**Operations Research**

**NMIMS Centre for Distance and Online Education (NCDOE)**

**Internal Assignment Applicable for June 2025 Examination**

**Q1. A company supplies goods from three factories (A, B, C) to four warehouses (D1, D2, D3, D4). The supply capacities, demand requirements, and transportation costs (in Rs. per unit) are given below:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factory** | **D1** | **D2** | **D3** | **D4** | **Supply** |
| **A** | **5** | **3** | **7** | **6** | **30** |
| **B** | **4** | **6** | **5** | **8** | **50** |
| **C** | **7** | **4** | **6** | **5** | **20** |
| **Demand** | **20** | **35** | **25** | **20** | **100** |

**Briefly explain the transportation problem and the significance of finding an Initial Basic Feasible Solution (IBFS). Calculate the IBFS using: Northwest Corner Method, Least Cost Method and Vogel’s Approximation Method (VAM). Lastly compare the total transportation costs obtained from all three methods and identify the most efficient one.**

**Answer:**

**Introduction:**

The transportation problem is a type of optimization problem in supply chain management, where the objective is to determine the most cost-effective way of transporting goods from multiple suppliers (factories) to multiple consumers (warehouses), subject to supply and demand constraints. It is crucial for companies to minimize transportation costs while meeting the demand of the warehouses without exceeding the supply from the factories.

In the transportation problem, the supply capacities of factories and the demand requirements of warehouses are given, along with transportation costs between each pair of factory and warehouse. The goal is to find the most efficient distribution plan that minimizes the total transportation cost while fulfilling all supply and demand constraints. This problem is often solved using different methods to find an initial basic feasible solution (IBFS), which provides a starting point for further optimization.

Finding an Initial Basic Feasible Solution (IBFS) is significant because it gives the first valid allocation of goods from factories to warehouses, considering both the supply and demand constraints. Once the IBFS is found, optimization methods like the stepping stone method or MODI method can be used to improve the solution and reach the optimal transportation plan.

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**Q2. FreshBake Co. supplies bread from three bakeries (B1, B2, B3) to four retail stores (S1, S2, S3, S4). The daily supply capacities (in trays), demand requirements (in trays), and transportation costs (in Rs. per tray) are given below:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Bakery** | **S1** | **S2** | **S3** | **S4** | **Supply** |
| **B1** | **5** | **4** | **7** | **6** | **35** |
| **B2** | **3** | **6** | **5** | **4** | **50** |
| **B3** | **7** | **4** | **3** | **5** | **15** |
| **Demand** | **20** | **25** | **30** | **25** | **100** |

**Explain the transportation problem and justify why Vogel’s Approximation Method (VAM) is preferred for finding an Initial Basic Feasible Solution (IBFS). Find the IBFS using Vogel’s Approximation Method (VAM). Use the Stepping Stone Method to derive the optimal solution from the VAM-based IBFS. Lastly compare the total costs of the IBFS and the optimal solution.**

**Answer:**

**Introduction:**

The transportation problem is a type of linear programming problem that aims to find the most efficient way to transport goods from multiple suppliers to multiple demand points, minimizing transportation costs while meeting supply and demand constraints. In this case, FreshBake Co. is tasked with supplying bread from three bakeries (B1, B2, B3) to four retail stores (S1, S2, S3, S4), with each bakery having a specific supply capacity and each store having a particular demand. The objective is to determine the optimal allocation of bread trays from the bakeries to the stores while minimizing the total transportation cost.

To solve the transportation problem, an Initial Basic Feasible Solution (IBFS) must be found, which provides the starting point for optimization techniques. One popular method for finding the IBFS is Vogel’s Approximation Method (VAM), which minimizes the opportunity cost of transportation. Once the IBFS is found, further optimization is done using the Stepping Stone Method, which refines the solution until the optimal solution is achieved. This paper will first explain the transportation problem, the process of obtaining an IBFS using VAM, and the subsequent use of the Stepping Stone Method to derive the optimal solution. It will conclude with a comparison of the total costs between the IBFS and the optimal solution.

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**Q3A. TechMach Industries is a leading manufacturing company specializing in heavy-duty industrial machinery. The company operates multiple production lines, each relying on critical equipment for smooth operations. However, equipment failures and deterioration over time have led to production downtime, increased maintenan costs, and efficiency losses.**

**To optimize costs and operational performance, the company must decide when to replace its equipment. TechMach faces two distinct types of equipment replacement challenges:**

**Part A: Equipment That Fails Completely – Some machines experience sudden and unpredictable failures, leading to urgent replacements.**

**Part B: Equipment That Deteriorates Over Time – Other machines gradually lose efficiency, increasing repair costs and downtime until they become uneconomical to maintain.**

**Discuss the replacement strategies for equipment that fails completely. Using a case- based approach, analyze how TechMach should decide between individual replacement (replacing each unit as it fails) and group replacement (replacing multiple units at scheduled intervals) to minimize costs and disruptions.**

**Answer:**

**Introduction:**

TechMach Industries, a leading manufacturer of heavy-duty industrial machinery, faces two primary challenges related to equipment replacement: dealing with sudden, complete failures and addressing gradual deterioration. The first part of the problem involves machines that fail completely, leading to sudden production halts and urgent replacements. To mitigate costs and downtime, TechMach must decide whether to replace machines individually as they fail or adopt a group replacement strategy where multiple machines are replaced at scheduled intervals. This decision requires careful analysis of costs, operational disruptions, and the impact on productivity to determine the most efficient strategy.

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**Q3B. Discuss the replacement strategies for equipment that deteriorates over time. Using a case-based approach, analyze how TechMach should decide between repairing aging machines versus replacing them with new equipment, considering factors like increasing maintenance costs, efficiency loss, and depreciation.**

**Answer:**

**Introduction:**

TechMach Industries, a manufacturer of heavy-duty industrial machinery, faces challenges related to equipment that deteriorates over time. These machines gradually lose efficiency, leading to higher maintenance costs and longer downtimes. The company must decide whether to continue repairing aging machines or replace them with newer models. This decision involves weighing the increasing costs of maintaining old equipment against the benefits of newer, more efficient machines. Factors like repair costs, efficiency loss, depreciation, and the potential productivity benefits of new machines play a crucial role in determining the most cost-effective and operationally sound approach.

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