O_4	1	6	2	14
Demand	7	9	18	

(2 × 4 = 8 weightage)

C 60114 (Pages : 4) Name..............................

Reg. No..............................

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH 2014

(U.G.–CCSS)

Mathematics

MM 6 B13 (E 02)—LINEAR PROGRAMMING AND GAME THEORY

(2010 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Part I

Answer **all** *questions.*
Each question carries $\frac{1}{4}$ *weightage.*

1. Define a surplus variable.
2. State True *or* False : Every half space determined by a hyperplane is convex.
3. Define a hyperplane in the Euclidean space E^n.
4. What is a degenerate basic solution of the system $AX = B$?
5. In chaines method, what is the cost of the artificial variable called ?
6. In the simplex table of a maximization LPP, a column corresponding to a non-basic variable has all entries ≤ 0 and net evaluation < 0. What does this indicate ?
7. The primal has 2 decision variables and 3 constraints. Then the dual has ——— decision variables and ——— constraints.
8. Write the dual of Min. $z = cx$ subject to $Ax \geq b$, $x \geq 0$.
9. Define a loop in a transportation problem.
10. State True *or* False :

    There exists a balanced Transportation problem without an optimal solution.
11. The number of zero in a non-degenerate basic feasible solution of a balanced TP with 7 sources and 10 destinations is ———.
12. The decision variables of an Assignment problem are :

    (a) 1 only.

    (b) 0 only.

    (c) Either 1 or 0.

    (d) None of these.

($12 \times \frac{1}{4} = 3$ weightage)

Turn over

Part II

Answer any **nine** *questions.*
Each question carries 1 weightage.

13. Write in standard form :

$$\text{Maximize } z = 9x - 6y$$
$$\text{subject to } x - y \geq -1$$
$$x + 5y \leq 10$$
$$x, y \geq 0.$$

14. Show that the set $k = \{(x, y) \in \mathbb{R}^2 ; 5x + 7y = 15\}$ is convex.

15. Show that every hyperplane in $\mathbb{R}^n$ convex.

16. Show that the intersection of an arbitrary family of convex sets is convex.

17. Show with an example that the dual of the dual is the primal.

18. Find the dual of :

$$\text{Maximize } z = x_1 - x_2$$
$$\text{subject to } 2x_1 - x_2 \leq -4$$
$$x_1 + 5x_2 = -2$$
$$x_1, x_2 \geq 0.$$

19. Convert to a minimization problem :

$$\text{Maximize } z = 5x_1 - x_2 + x_3$$
$$\text{subject to } x_1 + 2x_2 + 3x_3 \leq 8$$
$$x_1 - x_2 - x_3 \geq 1$$
$$x_1, x_2, x_3 \geq 0.$$

20. Find an IBFS by NWCR :

	A	B	C	D	
I	21	16	25	13	11
II	17	18	14	23	13
III	32	27	18	41	19
	6	10	12	15	

21. Find an IBFS to the above problem by matrix minimum method.

22. Test the optimality of $x_{11} = 20$, $x_{13} = 10$, $x_{22} = 20$, $x_{23} = 20$, $x_{24} = 10$, $x_{32} = 20$ for the following Transportation problem :

	A	B	C	D	
I	1	2	1	4	30
II	3	3	2	1	50
III	4	2	5	9	20
	20	40	30	10	

23. Give the mathematical form of the Assignment problem.

24. What is a restrictive AP ? How is it tackled ?

(9 × 1 = 9 weightage)

Part III

Answer any **five** *questions.*
Each question carries 2 *weightage.*

25. Show that a set S in E^n is convex iff every convex combination of points in S lies in S.

26. Show that the Basic Feasible Solutions of $Ax = b$ are the extreme points.

27. Explain the computational procedure of the simplex method in simple steps.

28. Solve :

$$\begin{aligned} \text{Minimize} \quad & z = x_1 - 3x_2 + 2x_3 \\ \text{subject to} \quad & 3x_1 - x_2 + 2x_3 \le 7 \\ & -2x_1 + 4x_2 \le 12 \\ & -4x_1 + 3x_2 + 8x_3 \le 10 \\ & x_1, x_2, x_3 \ge 0. \end{aligned}$$

