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BRAINWARE UNIVERSITY

Term End Examination 2025-2026

Programme – B.Tech.(CSE)-DS-2022/B.Tech.(CSE)-DS-2023/B.Tech.(CSE)-2023

Course Name – Operational Research

Course Code - OEC-CSD601C/OEC-CSG601C

(Semester VI)

Full Marks : 60

Time : 2:30 Hours

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question)

1 x 15=15

1. Choose the correct alternative from the following :

(i) If the primal (maximization) has an objective function value of 100 at the optimum, select the TRUE option.

- | | |
|---|---|
| a) Dual has an objective function value greater than 100 at optimum | b) Dual has an objective function value lesser than 100 at optimum |
| c) Dual has an objective function value equal to 100 at optimum | d) Dual's objective function value at optimum does not depend on the objective function value of the primal |

(ii)

Consider the napkins problem where the requirement is for 20 days. There are two types of laundries – fast and slow. The fast laundry takes 2 days (napkins sent at the end of day 1 can be used on day 3) and the slow laundry takes 3 days (napkins sent at the end of day 1 can be used on day 4). The costs of the new napkins and the two laundries are known. Identify the correct option. The objective function has _____ terms.

- | | |
|-------|-------|
| a) 54 | b) 55 |
| c) 56 | d) 57 |

- (iii) An investor has Rs 20 lakhs with her and considers three schemes to invest the money for one year. The expected returns are 10%, 12% and 15% for the three schemes per year. The third scheme accepts only up to 10 lakhs. The investor wants to invest more money in scheme 1 than in scheme 2. The investor assesses the risk associated with the three schemes as 0 units, 10 units and 20 units per lakh invested and does not want her risk to exceed 500 units. Identify the correct option. How many greater than or equal to constraints are in your formulation. (To answer this question you should write your constraints such that the right hand side value is non-negative).

a) 1
c) 3

b) 2
d) 4

- (iv) Identify the wrong one.

a) slack variables are used to convert the inequalities of the type 'less than or equal to' into equations
c) all LPP with all its constraints are of the type 'greater than or equal to' is said to be in standard form

b) surplus variables are used to convert the inequalities of the type 'greater than or equal to' into equations
d) an LPP with all its constraints are of the type 'less than or equal to' is said to be in canonical form

- (v) Solve the LP problem

Maximize $4X_1 + 3X_2 + 5X_3$

subject to

$$X_1 + X_2 + X_3 \leq 10$$

$$2X_1 + X_2 + 3X_3 \leq 20$$

$$3X_1 + 2X_2 + 4X_3 \leq 30$$

$X_1, X_2, X_3 \geq 0$ using the simplex algorithm and answer the following questions. If you have a tie to decide a leaving variable, break the tie arbitrarily. Identify the correct option. The total number of " $C_j - Z_j$ values are zero at the optimum" is

a) 1
c) 3

b) 2
d) 4

- (vi) You are given an LP problem with three variables and two constraints. You have to find the value of the objective function at the optimum. Choose the best way to do it using hand calculations.

a) It is possible to write the dual and solve it using the graphical method. The value of the objective function at the dual is the same as that of the primal

b) Write the dual and solve it by the graphical method. Apply complimentary slackness to find the primal solution and then evaluate the objective function.

c) Solve the given primal by simplex algorithm

d) Use the algebraic method.

- (vii) Two tasks have to be completed and require 10 hours and 12 hours of work if one person does the tasks. If n people do task 1, the time to complete the task becomes $10/n$ and so on. Similarly, if n people do task 2, the time becomes $12/n$ and so on. We have 5 people and they have to be assigned to the two tasks. We cannot assign more than three to task 1. Find the earliest time that both tasks are completed if they start at the same time. (Use ideas from the bicycle problem to write your objective function. At some point you may have to define a variable to represent the

reciprocal of another variable). Formulate an LP problem and choose the correct option. The final objective function is

- a) Maximization problem with one term in the objective function
- b) Minimization problem with one term in the objective function
- c) Maximization problem with two terms in the objective function
- d) Minimization problem with two terms in the objective function

(viii) Consider the LP problem

$$\text{Minimize } 3X_1 + 8X_2$$

subject to

$$3X_1 + 5X_2 \geq 16$$

$$5X_1 + 3X_2 \geq 12$$

$$X_1, X_2 \geq 0.$$

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Select the correct option. The number of artificial variables required to initialize the simplex table is ____

- a) 1
- b) 2
- c) 3
- d) 4

(ix) Identify the correct option. A constraint that does not affect the feasible region is a

- a) non-negativity constraint
- b) slack constraint
- c) redundant constraint
- d) standard constraint

(x) Consider the LP problem:

$$\text{Maximize } 7X_1 + 6X_2$$

subject to

$$X_1 + X_2 \leq 4$$

$$2X_1 + X_2 \leq 6$$

$$X_1, X_2 \geq 0.$$

Solve using the algebraic form of the simplex algorithm and answer the following: Select the correct option. When X_2 enters the solution, the value it takes is ____

- a) 1
- b) 2
- c) 3
- d) 4

(xi) An iso-profit line can be explained as

- a) an infinite number of solutions all of which yield same profit.
- b) an infinite number of optimum solutions
- c) An infinite number of solutions all of which yield the same cost.
- d) a boundary line of the feasible region.

