PARVATHANENI BRAHMAYYA
SIDDHARTHA COLLEGE OF ARTS & SCIENCE
Autonomous
Siddhartha Nagar, Vijayawada–520010
Re-accredited at 'A+' by the NAAC

Course Code				**23STMAL235**			
Title of the Course				**Descriptive Statistics and Probability**			
Offered to: (Programme/s)				B.Sc. Honours Computer Science			
L	**4**	**T**	**0**	**P**	**0**	**C**	**3**
Year of Introduction:	**2024-25**			**Semester:**			**3**
Course Category:	**MAJOR**			**Course Relates to:**	**Local, Regional, National, Global**		
Year of Revision	**2024 - 25**			**Percentage:**	**NA**		
Type of the Course:				**Skill Development Course**			
Crosscutting Issues of the Course:				**NA**			
Pre-requisites, if any				**23STMAL121**			

Course Description:

The course on Descriptive Statistics, Probability, Random Variables, and Probability Distributions provides a comprehensive introduction to the fundamental concepts of statistics and probability theory. Students will learn to summarize and interpret data using descriptive statistics, including measures of central tendency and dispersion. The course covers key probability concepts, including random variables and their distributions, allowing students to understand the behavior of data in uncertain environments. Through practical applications, students will explore various discrete and continuous probability distributions, enabling them to model real-world scenarios and make informed decisions based on statistical analysis. Emphasis will be placed on problem-solving and the use of statistical software for data analysis.

Course Aims and Objectives:

S. No	COURSE OBJECTIVES
1	compute and interpret measures of central tendency (mean, median, mode) for various datasets, highlighting their significance in summarizing data.
2	calculating and analyzing measures of dispersion (range, variance, standard deviation) and to explore the concepts of moments, skewness, and kurtosis in understanding data variability.
3	define and illustrate discrete and continuous random variables, and to analyze their corresponding probability mass functions (PMF) and probability density functions (PDF).
4	calculate mathematical expectations and variances, and to apply generating functions (moment generating, probability generating) in solving probability-related problems.
5	identify and analyze both discrete (e.g., Binomial, Poisson) and continuous (e.g., Normal, Exponential) probability distributions, and to apply these distributions in real-world statistical modeling scenarios.

Course Outcomes

At the end of the course, the student will be able to…

NO	COURSE OUTCOME	BTL	PO	PSO
CO1	explain the different types of mathematical averages and positional average their properties and applications in solving statistical problems.	K2	1	1
CO2	evaluate probabilistic scenarios using key probability laws and inequalities.	K5	1	1
CO3	apply probability mass and density functions to illustrate distribution functions and analyze mathematical expectations and their theorems,	K3	1	1
CO4	analyze the behavior of the probability distributions under different conditions and evaluate their applications in various statistical contexts."	K4	1	1
CO5	**apply** the concepts of sampling distribution and its uses in statistical analysis	K3	1	1

For BTL: K1: Remember; K2: Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

CO-PO-PSO MATRIX									
CO NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	2							2	
CO2	3							3	
CO3	2							2	
CO4	3							3	
CO5	2							2	

Use the codes 3, 2, 1 for High, Moderate and Low correlation Between CO-PO-PSO respectively

I. Course Structure:

Unit– I:Measures of Central Tendency

Mathematical averages- arithmetic mean, geometric mean and harmonic mean. Properties and applications. Positional Averages: Median, Mode – properties and problems. **Measures of Dispersion-**Absolute and Relative measures of Dispersion-Range, Quartile deviation, Mean deviation, Standard deviation, and co-efficient of variation - Properties and applications. Moments: Importance, types - central and non-central moments. Inter-relationships (Statements only), Sheppard's corrections for central moments for grouped data. Measures of Skewness and Kurtosis with simple problems

Applications :

1. Calculating average income, average test scores, average product ratings.
2. Identifying the most popular product, determining the most common shoe size, analyzing categorical data

Activities/Examples/Case Study:

1. Discuss real-world applications of these measures in various field (economics, finance, sports, etc.)
2. Collect data on a topic of interest (e.g., heights, exam scores, salaries) to create a tangible dataset for analysis.

