**Operations Research**

**NMIMS Solved Assignments for December 2024**

**Q1. Consider a clothing factory that manufactures two types of shirts, Cotton Shirts and Linen Shirts, with profits of Rs.400 and Rs.600 per unit sold, respectively. The production process for these shirts requires 200 minutes and 300 minutes per unit for Cotton Shirts and Linen Shirts, respectively, using a sewing machine with a limited working week of 40 hours due to maintenance/breakdown. Additionally, a production constraint states that for every 40 Cotton Shirts produced, at least 30 Linen Shirts must be produced. To optimize production and maximize profits, formulate the problem as a linear program to determine the maximum quantities of each shirt that can be produced. Additionally, the factory can consider hiring an additional sewing machine, which would double the effective production time available. Determine the maximum amount the company should be willing to pay per week for the hire of this machine and provide the reasoning behind this decision.**

**Answer:**

**Introduction:**

In a clothing factory that produces Cotton and Linen Shirts, the management aims to maximize profits while adhering to production constraints. Cotton Shirts yield a profit of Rs.400 each, while Linen Shirts provide Rs.600. The production process requires 200 minutes for Cotton Shirts and 300 minutes for Linen Shirts, with a limited working week of 40 hours (2,400 minutes) due to machine maintenance. A key production constraint is that for every 40 Cotton Shirts manufactured, at least 30 Linen Shirts must also be produced. To enhance production efficiency, the factory considers hiring an additional sewing machine, effectively doubling the available production time. This decision involves formulating a linear programming model to optimize shirt production and assessing the maximum weekly cost the factory should incur for hiring the extra machine based on its potential contribution to profits.

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**Q2. Consider a furniture manufacturing company that produces three types of furniture: Tables (A), Chairs (B), and Cabinets (C). The production process involves three departments: Cutting, Assembly, and Finishing. Each unit of Tables requires 4 hours in Cutting, 6 hours in Assembly, and 2 hours in Finishing. Chairs require 6 hours in Cutting, 8 hours in Assembly, and 4 hours in Finishing. Finally, Cabinets require 2 hours in Cutting, 4 hours in Assembly, and 6 hours in Finishing. The maximum capacity available in each department is 80 hours in Cutting, 100 hours in Assembly, and 60 hours in Finishing. The unit contribution for each product is Rs. 8 for Tables, Rs. 15 for Chairs, and Rs. 6 for Cabinets. Using the simplex method, determine the optimal number of units to produce for each type of furniture to maximize the total contribution to the cost. Additionally, determine if there would be any remaining unutilized capacity in any of the departments.**

**Answer:**

**Introduction:**

This problem revolves around optimizing production in a furniture manufacturing company that produces three types of furniture: Tables, Chairs, and Cabinets. Each type of furniture has specific production requirements across three departments: Cutting, Assembly, and Finishing. The challenge lies in maximizing the total contribution to the company's profits while adhering to the constraints of available hours in each department. Given the production time required for each furniture type and the maximum capacity of each department, the goal is to determine the optimal number of units to produce for Tables, Chairs, and Cabinets using the simplex method. This method will help identify the best production strategy that maximizes profit and assess whether any department will have unutilized capacity after production is optimized. This scenario illustrates the practical application of linear programming in resource allocation and production management.

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**Q3a. A real estate investor is considering two property options, 'Commercial Property A' and 'Residential Property B,' each with different potential returns and risk levels. Commercial Property A offers a return of 10% with a risk factor of 4 on a scale of zero to 10. In contrast, Residential Property B offers a higher return of 15% but comes with a higher risk factor of 6 on the same scale. The investor plans to allocate a total of Rs. 10,00,000/- and aims to achieve a minimum combined return of 12% on the investment. Additionally, to manage risk, the investor wants the maximum combined risk to stay below 5. To optimize the investment decision, formulate the problem as a Linear Programming Problem (LPP), considering the investment amounts in 'Commercial Property A' and 'Residential Property B' to achieve the desired returns while adhering to the risk constraint.**

**Answer:**

**Introduction:**

A real estate investor is evaluating two property options: Commercial Property A and Residential Property B, each with distinct potential returns and risk levels. The investor intends to invest a total of Rs. 10,00,000, targeting a minimum combined return of 12% while keeping the overall risk below 5. To make an informed decision, the investor seeks to optimize the allocation of funds between these two properties, leading to the formulation of a Linear Programming Problem (LPP) to achieve the desired financial goals.

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**Q3b. In a town near Pune, a small automotive start-up has begun manufacturing vehicles, including electric scooters, motorcycles, and cars. Each vehicle requires specific amounts of materials like steel, rubber, and electronics for production. The company sells electric scooters for Rs. 80,000, motorcycles for Rs. 1,50,000, and cars for Rs. 5,00,000. To optimize its revenue, the company needs to determine the best production strategy given the limited resources of 200 kgs of steel, 150 kgs of rubber, and 100 kgs of electronics available. The goal is to maximize revenue while staying within the resource constraints. Now, consider a larger automotive giant like Tesla, which is interested in acquiring materials from the smaller start-up. Tesla's challenge is to offer an appropriate amount of money for each unit of material that the smaller start-up finds acceptable. However, Tesla also aims to minimize its expenditures while making the offer. In summary, the small start-up aims to maximize revenue by optimizing its production strategy within resource limits, while the larger company (Tesla) needs to find the right pricing strategy for acquiring materials from the smaller start-up to minimize its expenses.**

**Answer:**

**Introduction:**

In a town near Pune, a small automotive start-up manufactures electric scooters, motorcycles, and cars, each requiring specific amounts of steel, rubber, and electronics. With resource constraints of 200 kgs of steel, 150 kgs of rubber, and 100 kgs of electronics, the start-up aims to optimize its production strategy to maximize revenue from vehicle sales. Meanwhile, Tesla seeks to acquire materials from the start-up, focusing on offering competitive pricing to minimize its expenditures while ensuring the start-up's profitability.

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