**Quantitative Methods - I**

**Sep 2025 Examination**

**Q1. A rare event occurs in a large population with probability 0.0004 per individual per year. In a city of 20,000 individuals, the event is tracked annually. (a) Using the Poisson approximation, compute the probability that in a given year, at least 10 but no more than 15 individuals experience the event. (b) If the city is divided into 4 equal districts, and the event occurrences are independent, what is the probability that at least one district records at least 5 occurrences in the same year? Show all steps, including justification for the use of the Poisson approximation and all intermediate calculations. (10 Marks)**

**Ans 1.**

**Introduction**

In statistical analysis, certain events occur so rarely and with such low individual probability that traditional binomial models become computationally intensive or impractical. In such cases, the Poisson distribution is often used as a close approximation. This becomes especially relevant when evaluating the probability of rare events within large populations over fixed intervals. The suitability of the Poisson model arises when the probability of success is very small and the number of trials is large, which simplifies analysis without significant loss of accuracy. In this question, we deal with a city of twenty thousand individuals where the probability of a rare event occurring is significantly low. The task involves calculating the likelihood of a specific number of occurrences and understanding probability distributions across subgroups using the Poisson

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**Q2. A light bulb's lifetime (in hours) is normally distributed with unknown mean \mu and known standard deviation =50 hours. A sample of 35 bulbs shows an average lifetime of 1200 hours. The company wants to ensure that at least 90% of bulbs last more than 1100 hours. Find the maximum mean lifetime that satisfies this and check if the sample supports this claim. (10 Marks)**

**Ans 2.**

**Introduction**

In quality control and product assurance, evaluating whether a product meets specific performance criteria is a key objective. When data such as product lifetime follows a normal distribution, statistical inference is used to estimate parameters and draw conclusions about the population based on sample data. In this case, the lifespan of light bulbs is assumed to follow a normal distribution with a known standard deviation, while the mean remains unknown. Using a sample of light bulb lifetimes, the company aims to determine whether it can confidently claim that a high percentage of bulbs last beyond a given threshold. Confidence intervals and hypothesis testing based on the normal distribution help assess whether the observed sample supports the product's reliability claim in practical scenarios.

**Concept and Application**

The normal distribution is a symmetric, bell-shaped probability distribution that is widely used to

are of strategic importance.

**Q3(A) A bakery claims that at least 60% of its customers are satisfied with their new bread recipe. To test this, a sample of 50 customers is surveyed, and 27 say they are satisfied. At the 5% significance level, test whether the bakery’s claim is true. (5 Marks)**

**Ans 3a.**

**Introduction**

When businesses make claims about customer satisfaction, it becomes important to verify these claims statistically through hypothesis testing. This ensures that decisions are data-driven and not based on assumptions. In the case of the bakery, the claim that at least sixty percent of customers are satisfied can be tested using a sample and applying a proportion hypothesis test. This method evaluates whether the observed sample evidence supports or contradicts the claim made about

**Q3(B) Suppose you are given a dataset of 10 observations where the independent variable X is the monthly advertising spend (in $1000s) and the dependent variable Y is the monthly sales (in $10,000s). The regression equation Y = a + bX is fitted, and the following is known: the sum of squared residuals (SSE) is 180, the total sum of squares (SST) is 600, and the explained sum of squares (SSR) is 420.**

**(a) Calculate the coefficient of determination (R²) and interpret its meaning.**

**(b) If the standard error of the regression is required for a 95% confidence interval for a forecast at X = 15, compute the standard error given n = 10 and k = 1.**

**(c) If the regression equation is Y = 2.5 + 1.8X, estimate the 95% confidence interval for the predicted sales when X = 15, using z = 1.96.**

**Show all steps and justify the use of each value. (5 Marks)**

**Ans 3b.**

**Introduction**

Regression analysis is a core statistical method used to understand the relationship between variables, often for forecasting purposes. When businesses assess the impact of advertising spend on sales, regression models help quantify this relationship. This allows decision-makers to predict outcomes, assess model accuracy, and build confidence intervals for future projections. The use of sum of squares, coefficient of determination, and standard error forms the foundation