Unit–II: Probability

Terminology - Random experiments, sample space, exhaustive, favorable, mutually exclusive, equally likely, conditional and independent events. Mathematical, Statistical and

Axiomatic definitions of probabilities. Addition law of probabilities. Boole's inequalities and problems. Conditional Probability- multiplication law of probability. Pair wise independent events and conditions for mutual independence of n events and Bayes theorem and its applications

Applications

1. Probability, the mathematical study of chance and uncertainty, finds applications in a vast array of fields. Here are some key areas
   - Business and Economics, Social Sciences
   - Engineering and Science, Medicine
   - Insurance, Investment.
2. Behavior analysis, decision-making, and social networks utilize probabilistic models.

Activities/Examples/Case Study:

1.Coin Flipping and Dice Rolling Experiments

2. Students can analyze lottery systems to understand probability and expected value.

Unit–III: Univariate Random Variables:

Definition, Discrete and Continuous random variables -Probability mass function and Probability density function with illustrations. Distribution function and its properties. Mathematical Expectations: Definition, Properties of Expectations - Addition and Multiplication theorems of expectation. Properties of Variance and Covariance. Cauchy-Schwartz Inequality, Chebyshev's Inequality (Statements only). Generating Functions. Definition of moment generating function (m.g.f), Cumulant generating function (c.g.f), Probability generating function (p.g.f) and Characteristic function (c.f) and their properties.

Applications

1. **Demographics:** Age, income, education level, and gender distribution within a population.
2. **Finance:** Stock prices, interest rates, and return on investments

Activities/Examples/Case Study:

1. Students can flip a coin multiple times and record the number of heads. They can then calculate the probability of getting different numbers of heads and compare it to the theoretical binomial distribution.

2.Students can roll a die multiple times and record the outcomes. They can then calculate the probability of different outcomes and compare it to the theoretical uniform distribution

Unit – IV : Probability Distributions:

Discrete Probability Distributions-Binomial, Poisson and Geometric distribution- Definition, properties and its applications, simple problems. **Continuous Probability Distributions-** Uniform, Normal and Exponential distributions- Definition, properties and its applications, simple problems.

Applications:

1. Normal Distribution: Widely used for modelling continuous data, such as heights, weights, and measurement errors.
2. Binomial Distribution: Used for modelling the number of successes in a fixed number of Bernoulli trials (e.g., coin flips, quality control).
3. Poisson Distribution: Used for modelling the number of events occurring in a fixed interval of time or space (e.g., arrivals at a service counter, radioactive decay).

Activities/Examples/Case Study:

1. Dice Experiments:Roll two dice and find the sum of the numbers and Create a table to record the Possible outcomes and their frequencies

2. Coin Tossing: Toss a coin multiple times and record the number of heads
3.Binomial Distribution: Simulate flipping a coin multiple times and count the number of heads.
4. Normal Distribution: Create a histogram of the data.

Unit – V :Exact Sampling distributions:

Terminology- Population, Sample, Parameter, Statistic, Sampling Distribution of a statistic and Standard Error and its uses. Chi-square distribution- definition, properties and applications. t-Distribution – definition, properties, and applications. F-distribution – definition, properties and applications

Applications:

1. Hypothesis Testing with Small Sample Sizes
2. Exact Confidence Intervals
3.Rare Event Probability Estimation

Activities/Examples/Case Study:

1. Empirical Sampling Distributions with Dice
2.Classroom Polling

Text Books:

1. Gupta. S.C. &Kapoor, V.K. (2023) . Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd. New Delhi.

References:

1. Bansilal and Arora (1989). New Mathematical Statistics, Satya Prakashan, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay, P. (2015). Mathematical Statistics.Publisher: BOOKS AND ALLIED (1 January 2016)

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23STMAL235: **Descriptive Statistics and Probability** **Credits: 4**
Major 8 B.Sc. Honours (Computer Science) Semester III
Time: 3 hours Maximum Marks: 70 M

