M.A./ M.Sc. Statistics Programme Course objectives and outcomes

Course code	Course Name	Course Objectives	Course Outcomes (CO)
STT 101	REAL ANALYSIS	• The aim of the course is to introduce fundamental concept of real analysis such as sequence, series of real numbers and their convergence, continuity, differentiability of real valued functions.	**CO1:** Describe fundamental properties of the real numbers that lead to the formal development of real analysis. **CO2:** Comprehend rigorous arguments developing the theory underpinning real analysis. **CO3:** Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration. Construct rigorous mathematical proofs of basic results in real analysis. **CO4:** Understand abstract ideas and rigorous methods in mathematical analysis to solve practical problems. .
STT 102	LINEAR ALGEBRA	• To learn the basic ideas of abstract algebra and techniques with proof in pure mathematics and further, it can be use in many other courses.	**CO1:** Use the basic concepts of vector and matrix algebra, including linear dependence / independence, basis and dimension of a subspace, rank and nullity, for analysis of matrices and systems of linear equations. **CO2:** Evaluate determinants and use them to discriminate between invertible and non-invertible matrices; Use the characteristic polynomial to compute the eigen values and eigenvectors of a square matrix and use them to diagonalizable matrices when this is possible. **CO3:** Discriminate between diagonalizable and non-diagonalisable matrices; orthogonally diagonalizable symmetric matrices and quadratic forms. **CO4:** Combine methods of matrix algebra to compose the change-of-basis matrix with respect to two bases of a vector space, identify linear transformations of finite dimensional vector spaces and compose their matrices in specific bases.
STT 103	DISTRI - BUTION THEORY	• To present the general theory of statistical distributions as well as the standard distributions found in statistical practice. • To train students with essential tools for statistical analyses at the post graduate level. Fostering understanding through real-world statistical applications.	**CO1:** Understand the most common discrete and continuous probability distributions and their real life applications. **CO2:** Compute marginal and conditional distributions from joint distributions. **CO3:** Get familiar with transformation of univariate and multivariate densities. Understanding of distribution helps to understand the nature of data and to perform appropriate analysis. **CO4:** Apply compound, Truncated, mixture and non-central probability distributions to solve problems.

STT 104	SAMPLING METHODS	• To learn scientific view to conduct the survey in proper way to collect the data about specific perspective. • To Learn variety of probability and non-probability sampling methods for selecting a sample from a population.	**CO1:** Understand the basic principles underlying survey design and estimation. **CO2:** Apply the different sampling methods for designing and selecting a sample from a population. **CO3:** Implement Cluster sampling, Ratio and Regression estimation in real life problems. **CO4:** Apply unequal probability sampling designs viz. PPSWR, PPSWOR including Lahiriøs method and Murthyøs estimator for survey.
STT 105	STATISTIC AL COMPUTIN G	• To familiar and to develop learning mindsets to analyze statistical data through R software. • To learn basic syntax, coding and vocabulary to aid in data analysis.	**CO1:** Get familiar with R software and learn basics of R with descriptive statistics. Access online resources for R and import new function packages into the R workspace. Import, review, manipulate and summarize data-sets in R. **CO2:** Compute probabilities and fitting of probability distribution with R environment. **CO3:** Explore small and large data-sets to create testable hypotheses and identify appropriate statistical tests. **CO4:** Perform correlation, regression analysis and appropriate statistical tests for real life situations using R.
STT 106	COMPUTER GRAPHICS	• To learn basic concepts used in computer graphics. • To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping, fundamentals of animation, virtual reality and its related technologies. • To understand a typical graphics pipeline and to design an application.	**CO1:** Understand input and output devices of computer. **CO2:** Understand how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition. **CO3:** Visualize the colors in computer graphics. **CO4:** Comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.
STT 107	STATISTICS EDUCATION AND RESEARCH METHODOL OGY	• To learn critical and creative thinking of model and its components of research.	**CO1:** Understand the basic of research and blooms taxonomy of learning levels. **CO2:** Find the topics from current research in statistics education. **CO3:** Apply statistical tools in design, research and development. **CO4:** Understand, implement and interpreted the general and specific research patterns.

