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**GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR**

# (GIET UNIVERSITY)

Ph.D. (First Semester-Winter) Examinations, June – 2025

## 23WPPEMT1013 – Introduction to Optimization Problems

(Mathematics)

Time: 3 hrs Maximum: 70 Marks

**The figures in the right hand margin indicate marks.**

**Answer *ANY FIVE* Questions. (14 x 5 = 70 Marks)** **Marks**

1.a. Determine the convex hull of the following set: $X = \{(x_1, x_2) + x_1^2 : x_2^2 = 1\}$ 6

b. Find the maximum and minimum values of $f(x,y) = x^3 + 3xy^2 - 15x^2 - 15y^2 + 72x$. 8

2. a. **Formulate the LPP for following:** 6

A diet must provide at least 500 calories, 6g protein, and 10g calcium. Two foods are available. Food A costs ₹5 per unit and provides 200 calories, 2g protein, 4g calcium. Food B costs ₹3 per unit and provides 100 calories, 2g protein, 2g calcium. Find the number of units to minimize cost.

b. Solve the LP problem: Max. $Z = 3x_1 + 5x_2 + 4x_3$, Subject to the constraints $2x_1 + 3x_2 \le 8, 2x_2 + 5x_3 \le 10, 3x_1 + 2x_2 + 4x_3 \le 15, \text{and } x_1, x_2, x_3 \ge 0$. 8

3.a. **Formulate the LPP for following:** 6

A factory must ship goods from 2 warehouses to 3 stores. Each warehouse has a supply limit and each store has a demand. There's a shipping cost from each warehouse to each store. Find the shipping plan that minimizes cost.

b. Use the two-phase simplex method to solve the problem: 8

Minimize $Z = x_1 - 2x_2 - 3x_3$, Subject to the constraints

$2x_1 + x_2 + 3x_3 = 2, 2x_1 + 3x_2 + +4x_3 = 1 \text{ and } x_1, x_2, x_3 \ge 0$

4.a. Find the initial basic feasible solution to the following transportation problem by North-West Corner rule 6

| Warehouse Factory | $W_1$ | $W_2$ | $W_3$ | $W_4$ | Factory Capacity |
|---|---|---|---|---|---|
| $F_1$ | 19 | 30 | 50 | 10 | 7 |
| F2 | 70 | 30 | 40 | 60 | 9 |
| F3 | 40 | 8 | 70 | 20 | 18 |
| Warehouse Requirement | 5 | 8 | 7 | 14 | |

b. A steel company has three open hearth furnaces and five rolling mills. Transportation cost (rupees per quintal) for shipping steel from furnaces to rolling mills are shown in the following table: 8

| Mills<br>Furnaces | M1 | M2 | M3 | M4 | M5 | Capacities |
|---|---|---|---|---|---|---|
| F1 | 4 | 2 | 3 | 2 | 6 | 8 |
| F2 | 5 | 4 | 5 | 2 | 1 | 12 |
| F3 | 6 | 5 | 4 | 7 | 3 | 14 |
| Requirement | 4 | 4 | 6 | 8 | 8 | |

5.a. A salesman estimates that the following would be the cost on his route, visiting the six cities as shown in the table below: 7

| To City From City | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | ∞ | 20 | 23 | 27 | 29 | 34 |
| 2 | 21 | ∞ | 19 | 26 | 31 | 24 |
| 3 | 26 | 28 | ∞ | 15 | 36 | 26 |
| 4 | 25 | 16 | 25 | ∞ | 23 | 18 |
| 5 | 23 | 40 | 23 | 31 | ∞ | 10 |
| 6 | 27 | 18 | 12 | 35 | 16 | ∞ |

The salesman can visit each of the cities once and only once. Determine the optimum sequence he should follow to minimize the total distance travelled. What is the total distance travelled?

b. Define inventory in the context of operations and supply chain management. What are the different types of inventories generally maintained in an organization? 7

6.a. What are the key decisions involved in inventory management? Discuss how demand forecasting and lead time impact these decisions. 7

b. Discuss the different types of costs associated with inventory management. How do ordering cost, holding cost, and shortage cost influence inventory decisions? 7

7.a. How are inventory models classified? Explain deterministic and probabilistic models with examples. 7

b. What are deterministic inventory models? Describe at least two elementary deterministic models and explain how they help in optimizing inventory. 7

8.a. Define EOQ. Derive the EOQ formula and explain the assumptions behind it. What are the implications of using EOQ in practice? 7

b. Derive the EOQ model without allowing shortages. What are the key assumptions and how does it help minimize total inventory cost? 7

---End of Paper---