29. Solve :

$$\begin{aligned} \text{Maximize} \quad & z = 2x_1 - 3x_2 \\ \text{subject to} \quad & -x_1 + x_2 \ge -2 \\ & 5x_1 + 4x_2 \le 46 \\ & 7x_1 + 2x_2 \ge 32 \\ & x_1, x_2 \ge 0. \end{aligned}$$

30. Find an IBFS by VAM and test for optimality :

	A	B	C	D	
I	19	30	50	10	7
II	70	30	40	60	9
III	40	8	70	20	18
	5	8	7	14	

31. Solve the Assignment problem to minimize cost :

	1	2	3	4
I	12	30	21	15
II	18	33	9	31
III	44	25	24	21
IV	23	30	28	14

32. Prove that in a balanced Transportation problem, there can be at the most $m + n - 1$ basic variables. (m – *no* : of sources, n – *no* : of destinations).

(5 × 2 = 10 weightage)

Part IV

Answer **both** *questions.*
Each question carries 4 *weightage.*

33. Find an optimal solution to the following Transportation problem :

	A	B	C	D	E	
I	5	8	6	6	3	80
II	4	7	7	6	6	50
III	8	4	6	6	3	90
IV	0	0	0	0	0	30
	40	40	50	40	80	

34. Solve the following maximization Assignment problem :

	1	2	3	4	5
A	9	3	4	2	10
B	12	10	8	11	9
C	11	2	9	0	8
D	8	0	10	3	7
E	7	5	6	2	9

(2 × 4 = 8 weightage)

C 60115 (Pages : 4) Name..................................

Reg. No..................................

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH 2014

(U.G.–CCSS)

Mathematics (Elective)

MM 6B 13 (02)—LINEAR PROGRAMMING AND GAME THEORY

(2009 admissions)

Time : Three Hours Maximum : 30 Weightage

Part I

Answer **all** *questions.*

1. In a mathematical programming problem, the function to be maximized or minimized is called an ——————.
2. Define a convex set in $\mathbb{R}^n$.
3. State True *or* False : The union of two convex sets is convex.
4. What is the standard form of an L.P.P. ?
5. What is the optimality condition for the BFS of a maximization L.P.P. to be optimal ?
6. Dual of the dual is the ——————.
7. When is a transportation problem said to be balanced ?
8. At most how many basic variables can be there in a balanced transportation problem with 'n' destinations and 'm' sources.
9. State True *or* False : The Assignment problem is a special case of the transportation problem.
10. Define "two person zero sum" game.
11. Define "Lower value" of a two person zero sum game.
12. What is a fair game ?

(12 × ¼ = 3 weightage)

Part II

Answer any **nine** *questions.*

13. Write the Canonical form of the maximization L.P.P.
14. Show that the set $K = \{(x, y) \in \mathbb{R}^2 ; x + 7y = 12\}$ is convex.
15. Show that every hyperplane in $\mathbb{R}^n$ is convex.

Turn over

16. Show that an optimal solution of :

Minimize $Z = cx$

subject to $Ax = b, x \geq 0$ is also an optimal solution of :

Maximize $Z' = -cx$

subject to $Ax = b, x \geq 0$.

17. Find the dual of :

Maximize $Z = 2x_1 - x_2$

subject to $x_1 + 2x_2 \leq 4$

$3x_1 - x_2 \geq 3$

$x_1 \geq 0, x_2$

unrestricted.