STP 01	Practical-I	**(based on STT 101 to 104)**	**CO1:** Solve the real analysis problems. **CO2:** Apply linear algebra problems in real life situations. **CO3:** Fit the distributions to a real life data using R-software. **CO4:** Perform sampling methods analysis using R-software.
STT 201	PROBABILITY THEORY	• To understand the uncertain occurrence situations with logical manner.	**CO1:** Recognize common probability distributions for discrete and continuous variables. **CO2:** Apply methods from algebra and calculus to derive the mean and variance for a range of probability distributions. **CO3:** Calculate probabilities relevant to multivariate distributions, including marginal and conditional probabilities and the covariance of two random variables. **CO4:** Understand the concept of convergence, common methods for evaluating an inequalities performance and properties of desirable estimators. Understand the central limit theorem and large-sample approximations for common statistics.
STT 202	REGRESSION ANALYSIS	• To develop a deeper understanding of the linear and non-linear regression model and its limitations. • To learn how to develop regression model and apply for the specific perspective data appropriate manner.	**CO1:** Apply simple linear regression model to real life examples. **CO2:** Understand multiple linear regression models with applications and concept of Multicollinearity and autocorrelation. **CO3:** Compute multiple and partial correlation and checking residual diagnostic to validate model. **CO4:** Apply Logistic and Non-linear regression models and its implementation in real life situation.
STT 203	PARAMETRIC INFERENCE	• To derive suitable point estimators of the parameters of the distribution of a random variable and give a measure of their precision. • To learn computational skills to implement various statistical inferential approaches.	**CO1:** Understand the notion of a parametric models, point and interval estimation of the parameters of those models. **CO2:** Obtain the sufficient statistic, minimal sufficient statistic, m.l.e., moment estimator of the parameter. **CO3:** Understand the concept of MVUE, MVBUE, UMVUE. **CO4:** Describe the concept of Bayesian inference and their real life applications.

STT 204	STOCHASTIC PROCESSES	• To learn and to understand stochastic processes predictive approach. • To develop an ability to analyze and apply some basic stochastic processes for solving real life situations.	**CO1:** Understand the stochastic processes, Markov chains, Transition probability matrix and various types of states. **CO2:** Explain Random walk, Gambler ruins problem and apply Poisson process in real life situations. **CO3:** Formulate and solve problems which involve setting up stochastic models. **CO4:** Understand renewal theory and branching processes with applications.
STT 205	CALCULUS	• To compute and analyze limits, derivatives, and integrals functions. • To recognize the appropriate tools of calculus to solve applied problems.	**CO1:** Understand the type of variable and useful in the development of the function. **CO2:** Verify the value of the limit of a function at a point using the definition of the limit. **CO3:** Understand the consequences of the Intermediate value theorem for continuous function. **CO4:** Know the chain rule and use it to find derivatives of composite functions and obtain expression for higher order derivatives of a function using the rule of differentiation. Solve integrals and evaluation of multiple integrals with numerical problems.
STT 206	DEMOGRAPHY	• To identify appropriate sources of data and to perform basic demographic analyses using various techniques across populations. • To learn the main theories used to understand population studies and societal change.	**CO1:** Understand the interdisciplinary nature of demography, balancing equation, use of Whipple's, Myers and UN indices. **CO2:** Understand the measures of mortality and fertility. **CO3:** Describe the concept of life tables. **CO4:** Apply Quasi, Lotka's stable population models.
STT 207	STATISTICAL METHODS IN EPIDEMIOLOGY AND ECOLOGY	• To learn different methods of carrying out and analysing, epidemiological studies. • To study pertinent issues such as appropriate design, data quality, analysis, and interpretation and presentation of results in environmental studies.	**CO1:** Understand the basic epidemiology, parametric growth models and single species growth models. **CO2:** Understand effect of measurement errors on growth rate and related inference problems. **CO3:** Understand the concept of demographic and environmental stochasticity. **CO4:** Understand mathematical models of infectious diseases in stochastic environment.