(xii) Select from below:

Operations Research achieved recognition as a subject of academic study in the year

- a) 1949
- b) 1950
- c) 1953
- d) 1957

(xiii) Select the correct option. "Operations Research approach is"

- a) intuitive
- b) objective
- c) multi-disciplinary
- d) all of these

(xiv) Choose the correct option: In duality, the dual of the dual problem is

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(Short Answer Type Questions)

2. Identify all the basic feasible solution of the system of equations (3)

3. A firm can produce three types of cloths say A, B and C. Three kinds of wools are required for it, say red wool, green wool and blue wool. One length of type A cloth needs 2 yards of red wool and 3 yards of green wool; One-unit length of type B cloth needs 3 yards of red wool, 2 yards of green wool and 2 yards of blue wool and one unit of type C cloth need 5 yards of green wool and 4 yards of blue wool. The firm has only a stock of 8 yards of red wool, 10 yards of green wool and 15 yards of blue wool. It is assumed that the income from the cloths are Rs 2.00, Rs. 3.00 and Rs. 4.00 respectively. Illustrate a LPP to maximize the profit. (3)

4. Write the dual of the following L. P. P: (3)

subject to: $3x_1 + 5x_2 \leq 20$

$$2x_1 + x_2 \geq 40 \quad \text{and } x_1, x_2 \geq 0$$

- $$Maxz = 4x_1 + 3x_2$$

$$2x_1 + 3x_2 \leq 8$$

$$3x_1 + 2x_2 \leq 12$$

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6. Use Graphical Method to solve the LPP (3)

$$\text{Max } z = -2x_1 + x_2$$

subject to

$$\begin{aligned}x_1 + 2x_2 &\leq 10 \\x_1 + x_2 &\leq 6 \\x_1 - x_2 &\leq 2 \\x_1 - 2x_2 &\leq 1 \\x_1, x_2 &\geq 0\end{aligned}$$

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OR

- Use Graphical Method to solve the LPP (3)

$$\text{Max } z = -2x_1 + x_2$$

subject to

$$\begin{aligned}x_1 + 2x_2 &\leq 10 \\x_1 + x_2 &\leq 6 \\x_1 - x_2 &\leq 2 \\x_1 - 2x_2 &\leq 1 \\x_1, x_2 &\geq 0\end{aligned}$$

Group-C

(Long Answer Type Questions)

5 x 6=30

7. Describe the historical development of Operations Research. (5)
8. Illustrate the L.P.P in standard maximization form: (5)

$$\text{Max } z = x_1 + 3x_2 + 6x_3$$

Subject to

$$\begin{aligned}2x_1 + x_2 + 7x_3 &\leq 40 \\x_1 + 9x_2 - 5x_3 &\geq 70 \\5x_1 + 3x_3 &= 150 \\3x_2 + 4x_3 &\leq 100 \\ \text{for } x_1, x_2, x_3 &\geq 0.\end{aligned}$$

9. A small-scale delivery service has to transport goods using two types of vehicles: (5)
Truck A and Truck B. Truck A can carry 3 tons, and Truck B can carry 5 tons. The company has 30 drivers, and each Truck A requires 1 driver, while each Truck B requires 2 drivers. The company earns ₹2000 per trip for Truck A and ₹3500 per trip for Truck B. Estimate the solution of this problem graphically to maximize revenue.

10. Given the constraints:

$$2x+y \leq 10,$$

$$x+3y \leq 15,$$

$$x, y \geq 0$$

(5)

Estimate the feasible region and evaluate the corner points. Also, test if the function $Z=4x+3y$ attains its maximum at any of these points.

11. Estimate the optimal solution of the following L.P.P by applying the Charne's Big-M method:

(5)

$$\text{Min } z = 4x_1 + x_2$$

Subject to the constraint

$$3x_1 + x_2 = 3$$

$$4x_1 + 3x_2 \geq 6$$

$$x_1 + 2x_2 \leq 4$$

$$\text{for } x_1, x_2 \geq 0$$

12. Solve the following LPP and check if it has multiple optimal solutions:

(5)

Maximize

$$Z = 6x + 4y$$

Subject to:

$$2x + y \leq 10,$$

$$x + 2y \leq 10,$$

$$x \geq 0, y \geq 0.$$

OR

A dietitian wants to minimize the cost of a diet consisting of two foods, F1 and F2. Each unit of F1 costs ₹10 and contains 2 units of protein and 4 units of carbohydrates. Each unit of F2 costs ₹15 and contains 3 units of protein and 2 units of carbohydrates. The diet must have at least 12 units of protein and 16 units of carbohydrates. Formulate the LPP to minimize the cost.

(5)