18. Give the mathematical form of the Transportation Problem (T.P.)

19. Find an 1 BFS by NWCR.

	A	B	C	D	
I	21	16	25	13	11
II	17	18	14	23	13
III	32	27	18	41	19
	6	10	12	15	

20. Find an IBFS to the above transportation problem by Matrix Minima method.

21. Explain briefly the method to solve a maximization assignment problem.

22. State and prove the fundamental theorem of Game theory.

23. What is the saddle point of the following game ?

$$\begin{bmatrix} 1 & 7 & 3 & 4 \\ 5 & 6 & 4 & 5 \\ 7 & 2 & 0 & 3 \end{bmatrix}$$

24. Differentiate between pure strategy and mixed strategy.

(9 × 1 = 9 weightage)

Part III

Answer any **five** *questions.*

25. State and prove a necessary and sufficient condition for a set 'S' in E^n to be convex.

26. Show that the extreme of the set of feasible solutions of $Ax = b$ are the basic feasible solutions.

27. Solve by simplex method :

Maximize $Z = 4x_1 + 7x_2$

subject to $2x_1 + x_2 \leq 1000$

$x_1 + x_2 \leq 600$

$-x_1 - 2x_2 \geq -1000$

$x_1, x_2 \geq 0.$

28. Solve : Minimize $Z = 4x_1 + 3x_2$

subject to $x_1 + 2x_2 \geq 8$

$3x_1 + 2x_2 \geq 12$

$x_1, x_2 \geq 0.$

29. Find an IBFS by VAM and test for optimality :

	A	B	C	
I	5	1	8	12
II	2	4	0	14
III	3	6	7	4
	9	10	11	

30. Find an optimal assignment to minimize cost :

	M_1	M_2	M_3
J_1	12	24	15
J_2	23	18	24
J_3	30	14	28

31. Prove that the set of optimal strategies of a player in a two person zero sum game is a convex set.

32. Use the principle of dominance to reduce the following pay-off matrix :

Player B

		B_1	B_2	B_3
Player A	A_1	1	2	–1
	A_2	3	1	2
	A_3	–1	3	2

(5 × 2 = 10 weightage)

Part IV

Answer **both** *questions.*

33. Four new machines M_1, M_2, M_3 and M_4 are to be installed in four vacant plots A, B, C, D. M_2 cannot be placed at C and M_3 cannot be placed at A. The assignment cost in rupees are :

	A	B	C	D
M_1	9	11	15	10
M_2	12	9	–	10
M_3	–	11	14	11
M_4	14	8	12	7

Obtain an optimal solution that minimizes cost.

34. Solve the following two person zero sum game :

Player B

$$\text{Player A} \begin{array}{c} \\ A_2 \\ A_4 \end{array} \begin{array}{c} \begin{array}{cc} B_1 & B_2 \end{array} \\ \begin{bmatrix} a & -b \\ -c & d \end{bmatrix} \end{array} ; a, b, c, d > 0.$$

(2 × 4 = 8 weightage)

C 40401

(Pages : 4)

Name.....................................

Reg. No..................................

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH 2013

(CCSS)

Mathematics—(Elective Course)

MM 6B 13 (E 02)—LINEAR PROGRAMMING AND GAME THEORY

(2009 Admissions)

Time : Three Hours

Maximum : 30 Weightage

Part I

Answer **all** *questions.*

1. Maximum $Z = 2x_1 + 3x_2$ subject to $x_1 - x_2 \leq 5,\ 3x_1 + 2x_2 \geq 1,\ x_1 \geq 0,\ x_2 \geq 0$ is a :
   - (a) Linear programming problem.
   - (b) Quadratic programming problem.
   - (c) Transportation problem.
   - (d) Assignment problem.
2. Define an objective function of a linear programming problem.
3. What is a slack variable ?
4. Which of the following is a convex set in R^2 ?
   - (a) $\{(1, 0), (0, 1)\}$.
   - (b) $\{(x, y) / y = \sin x\}$.
   - (c) $\{(x, y) / x^2 + y^2 = 1\}$.
   - (d) $\{(x, y) / a \leq x \leq b\}$.
5. Define a convex hull of a set in E^n.
6. Define a convex combination of the vectors $a_1, a_2, ...a_n$ in R^n.
7. Write an ortho normal basis of R^3.
8. Find a basic feasible solution of $x_1 + 2x_2 - x_3 + x_4 = 4,\ x_1 - x_2 + 2x_3 - x_4 = -2$ taking x_3 and x_4 as non-basic variables.
9. The set $\{(x, y) \in E^2 / 2x - y > 0\}$ is :
   - (a) Closed and bounded.
   - (b) Closed and convex.
   - (c) Open and convex.
   - (d) Compact and convex.
10. What is a zero-sum game ?