STT 208	CATEGORICAL DATA ANALYSIS	• To study distributions for categorical data. • To describe and make statistical inference for contingency tables. • To learn different models for categorical data such as Generalized Linear, logit, logistic, log linear and matched pair models.	**CO1:** Visualize categorical data, compute measures of association and structural models for discrete data. **CO2:** Fit logistic models and Poisson models to data set. **CO3:** Check model assumptions and analyze residuals and goodness-of-fit, Conduct inference for model parameters. **CO4:** Understand path and structural equation modeling.
STP-02	Practical-II	**(based on STT 201 to 204)**	**CO1:** Solve the problems related to distribution function. **CO2:** Apply regression analysis technique real life problems. **CO3:** Estimate the parameter of a distribution from sample. **CO4:** Obtain the TPM of real life problems and give conclusions.
STT 301	INDUSTRIAL STATISTICS	• To develop scientific view to analyze the industrial data about specific perspective. • To learn the statistical quality control techniques used in industries such as control charts, acceptance sampling plans etc. • To learn some advanced control charts, capability indices and the concept of six-sigma.	**CO1:** Understand basic of production process monitoring and apply concept of control charts on it. **CO2:** Apply the acceptance and continuous sampling plans in production process. **CO3:** Compute capability indices. **CO4:** Know and apply the concept of weighted control charts, six sigma, ISO: 9000 series standards and Taguchi design.
STT 302	OPERATIONS RESEARCH I	• To develop the optimization techniques that will be useful in the personal and professional life. • To learn the mathematical formulation of complex decision-making problems and arrives at optimal or near-optimal solutions using different techniques of operations research.	**CO1:** Understand basics and formulation of linear programming problems and appreciate their limitations; solve linear programming problems using graphical method. **CO2:** Apply simplex method to solve real life problems. **CO3:** Solve artificial variable technique, duality theory, revised simplex method, sensitivity analysis, transportation and assignment problems. **CO4:** Understand the concept of Game theory, PERT/ CPM, simulation, investment analysis with real life applications.

STT 303	DESIGN OF EXPERIMENTS	- To learn the basic principles in the design of simple experiments. - To learn different tests for comparing pairs of treatment means, ANCOVA, factorial experiments, fractional factorial experiments, confounding, BIBD, PBIBD with solving real life examples. - To learn the applications of different designs in agriculture.	**CO1:** Compare the pairs of treatment means using different methods when null hypothesis in rejected in ANOVA. **CO2:** Analyze the data using split plot, strip plot and general factorial experiments. **CO3:** Construct fractional factorial experiments and apply confounding in real life problems. **CO4:** Understand the analysis of BIBD, PBIBD, Quasi-Latin square, Youden square and cross over design and their applications in agriculture, business and industries.
STT 304	TESTING OF HYPOTHESES	- To learn the development of null and alternative hypotheses. - To learn types of errors, non-parametric tests. - To perform Test of Hypothesis as well as obtain MP, UMP tests.	**CO1:** Formulate null and alternative hypotheses and apply small, large sample and non-parametric tests in real life problems. **CO2:** Compute probabilities of types of error, MP tests and MLR property. **CO3:** Understand UMP and UMPU test with their applications. **CO4:** Obtain asymptotic confidence interval of a parameter and its relation with testing of hypothesis problem.
STT 305	TIME SERIES ANALYSIS	- To learn and develop scientific view to understand the time series data and its analysis. - To learn stationary and non-stationary, and seasonal and non-seasonal time series models. - Learn to estimate model parameters and compare different models developed for the same dataset in terms of their estimation and prediction accuracy.	**CO1:** Understand the concept of time series with its components and able to compute ACVF and ACF. **CO2:** Remove trend and seasonality using different methods to convert the time series into stationary. **CO3:** Apply auto regressive, moving average, ARMA, ARIMA models, Box-Jenkins approach to forecast time-series data empirically. **CO4:** Check and validate models with its residual analysis and diagnostic checking.
STT 306	DECISION THEORY	To learn various decision rules theories and its applications of	**CO1:** Understand decision problem, loss function, risk function and decision rules. **CO2:** Understand the concept of

