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| **SESSION** | **APRIL 2025** |
| **PROGRAM** | **MASTER OF COMPUTER APPLICATION (MCA)** |
| **SEMESTER** | **III** |
| **COURSE CODE & NAME** | **DCA7101 PROBABILITY AND STATISTICS** |
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**Assignment Set – I**

**Q1. a. Define and explain the concepts of conditional probability and Bayes' theorem. Illustrate how these concepts are applied in real-world decision-making scenarios.**

**b. In a certain town, 1% of the population has a rare disease. A test used to detect this disease gives a positive result in 99% of the cases when the person actually has the disease (true positive), but also gives a false positive in 5% of healthy individuals. If a randomly selected person tests positive, what is the probability that the person actually has the disease?**

**Ans 1.**

**1a. Understanding Conditional Probability and Bayes’ Theorem**

**Conditional Probability**

Conditional probability refers to the likelihood of an event occurring given that another related event has already occurred. It is denoted as P(A|B), meaning the probability of event A given that B has occurred. This concept is crucial when the outcome or occurrence of one event is influenced by the outcome of another. For instance, the probability that it will rain today given that it is cloudy is an example of conditional probability. It allows for more refined probability assessments in the presence of known conditions.

**Definition and Explanation of Bayes’ Theorem**

Bayes’ Theorem is a mathematical formula that allows us to update the probability estimate

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**Q2.a. Define a two-dimensional random variable and explain the concepts of joint, marginal, and conditional distributions. Highlight how these are used to understand relationships between variables in real-world data analysis.**

**b. The joint probability distribution of two discrete random variables X and Y is given by:**

|  |  |  |  |
| --- | --- | --- | --- |
| **X \ Y** | **-1** | **0** | **1** |
| **-1** | **0.1** | **0.1** | **0** |
| **0** | **0.1** | **0.2** | **0.1** |
| **1** | **0** | **0.1** | **0.3** |

**Find:**

**E(X),**

**E(Y),**

**Var(X),**

**Cov(X,Y)**

**Ans 2.**

**2a. Two-Dimensional Random Variable and Distribution Concepts**

**Two-Dimensional Random Variable**

A two-dimensional or bivariate random variable refers to a pair of random variables considered simultaneously. It is denoted as (X, Y), where X and Y are two random variables that can be either discrete or continuous. These variables are studied together to understand their mutual dependence, joint behavior, and how the values of one may influence or relate to the other. This kind of analysis is foundational in statistics and probability, particularly in

**Q3a. Define the Moment Generating Function (MGF). Explain how it is used to derive the moments (mean and variance) of a random variable.**

**b. Define standard deviation and coefficient of variation. Discuss their significance and mention cases where coefficient of variation is preferred over standard deviation.**

**Ans 3.**

**3a. Moment Generating Function (MGF) and Its Use in Finding Moments**

**Definition of Moment Generating Function (MGF)**

The Moment Generating Function (MGF) of a random variable is a mathematical function that helps in summarizing all the moments (i.e., expected values of powers) of a probability distribution. For a random variable $X$, the MGF is defined as:

$$M\_{X}(t)=E[e^{tX}]$$

where $t$ is a real number in the domain of the function, and $E$ denotes the expected value. The MGF exists if the expectation converges to a finite value for some interval around $t=0$. MGFs are especially useful in probability theory because they uniquely determine the distribution of a random variable when it exists.

**Deriving Mean and Variance Using MGF**

MGFs provide a systematic method for finding moments of a random variable. The nth

**Assignment Set - II**

**4a. The following table shows the wages (in Rs.) and number of workers:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Wages (X)** | **15** | **25** | **35** | **45** | **55** |
| **No. of Workers (f)** | **3** | **4** | **6** | **3** | **4** |

**Calculate the arithmetic mean using the direct method.**

**b. Given the following distribution:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **X** | **1** | **2** | **3** | **4** | **5** |
| **f** | **3** | **2** | **4** | **6** | **5** |

**Ans 4.**

### **4a. Arithmetic Mean Using the Direct Method**

**Given:**

| Wages (X) | Frequency (f) |
| --- | --- |
| 15 | 3 |
| 25 | 4 |
| 35 | 6 |
| 45 | 3 |
| 55 | 4 |
| **Total** | **20** |

**Formula (Direct Method):**

**Q5a. Explain Karl Pearson’s Coefficient of Correlation. Mention its properties and significance in statistical analysis.**

**b. Fit a trend line by the method of semi-averages for the following data:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **2012** | **2013** | **2014** | **2015** | **2106** | **2017** |
| **Sales (In lakhs)** | **120** | **135** | **150** | **165** | **180** | **195** |

**Ans 5.**

 **5a. Karl Pearson’s Coefficient of Correlation – Explanation, Properties, and Significance**

Karl Pearson’s Coefficient of Correlation is a statistical measure that quantifies the strength and direction of a linear relationship between two continuous variables. It is denoted by the symbol r and its value ranges between -1 and +1. A value of +1 indicates a perfect positive linear correlation, where an increase in one variable leads to a proportionate increase in the other. Conversely, a value of -1 signifies a perfect negative linear relationship, where an increase in one variable results in a proportional decrease in the other. If the coefficient is 0,

**Q6a. What is a one-tailed and two-tailed test in hypothesis testing? Explain with suitable examples and diagrams.**

**b. The average test score of a sample of 10 students was found to be 68 with a standard deviation of 5. Test the hypothesis that the population mean is 70 using t-test at 5% level of significance.**

**Ans 6.**

## **6a. One-Tailed and Two-Tailed Tests in Hypothesis Testing**

### **Hypothesis Testing**

Hypothesis testing is a fundamental statistical method used to make decisions or inferences about population parameters based on sample data. The process involves formulating two competing hypotheses: the null hypothesis (denoted as H₀) and the alternative hypothesis (denoted as H₁). The null hypothesis represents the default or assumed condition, while the alternative hypothesis suggests a change or deviation from the assumed condition.

The objective is to assess whether there is enough evidence in the sample data to reject the null hypothesis in favor of the alternative. This assessment is based on a calculated test statistic and its comparison to a critical value or p-value derived from a probability