Turn over

11. Determine the dual of :

Minimize $Z = 4x_1 - x_2$

subject to

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

12. Define a translate of set S in a vector space.

($12 \times \frac{1}{4} = 3$ **weightage**)

Part II

Answer **all** *questions.*

13. Show that (1, 1, 0), (0, 2, 1) and (1, –1, 2) is a linearly independent set.
14. Express (1, 3) as a linear combination of (1, 2) and (2, 3).
15. Find a feasible solution of the system :

$$x_1 + 2x_2 = 10, \; x_1 + x_3 = 4$$
$$x_1 \geq 0, \; x_2 \geq 0, \; x_3 \geq 0.$$

16. Prove that intersection of two convex set is convex.
17. Rewrite the following L.P.P. in the standard form :

Maximize $Z = 3x - 2y$

subject to

$$x - y \leq 1,$$
$$3x - 2y \leq 6,$$
$$x \geq 0,$$
$$y \geq 0.$$

18. Obtain the dual of the L.P.P. :

Maximize $Z = 3x_1 + 4x_2$

subject to

$$x_1 - x_2 \leq 1,$$
$$x_1 + x_2 \geq 4,$$
$$x_1 - 3x_2 \leq 3, \text{ and}$$
$$x_1 \geq 0,$$
$$x_2 \geq 0.$$

19. State the fundamental theorem of Game theory.
20. Give an example of a balanced transportation problem.
21. Find a non-degenerate basic feasible solution of the system

$$x_1 + 2x_2 - x_3 + x_4 = 4$$
$$x_1 - x_2 + 2x_3 - x_4 = 2.$$

(9 × 1 = 9 weightage)

Part III

Answer any **five** *questions.*

22. Find graphically the feasible space of the following in equations :

$$x_1 + 2x_2 \leq 7,\ x_1 - x_2 \leq 4,\ \ x_1 \geq 0,\ \ x_2 \geq 0.$$

23. Show that the points (1, 2, 1) (2, 3, 0) and (1, 2, 2) form a basis for E^3.
24. Prove that convex hull of a set S in E^n consists of all convex combination of elements of S.
25. Find the convex hull of the set

S = {(1, 2) (3, 7) (2, –1)}.

26. Prove that if a constant is added to any row or column of the cost matrix of an assignment problem, an optimal solution of the original problem remains optimal for the new problem.
27. Using north-west corner rule find an initial solution to the transportation problem :

	D_1	D_2	D_3	
O_1	2	1	3	8
O_2	1	4	5	5
O_3	2	3	4	7
	6	9	5	

28. A company has 3 senior executives. Each is judged against each of the 3 positions and their rating are given by :

Position

Executives		I	II	III
	E_1	7	5	6
	E_2	8	4	7
	E_3	9	6	4

Assign each executive to one position so that sum of ratings for all 3 is highest.

(5 × 2 = 10 weightage)

Part IV

Answer any **two** *questions.*

29. Solve by principle of duality :

Maximize $Z = 3x_1 - 2x_2$

subject to

$$x_1 \le 4, \quad x_2 \le 6,$$
$$x_1 + x_2 \le 5, \quad x_2 \ge 1$$
$$x_1 \ge 0, \quad x_2 \ge 0.$$

30. Find a basic solution by Vogel's approximation method :

	D_1	D_2	D_3	D_4	
O_1	6	1	9	3	70
O_2	11	5	2	8	55
O_3	10	12	4	7	90
	85	35	50	45	

31. Solve the game using principle of Dominance :

Player B

Player A				
	3	2	4	0
	3	4	2	4
	4	2	4	0
	0	4	0	8

(2 × 4 = 8 weightage)