**Operations Research**

**December 2024 Examination**

**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. (10 Marks)**

**Ans 1.**

**Introduction**

Operations research (OR) is a critical field of study for decision-making, focusing on using mathematical models to optimize resource allocation in various industries, including manufacturing. In this problem, we are tasked with optimizing the production of two types of shirts—Cotton Shirts and Linen Shirts—in a factory constrained by production time and a specified ratio of output. The goal is to determine the optimal number of shirts that should be produced to maximize profits, considering production constraints and available time. Additionally, we need to assess the potential benefit of hiring an extra sewing machine, which would double the available production time. This case study provides an excellent opportunity to apply linear

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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. (10 Marks)**

**Ans 2.**

**Introduction**

The optimization of production resources in a manufacturing setup is a crucial factor in maximizing profitability. In the context of a furniture manufacturing company producing tables, chairs, and cabinets, the effective allocation of available hours in various departments, such as Cutting, Assembly, and Finishing, is necessary to enhance total contribution. Each product type requires different labor hours, and the company has limited hours for each department. Thus, the

**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. (5 Marks)**

**Ans 3a.**

**Introduction**

In investment decision-making, it is essential to balance risk and return to meet specific financial objectives. A real estate investor is evaluating two property options: Commercial Property A and Residential Property B. Each property offers distinct returns and risk levels. The investor’s goal is to allocate Rs. 10,00,000 across these options to achieve a minimum combined return of 12%, while keeping the maximum risk factor below 5. To make an optimal investment choice, this scenario can be formulated as a Linear Programming Problem (LPP), which allows for the precise calculation of how much to invest in each property while meeting both return and risk constraints

**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. (5 Marks)**

**Ans 3b.**

**Introduction**

In the competitive automotive industry, optimizing production strategies and resource allocation is essential for small and large companies alike. In this scenario, a small automotive start-up near Pune manufactures electric scooters, motorcycles, and cars, each generating different revenues. However, the company has limited resources in terms of steel, rubber, and electronics. On the other hand, a larger automotive giant like Tesla is interested in acquiring materials from the start-up but aims to minimize its expenditure. This situation can be formulated as an optimization