Section - A

Answer the following questions **5 X 4M = 20M**

1. a. Write the properties of a good measure of central tendency. (Co-1, K-1)
   (OR)
   b. Write the comparison between absolute and relative measures of dispersion (Co-1, K-1)

2. a. Explain the terms exhaustive, mutually exclusive and equally likely events (Co-2, K-2)
   (OR)
   b. Define Axiomatic definitions of probability. (Co-2, K-2)

3. a .Define a random variable and explain its types . (Co-3, K-1)
   (OR)
   b. Define mathematical expectation and write its properties. (Co-3, K-1)

4. a. Define binomial distributions and its applications. (Co-4, K-2)
   (OR)
   b. writes any five properties of normal distribution. (Co-4, K-2)

5. a. What is a sampling distribution of a statistic? (Co-5, K-1)
   (OR)
   b. Write the properties of a chi-square distribution. (Co-5, K-1)

Section - B

Answer the following questions **5 X 10M = 50M**

6.a. A survey conducted on 20 households in a locality by a group of students resulted in the following frequency table for the number of family members in a household study the empirical relation between mean, median and mode (Co-1, K-3)

Family size	1-3	3-5	5-7	7-9	9-11
No. Families	7	8	2	2	1

(OR)

b. The following table shows the information related to the age groups and income levels of a certain city of Andhra Pradesh. Find out which income level having more variability (CO-1, K-3)

Age group	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60
Middle Income	6	8	13	17	20	23	15	12	5
High Income	2	5	8	20	25	30	14	7	3

7. a. A tyre manufacturing company kept a record of the distance covered before a tyre needed tobe replaced. The table shows the results of 1000 cases.

Distance(in km)	Less than 4000	4000 - 9000	9001 - 14000	More than 14000
Frequency	20	210	325	445

If a tyre is bought from this company, what is the probability that :

(i) it has to be substituted before 4000 km is covered? (ii) it will last more than 9000km?

(iii) It has to be replaced after 4000 km and 14000 km is covered by it? (CO-2, K-3)

(OR)

b. In my town, it's rainy one third of the days. Given that it is rainy, there will be heavy traffic with probability $\frac{1}{2}$, and given that it is not rainy, there will be heavy traffic with probability $\frac{1}{4}$. If it's rainy and there is heavy traffic, I arrive late for work with probability $\frac{1}{2}$. On the other hand, the probability of being late is reduced to $\frac{1}{8}$ if it is not rainy and there is no heavy traffic. In other situations (rainy and no traffic, not rainy and traffic) the probability of being late is 0.25. You pick a random day.

(i) What is the probability that it's not raining and there is heavy traffic, and I am not late?

(ii) What is the probability that I am late?

(iii) Given that I arrived late at work, what is the probability that it rained that day?

(Co-2, K-3)

8. a A random variable has the following probability distribution

x	0	1	2	3	4	5	6	7	8
P(X= x)	a	3a	5a	7a	9a	11a	13a	15a	17a

(i) Determine 'a' (ii) Find P(X<3), P(X ≥ 3) and P(0<X<5)

(iii) Find the distribution function of X. (Co-3, K-3)

(OR)

b. The diameter of an electric cable, say X, is assumed to be a continuous random variable with p.d.f. $f(x) = 6x(1-x),\ 0 \le x \le 1$.

i) Check that f(x) is p.d.f.,

ii) Determine a number **b** such that P(X <**b**) = P(X >**b**). (Co-3, K-3)

9.a. (i) Telephone calls arrive at an exchange according to the Poisson process at a rate λ = 2/min. Calculate the probability that exactly two calls will be received during each of the first 5 minutes of the hour.

(ii). Find the binomial distribution of getting a six in three tosses of an unbiased dice.

(Co-4, K-5)

(OR)

b. The speeds of cars are measured using a radar unit, on a motorway. The speeds are normally distributed with a mean of 90 km/hr and a standard deviation of 10 km/hr. What is the probability that a car selected at chance is moving at more than 100 km/hr? (Co-4, K-5)

10. a. Explain student's t- distribution and write its applications. (Co-5, K-3)

(OR)

b. Explain Snedecor's F- distribution write its applications. (Co-5, K-3)

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