

## **DEPARTMENT OF STATISTICS**

### **Programme Offered: B. Sc. (Hons.) Statistics**

#### **Program Outcome:**

When the student joins college after school they are free to make their own choices which are very instrumental in changing their attitude towards life and society. It is very important to give them an appropriate and conducive environment to learn and grow. After completion of the degree apart from his/her specialty in the program of his/her choice the student learns a lot during their three year stay that makes them mature enough to take the right decisions at the right time.

Students develop analytical thinking and good communication skills during classroom teaching (through projects/presentation/practical) and also as they participate in various activities both at departmental as well as college level.

Being a Central University, the student gets a chance to communicate with students of other states of India which makes them culturally sensitive and socially interactive.

As part of various departmental /college seminars and workshops he learns to respect and protect the environment. These programs also help in generating gender sensitization and building of ethical values to become a responsible citizen when he/she graduates from the college.

#### **Program Specific Outcome:**

Statistics is the language of the uncertainties riddled modern information age. This program is a compact combination of detailed courses of Statistics and adequate amount of courses on Computer Science, Mathematics and Operations research to complement and offer diversification after the completion of program. The thrust of the program is to provide a platform for pursuing higher studies leading to post-graduate or doctorate degrees. Along with this students are equipped with skill enhancement courses like Research methodology, Statistical packages and R language. Apart from this there is a range of Generic elective courses in Economics, Commerce, Computer Science etc. which students choose as per their interest and aptitude. This enhances theoretical rigor with technical skills which prepare students to become globally competitive to enter into a promising professional life even after graduation.

This program offers a range of traditional avenues in academics, Govt. Service, IAS, Indian Statistical/ Economic Services, Industries, Commerce, Investment Banking, Banks and Insurance Sectors, CSO and NSSO, Research Personnel/Investigator in Govt. organizations such as NCAER, IAMR, ICMR, Statistical and Economic Bureau & various PSUs., Market Research, Actuarial Sciences, Biostatistics, Demography etc. It also provides an array of non-traditional employment avenues ranging from Stock Brokers Analyst, Sports Analyst, Poll Analyst, Business Analyst, Financial Analyst, Content Analyst etc.

**Given below are Course Outcomes of the various courses taught as part of this three-year under-graduate program.**

## **Course Outcome:**

- **STAT-C-101 Descriptive Statistics (Theory+ Practical)**

The learning objectives include summarizing the data and to obtain its salient features from the vast mass of original data.

After completing this course, the students should have developed a clear understanding of

- Concepts of statistical population and sample, variables and attributes.
- Tabular and graphical representation of data based on variables.
- 'Conditions for the consistency' and criteria for the independence of data based on attributes.
- Measures of central tendency, Dispersion, Skewness and Kurtosis.
- Moments and their use in studying various characteristics of data.
- Different approaches to the theory of probability.
- Important theorems on probability and their use in solving problem
- Concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient, partial correlation coefficient and Multiple correlation coefficient.
- Concept of Principle of least squares for curve fitting and regression lines.

- **STAT C-102 Calculus**

Calculus is versatile and Valuable tool for the statistics. Calculus being used in statistics involves integrating over sections of a probability distribution. The content of this paper involves differential calculation, integral calculus and solution of different differential equations which are extremely prevalent in more advanced statistical application.

- **STAT-C-201 Probability and Probability Distributions (Theory+ Practical)**

A probability distribution is a statistical model that shows the possible outcomes of a particular event or course of action as well as the statistical likelihood of each event. Probability distribution functions are quite important and widely used in actuarial science (insurance), engineering, physics, evolutionary biology, computer science and even social sciences such as psychiatry, economics and even medical trials.

- **STAT C-202 Algebra (Theory+ Practical)**

Algebra is one of the most important courses in the field of statistical computing. The course serves as a building block that will enable students to learn more advanced techniques that will help them to solve problems more quickly and easily.

After completing course, students should have developed a clear understanding of:

- Theory of equations

- Properties of matrices and determinants
- Linear equations
- Rank of a matrix
- Generalized inverse
- Characteristics roots and vectors
- Quadratic forms

. The students will be conversant for their potential studies of Markov chain & stochastic process, Multivariate analysis, Regression analysis, Design of Experiments.

- **STAT-C-301 Sampling Distributions (Theory+ Practical)**

1. To understand the concept of sampling distributions and their applications in statistical inference.
2. To understand the process of hypothesis testing and its significance
3. Importance of Standard Error and to draw conclusions using p-value

- **STAT-C-302 Survey Sampling and Indian Official Statistics (Theory+ Practical)**

Survey Sampling provides the tolls/ techniques for selecting a sample of elements from a target population keeping in mind the objectives and nature of population. Most of the research work is done through Sample Survey. The students are able to know about Indian Official Statistical System.

After completing the course, students should have developed clear understanding of :

- Basic concepts of survey sampling
- Principles of survey sampling and main steps involved in selecting a sample
- Simple random sampling
- Stratified random sampling
- Systematic sampling
- Ratio and Regression method of estimation
- Cluster sampling (equal cluster size)
- Concepts of sub sampling
- Indian Official Statistical System

- **STAT C-303 Mathematical Analysis (Theory+ Practical)**

Numerical Analysis:

Theory of finite differences deals with the changes that take place in the value of the dependent variable due to finite changes in the independent variable.

On completion of the course, students should have achieved the following

- 1) Mathematical Operators ( Forward and Backward difference operators , Shift Operator ,Central difference operator ,Derivative)
- 2) Approximating a given set of data by a function using interpolation formula.
- 3) Newton Gregory interpolation formula (forward and backward) for arguments at equal intervals
- 4) Newton's Divided difference interpolation formula and Lagrange's interpolation formula( for unequal intervals)
- 5) Central Difference interpolation formula(Gauss and Stirling's)
- 6) Representation of a polynomial in factorial Notation
- 7) Numerical Quadrature using the interpolation formula( Trapezoidal Rule, Simpson's 1/3<sup>rd</sup> and 3/8<sup>th</sup> quadrature formula
- 8) Solution of Difference equations

Real Analysis:

Students will have the knowledge of basic properties of the field of real numbers, the knowledge of the series of real numbers and convergence, Bolzano –Weirstrass theorem, Cauchy criteria, the knowledge of real functions-limits of functions and their properties, notion of continuous functions and their properties and the differentiability of real functions and related theorems

- **STAT-C-401 Statistical Inference (Theory+ Practical)**

Statistical inference: Drawing conclusions about the whole population on the basis of a sample.

Statistical inference is the process of deducing properties of an underlying probability distribution by analysis of data. Inferential statistical analysis infers properties about a population, this includes testing hypotheses and deriving estimates.

- **STAT-C-402 Linear Models (Theory+ Practical)**

The learning objectives includes developing a clear understanding of the fundamental concepts of linear models and a range of associated skills allowing the students to work effectively with them. The linear models are useful both in the planning stages of research and in the analysis of resulting data. The combination of theory and applications will prepare students to explore the course & more correctly interpret the output from linear model computer package.

After completing the course students should have developed clear understanding of:

- Basic concepts of linear models. Theory and estimation of linear models
- Gauss Markov Theorem and its use

- Fitting of these models, derivation of confidence interval, testing the hypothesis and interpretation of results
- Simple and multiple linear regression models and their applications
- Distribution of Quadratic Forms
- Techniques of analysis of variance and covariance for fixed effect models
- Concepts of residuals and outliers.

- **STAT-C-501 Stochastic Processes and Queuing Theory (Theory+ Practical)**

After completing this course, students should have developed a clear understanding of

- 1) The fundamental concepts of stochastic processes
- 2) Tools needed to analyze stochastic processes
- 3) Markov chains
- 4) Stability of Markov chains
- 5) Poisson process and its variations
- 6) Queuing systems
- 7) Random walk and ruin theory
- 8) To identify the real life applications of stochastic processes

- **STAT-C-502 Statistical Computing Using C/C++ Programming (Theory+ Practical)**

1. In this course students learn to write code in C to do statistical computing and its role in problem solving. C is a powerful, structured programming language widely used in all areas of study.
2. Student will understand basic data structures and develop logics which will help them to create well-structured programs using C language. It develops the analytical as well as logical thinking of the student.
3. It also opens the adaptability to learn any other programming language and using computer languages/software as a tool to analyze data statistically.

- **STAT-C-601 Design of Experiments (Theory+ Practical)**

DOE is a tool to develop an experimentation strategy that maximizes learning using a minimum of resources. Extensively used by engineers and scientists involved in the improvement of manufacturing processes to maximize yield and decrease variability. It is widely used in many fields with broad application across all the natural and social sciences, to name a few: Biostatistics, Agriculture, Marketing, Software engineering. Industry etc. After completing Course in DOE students should have developed a clear understanding of:

- The fundamental concepts of design of experiments.
- Introduction to planning valid and economical experiments within given resources.
- Completely randomized design.

- Randomized block design.
  - Latin square design.
  - Balanced incomplete block design.
  - Full and confounded factorial designs with two and three levels.
  - Fractional factorial designs with two levels.
- **STAT-C-602 Multivariate Analysis and Nonparametric Methods (Theory+ Practical)**

The learning objectives include:

- 1) Study of theoretical concepts of Bivariate Normal and Multivariate Normal Distributions along with their properties.
- 2) Analyze multivariate data.
- 3) Application of Wald's SPRT and Non-Parametric methods of testing of hypothesis

### **Course Learning Outcomes**

On completion of the course, students should have achieved the following

- 1) The understanding of basic concepts associated with Multivariate Normal Distributions and their properties with special emphasis on Bivariate Normal Distribution.
- 2) Analyzing Multivariate data using data reduction techniques like Principal Component Analysis, Factor Analysis.
- 3) Classification method namely Discriminant Analysis.
- 4) Application of Wald's SPRT for testing simple null hypothesis vs simple alternative hypothesis along with the study of the O.C. function and the ASN function for various underlying continuous and discrete distributions.
- 5) Testing of hypothesis using Non-Parametric tests like Median test, Runs test, U test, Kruskal Wallis test etc. and ability to use them judiciously for the testing of given data.

### **Discipline Specific Elective Papers**

- **DSE-1 (A) Time Series Analysis (Theory+ Practical)**

Students of this course are taught to understand and predict the changes in economy. Areas of learning include:

- 1 Profit of experience.
- 2 Safety from future
- 3 Utility Studies
- 4 Sales Forecasting
- 5 Budgetary Analysis
- 6 Stock Market Analysis
- 7 Yield Projections

- 8 Economic Forecasting
- 9 Census Analysis
- 10 Risk Analysis & Evaluation of changes.

- **DSE-2 (A) Operations Research (Theory+ Practical)**

The 'Operations Research' is not only confined to any specific agency like defence services but today it is widely used in all industrial organizations. It can be used to find the best solution to any problem be it simple or complex. It is useful in every field of human activities. Thus, it attempts to resolve the conflicts of interest among the components of organization in a way that is best for the organization as a whole. Main fields where OR is extensively used are:

1. National Planning and Budgeting
2. Defense Services
3. Industrial Establishment and Private Sector Units
4. Research & Development and Engineering

- **DSE-2 (B) Econometrics (Theory+ Practical)**

Econometrics deals with the measurement of economic relationships. It is an integration of economics, mathematical economics and statistics with an objective to provide numerical values to the parameters of economic relationships. It may be pointed out that the econometric methods can be used in other areas like engineering sciences, biological sciences, medical sciences, geosciences, agricultural sciences etc. In simple words, whenever there is a need of finding the stochastic relationship in mathematical format, the econometric methods and tools help.

After completing this course, students should have developed a clear understanding of:

- The fundamental concepts of econometrics.
- Specification of the model.
- Multiple Linear Regression.
- Multicollinearity.
- Heteroscedasticity.
- Autocorrelation.
- Autoregressive and Lag models
- Use of Dummy Variables
- Specification Errors

- **DSE-3 (B) Survival Analysis and Biostatistics (Theory+ Practical)**

Students learn to handle censored data, techniques and tools to obtain survival probability and knowledge of clinical drug trials. After completion they can work in health industry.

- **DSE-4 (A) Financial Statistics (Theory+ Practical)**

In this course students learn about Probability, Tools Needed for Option Pricing: Wiener process, stochastic integration, and stochastic differential equations; Pricing Derivatives: Arbitrage relations and perfect financial markets, pricing futures, put-call parity for European options, relationship between strike price and option price; Stochastic Models in Finance; Continuous time-process-geometric Brownian motion; Ito's lemma, Black-Scholes formula for European options; Hedging portfolios: Delta, Gamma and Theta hedging; Binomial Model for European options: Cox-Ross-Rubinstein approach to option pricing and discrete dividends

### **Skill Enhancement Electives**

#### **1. Statistical-Data Analysis Using Software Packages**

SPSS is a comprehensive and flexible statistical analysis and data management solution. SPSS can take data from any type of file and use them to generate tabulated reports, charts, and plots of distributions and trends, descriptive statistics, and conduct complex statistical analyses, thus most popular and widely used statistical software. This paper not only equips them with a data analysis tool but it also helps students learn and understand their statistical fundamentals better and with ease. Learning the basic statistical software will help students to easily switch over to any other statistical software in future.

After completing this course, students should have developed a clear understanding of SPSS.

#### **2. Statistical Data Analysis Using R**

1. This course will review and expand upon core topics in probability and statistics through the study and practice of data analysis and graphical interpretation using 'R'.
2. Being an open-source and user-friendly statistical programming language, students would be able to perform better in research as well.
3. R is one of the most powerful and popular statistical programming languages used by data scientists today thus it will prepare the students with current market pace.



## **GENERIC ELECTIVES OFFERED BY DEPARTMENT OF STATISTICS TO STUDENTS OF OTHER COURSES**

### **1. Statistical Methods**

The learning objectives include:

- Acquainting the students with various statistical methods.
- To introduce students to different measurement scales, qualitative and quantitative and discrete and continuous data.
- To help students to organize data into frequency distribution graphs, including bar graphs, histograms, polygons, and ogives.
- Students should be able to understand the purpose for measuring central tendency, variation, skewness and kurtosis and should be able to compute them as well.
- Students should be able to understand and compute various statistical measures of correlation, fitting of curve and regression

#### **Course Learning Outcomes:**

This paper equips students coming from diverse streams to handle data meaningfully and to ensure that data is interpreted correctly. Upon successful completion of this course students will be able to demonstrate the knowledge of:

- Introduction to Statistics, definitions and data classification, types of studies and types of samples
- Graphical displays of data, frequency distributions, analyzing graphs
- Numerical descriptions of data, measures of center tendency, measures of dispersion, skewness and kurtosis
- Correlation and regression
- Theory of attributes

### **2. Introductory Probability**

A probability distribution is a statistical model that shows the possible outcomes of a particular event or course of action as well as the statistical likelihood of each event. Probability distribution functions are quite important and widely used in actuarial science (insurance), engineering, physics, evolutionary biology, computer science and even social sciences such as psychiatry, economics and even medical trials.

### **3. Basics of Statistical Inference**

Statistical Inference is a crucial part of the process of informing ourselves about the world around us. Statistical inference helps us understand our world and make sound decisions about how to act. The content of this paper is based on basic statistical methodology which is vital for industry, biosciences and others streams.

#### 4. **Applied Statistics**

1. This course will help students to know the applications of Statistics and learn and apply these techniques in the core course of their study.
2. This course will give exposure to four applied fields of statistics viz. Time Series, Index Numbers, Statistical Quality Control and Demographic methods.
3. They will be having hands on practice of working on the data and interpreting the results related to above mentioned fields.