

balanced. During the peak sales period in the first week of November, both stores plan to run promotional campaigns via newspaper, radio, or television. The gain in customers for ElectroMart (and corresponding loss for TechHub) depends on the advertising strategies used by both. This gain/loss is summarized in the following payoff matrix (values indicate the gain or loss of customers for ElectroMart):

|              |            | TechHub   |       |            |
|--------------|------------|-----------|-------|------------|
|              |            | Newspaper | Radio | Television |
| Electro Mart | Newspaper  | 30        | 40    | -80        |
|              | Radio      | 0         | 15    | -20        |
|              | Television | 90        | 20    | 50         |

Determine the optimal advertising strategies for both ElectroMart and TechHub and calculate the value of the game. (9)

6. Short Notes on any **four**: (4.5\*4)

- (i) Fundamental Matrix of Markov Chains
- (ii) Pay-off and regret functions
- (iii) Beta Distribution of Activity Times in PERT
- (iv) Saddle Point (Game Theory)
- (v) MODI Method

(1000)

[This question paper contains 8 printed pages.]

**Your Roll No.....**

**Sr. No. of Question Paper : 6036**

**J**

Unique Paper Code : 2922103601

Name of the Paper : Operations Research

Name of the Course : **B.A. (H) Business Economics (2025)**

Semester : VI

Duration : 3 Hours

Maximum Marks : 90

### Instructions for Candidates

1. Write your Roll. No. on the top immediately on receipt of this question paper.
2. Attempt **any five** questions.
3. The use of a basic calculator and standard Z Table is permitted for solving relevant questions.
4. If any value is missing in a question, assume a reasonable value, clearly state your assumption, and proceed with the solution accordingly.

P.T.O.

1. (a) A company produces two products, A and B. Each unit of product A consumes 3 kg of raw material and requires 2 labour hours for processing. In comparison, each unit of product B requires 2 kg of raw materials and 3 labour hours. The firm has a daily availability of 70 kg of raw material and 80 labour hours. The profit from selling one unit of product A is Rs 50, while each unit of product B yields a profit of Rs 40. Formulate and solve this as a linear programming problem (LPP) using simplex method to find the optimal number of units of each product that should be manufactured daily in order to maximize profit. (14)

OR

Consider the following problem and optimum table given along with that:

**Maximize:**

$$Z = x_1 + 4x_2$$

**Subject to:**

$$2x_1 + 4x_2 \leq 7$$

$$5x_1 + 3x_2 \leq 15$$

$x_1, x_2 \geq 0$ , and are integers

Assuming no further changes in consumer buying habits:

1. What will be the market shares of the three brands at the end of the first and second year?
  2. What will be the long-run (steady-state) market shares of Alpha, Beta, and Corex? (9)
5. (a) Write the dual of the following Linear Programming Problem:

**Maximize**

$$Z = 1600X_1 + 1500X_2 + 3000X_3$$

**Subject to:**

$$X_1 \leq 500$$

$$X_2 \leq 800$$

$$X_3 \leq 300$$

$$1.5X_1 + 1.5X_2 + 3.0X_3 \leq 4200$$

$$2.0X_1 + 2.0X_2 + 4.0X_3 \leq 3600$$

$$X_1, X_2, X_3 \geq 0$$

(9)

- (b) In a small town, two competing electronics stores- ElectroMart and TechHub - operate and sell similar products at the same price. The local market consists of a fixed number of customers equally divided between the two stores. Both brands enjoy a good reputation, and customer loyalty is fairly

|                |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|
| Cakes Demanded | 0    | 1    | 2    | 3    | 4    | 5    |
| Probability    | 0.05 | 0.10 | 0.20 | 0.30 | 0.20 | 0.15 |

- (i) How many cakes should the bakery prepare each day to minimize the expected total cost?
- (ii) Calculate the Expected Value of Perfect Information (EVPI)

The owner is considering conducting a local customer survey to better forecast daily demand. What is the maximum amount they should be willing to spend on such a survey? (9)

- (b) Suppose three smartphone brands - Alpha, Beta, and Corex - launched their flagship models at the same time and initially captured equal shares of the market. However, during the first year, customer loyalty and switching trends were observed as follows:

- Alpha retained 90% of its customers, but lost 3% to Beta and 7% to Corex.
- Beta retained 70% of its customers, but lost 10% to Alpha and 20% to Corex.
- Corex retained 80% of its customers, but lost 10% to Alpha and 10% to Beta.

| Cj | Basic Variable | Bi   | 1     | 4     | 0     | 0     |
|----|----------------|------|-------|-------|-------|-------|
|    |                |      | $x_1$ | $x_2$ | $S_1$ | $S_2$ |
| 4  | $x_2$          | 7/4  | 1/2   | 1     | 1/4   | 0     |
| 0  | $S_2$          | 39/4 | 7/2   | 0     | -3/4  | 1     |
|    | Z              | 7    | 2     | 4     | 1     | 0     |

Solve Integer Programming Problem using Gomory's cutting plane algorithm. (14)

- (b) Explain the assumptions of Linear Programming. Critically evaluate how realistic these assumptions are in real-world business situations. (4)

2. (a) A small garment making unit has five tailors stitching five different types of garments. All the five are capable of stitching all five types of garments. The output per day per tailor and the profit (Rs.) for each type of garment are given below:

| Tailors              | Garments |   |    |    |    |
|----------------------|----------|---|----|----|----|
|                      | 1        | 2 | 3  | 4  | 5  |
| A                    | 7        | 9 | 4  | 8  | 6  |
| B                    | 4        | 9 | 5  | 7  | 8  |
| C                    | 8        | 5 | 2  | 9  | 8  |
| D                    | 6        | 5 | 8  | 10 | 10 |
| E                    | 7        | 8 | 10 | 9  | 9  |
| Profit/Garment (Rs.) | 2        | 3 | 2  | 3  | 4  |

Which type of garment should be assigned to which tailor to maximize profit? (9)

(b) A product is produced by four factories A, B, C and D. The unit costs of production in these factories are Rs. 2, Rs. 3, Re. 1 and Rs. 5 respectively. The production capacities are:

Factory A-50 units, B- 70 units, C- 30 and D-50 units. These factories supply the product to four stores, 1, 2, 3, 4 the demands of which are 25, 35, 105 and 20 units respectively. Unit transportation costs in rupees from each factory to each store is given in the table below.

| Factories | Stores {Unit Transportation Costs (Rs.)} |   |   |    |
|-----------|------------------------------------------|---|---|----|
|           | 1                                        | 2 | 3 | 4  |
| A         | 2                                        | 4 | 6 | 11 |
| B         | 10                                       | 8 | 7 | 5  |
| C         | 13                                       | 3 | 9 | 12 |
| D         | 4                                        | 6 | 8 | 3  |

Determine the extent of deliveries from each of the factories to each of the stores so that the total production and transportation cost is minimum. (9)

3. A project consists of following activities with the following relevant information:

| Activity | Immediate Predecessor | Estimated Duration (days) |             |             |
|----------|-----------------------|---------------------------|-------------|-------------|
|          |                       | Optimistic                | Most Likely | Pessimistic |
| A        | -                     | 1                         | 1           | 7           |
| B        | -                     | 1                         | 4           | 7           |
| C        | -                     | 2                         | 2           | 8           |
| D        | A                     | 1                         | 1           | 1           |
| E        | B                     | 2                         | 5           | 14          |
| F        | C                     | 2                         | 5           | 8           |
| G        | D, E                  | 3                         | 6           | 15          |
| H        | F, G                  | 1                         | 2           | 3           |

- (i) Find the Project Completion Time.
- (ii) What duration will have 95% confidence for project completion time?
- (iii) If the average duration for activity F increases to 14 days, what will be its effect on the expected project completion time which will have 95% confidence?
- (iv) What is the probability of completing the project by 2 more days than the expected completion time? (6, 4\*3).

4. (a) A bakery owner produces gourmet cakes and incurs a storage cost of ₹50 per unsold cake each day. If a customer cannot purchase a cake due to stock-out, they typically go to a competitor, resulting in an estimated lost profit of Rs. 200 per customer. Based on historical data, the probabilities for daily demand of 0 to 5 cakes are as follows: