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Linear Programming

IFoS (IFS) Previous Year Questions (PYQ) from 2025 to 2009

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IAS, UPSC, IFS, IFoS, CIVIL SERVICE MAINS EXAMS MATHS OPTIONAL STUDY MATERIALS

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2025

1. The forest department aims to afforest up to 100 hectares with teak and pine to maximize CO_2 absorption, planting at least 10 hectares of each, and no more than 60 hectares of teak. The table below provides the CO_2 absorption and resource requirements: **[8 Marks]**

Tree	CO_2 Absorption (tons/ha/year)	Labour (hours/ha/week)	Water (litres/ha/week)
Teak	20	40	200
Pine	15	20	150

The available resources are 3200 labour hours and 16000 litres of water per week. Formulate this as a linear programming problem.

2. Solve the following linear programming problem by simplex method: **[15 Marks]**

Maximize $Z = 3x_1 + 2x_2 + 3x_3$
subject to

$$x_1 + x_2 + x_3 \leq 4, \qquad 2x_1 + x_2 + 3x_3 \leq 10, \qquad x_1 + 2x_2 + x_3 \leq 6,$$

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

Is the solution unique? If not, find all the optimal solutions.

3. A company has 5 workers A, B, C, D, E and 4 jobs I, II, III, IV. The profit (in rupees) that each worker earns from completing each job is given in the table below: **[15 Marks]**

Worker / Job	I	II	III	IV
A	17	20	18	21
B	19	16	17	20
C	16	15	20	18
D	18	17	15	16
E	14	19	13	15

Assign each job to exactly one worker in such a way that the profit is maximized.

2024

4. Find all optimal solutions of the following linear programming problems graphically: **[5+3 Marks]**

(i) Maximize $z = 3x_1 + 6x_2$ subject to

$$x_1 + x_2 \leq 8, \qquad x_1 - x_2 \leq 4, \qquad 2x_1 - x_2 \geq 4, \qquad x_1, x_2 \geq 0.$$

(ii) The LPP in part (i) with the first constraint $x_1 + x_2 \leq 8$ changed to $x_1 + 2x_2 \leq 12$.

5. Solve the LPP by the simplex method: **[15 Marks]**

Maximize $z = 2x_1 + x_2 + x_3$
subject to

$$x_1 + 2x_2 - x_3 \leq 3, \qquad x_1 - 2x_2 - 5x_3 \geq -9, \qquad x_1, x_2, x_3 \geq 0.$$

Write its dual problem and from the optimal table of the given problem, obtain the optimal solution of the dual problem.

6. Find the initial basic feasible solution of the following minimum cost transportation problem by Vogel's Approximation Method (VAM). Using it, find the optimal solution and the minimum transportation cost. Is the optimal solution unique? If not, find an alternative optimal solution. **[15 Marks]**

Origin / Destination	D_1	D_2	D_3	D_4	Availability
O_1	3	5	8	2	50
O_2	5	7	2	9	40
O_3	7	1	3	4	30
Demand	40	35	25	20	

2023

7. Prove that $x_1 = 2,\ x_2 = 1,\ x_3 = 0$ is a feasible solution to the following set of equations: **[8 Marks]**

$$2x_1 - x_2 + 3x_3 = 3, \qquad -6x_1 + 3x_2 + 7x_3 = -9.$$

Is the solution basic? Justify your answer. If the solution is not basic, reduce it to a basic feasible one.

8. Consider the LPP: **[15 Marks]**

Minimize $z = 10x_1 + 2x_2$
subject to

$$x_1 + 2x_2 + 2x_3 \geq 1, \qquad x_1 - 2x_3 \geq -1, \qquad x_1 - x_2 + 3x_3 \geq 3,$$

$$x_i \geq 0, \quad \text{for } i = 1, 2, 3.$$

Solve the dual of the above LPP and find the minimum value of z.

9. Five workers perform five jobs and the operating cost is given below, but there is a restriction that the worker C cannot perform the third job and B cannot perform the fifth job. Find the optimal assignment and the optimal assignment cost. **[15 Marks]**

Worker / Job	I	II	III	IV	V
A	24	29	18	32	19
B	17	26	34	22	–
C	27	16	–	17	25
D	22	18	28	30	24
E	28	16	31	24	27

2022

10. Prove that the linear programming problem **[8 Marks]**

Maximize $z = 3x_1 + 2x_2$
subject to the constraints

$$2x_1 + x_2 \leq 2, \qquad 3x_1 + 4x_2 \geq 12, \qquad x_1, x_2 \geq 0,$$

does not admit an optimum basic feasible solution.

11. Employ duality to solve the following linear programming problem: **[15 Marks]**

Maximize $z = 2x_1 + x_2$
subject to the constraints

$$x_1+2x_2 \leq 10, \qquad x_1+x_2 \leq 6, \qquad x_1-x_2 \leq 2, \qquad x_1-2x_2 \leq 1, \qquad x_1, x_2 \geq 0.$$

12. Find the initial basic feasible solution to the following transportation problem by the North-West corner rule and then optimize it. **[15 Marks]**

From / To	**D_1**	**D_2**	**D_3**	**Availability**
1	7	3	4	2
2	2	1	3	3
3	3	4	6	5
Demand	4	1	5	10

2021

13. An automobile dealer wishes to put four repairmen R_1, R_2, R_3 and R_4 to four different jobs J_1, J_2, J_3 and J_4. But R_3 cannot do the job J_2. The dealer has estimated the number of man-hours that would be required for each job-man on one-one basis as given in the following table: **[8 Marks]**

Job / Repairman	**R_1**	**R_2**	**R_3**	**R_4**
J_1	6	2	3	4
J_2	9	7	–	5
J_3	6	4	7	5
J_4	6	8	8	9

Formulate the above as a Linear Programming Problem.

14. Consider the following Linear Programming Problem as primal: **[15 Marks]**

Minimize $z = 30x_1 + 20x_2$
s/t,

$$3x_1 + 5x_2 \geq 100, \qquad 2x_1 + x_2 \geq 120, \qquad 5x_1 + 3x_2 \geq 90, \qquad x_1, x_2 \geq 0.$$

Then using the principle of duality, find the optimal solution of the primal.

15. Starting with Least Cost Method, find all the solutions to the following transportation problem: **[15 Marks]**

Plants / Warehouses	**I**	**II**	**III**	**IV**	**Supply**
A	8	6	5	3	18
B	6	7	6	8	20
C	10	8	4	5	18
Demand	15	16	12	13	