			admissibility and completeness. **CO3:** Implement nonparametric statistical tests. **CO4:** Apply two sample problems on real life examples.
STT 307	STATISTIC AL METHODS IN FINANCE	• To learn and develop an analytic approach to deal with financial data.	**CO1:** Understand the concept of returns, efficient market hypothesis and compounding. **CO2:** Understand the concept of one risky and two risky assets, portfolio theory. **CO3:** Apply the concept capital asset pricing model. **CO4:** Understand option pricing, Value at risk, the concept of re-sampling.
STT 308	MATHEMA TICAL BIOLOGY	• To learn the theory of mathematical modeling and its applications in the analysis of biological systems including populations of molecules, cells and organisms. • To develop skills in mathematical modeling.	**CO1:** Understand linearization of dynamical systems with various dimensions. **CO2:** Understand translation properties and various criterions. **CO3:** Describe single and multi-species population growth models. **CO4:** Apply the concept of deterministic and stochastic models on simple and general epidemics.
STP 03	Practical III	**(Based on STT 301 to 304)**	**CO1:** Draw controls charts and apply acceptance sampling plans in industry point of view. **CO2:** Apply operations research techniques to solve real life problems. **CO3:** Apply different designs in real life situations. **CO4:** Obtain MP and UMP test.
STT 401	ASYMPTOT IC INFERENCE	• To develop generalization aspect of inferential theory. • To get familiarise with the theories and methods of asymptotic inference.	**CO1:** Understand the concept of consistency and asymptotic normality. **CO2:** Understand method of moments and percentiles, maximum likelihood to find consistent estimator and Cramer Huzurbazar theorem. **CO3:** Apply likelihood ratio tests, Wald, Score and Bartlettøs test in real life situations. **CO4:** Compare various tests through relative asymptotic efficiency.
STT 402	OPERATIO NS RESEARCH-	• To learn advanced methods in operations research course that	**CO1:** Solve real life problem using integer programming. **CO2:** Use dynamic programming in

	II	are used in the systems approach to Engineering and Management, so as to provide them with the requisite tools for the mathematical representation of decision-making problems, in particular emphasizing the roles of uncertainty and risk.	multistage solution problem. **CO3:** Deal with inventories of various goods with and without shortages. **CO4:** Understand and deal with queuing theory, Non-linear (concave) real life optimization problems, Quadratic programming problems.
STT 403	MULTIVARI ATE ANALYSIS	• To learn and develop scientific view to deal with multidimensional datasets and its uses in the analysis of research data. • To understand the extensions of univariate techniques to multivariate frameworks and learn to apply dimension reduction techniques used in the data analysis.	**CO1:** Understand multivariate normal distribution and their real life applications. **CO2:** Understand Wishart distribution, Hotelling T^2 and Mahalanobis D^2 statistic. **CO3:** Implement dimension reduction techniques using software on real life problems. **CO4:** Demonstrate knowledge and understanding of the basic ideas behind discriminant and clustering analysis techniques with applications.
STT 404	RELIABILIT Y AND SURVIVAL ANALYSIS	• To learn the reliability theory and analysis of survival data. • To distinguish censored and uncensored data. • To visualize and communicate time-to-event data, to fit and interpret failure time model.	**CO1:** Understand the elements of reliability, hazard function and its applications. **CO2:** Understand the concept of censoring, life distributions and ageing classes. **CO3:** Estimate nonparametric survival function of the data. **CO4:** Explain test of exponentiality against nonparametric classes, two sample problems.
STT 405	DATA MINING TECHNIQU ES	• To understand the concept of data Mining for enterprise data management and as a cutting edge technology tool. • To enable to identify data sources, processing and imparting knowledge tools to analyze sets of data to gain useful business understanding.	**CO1:** Organize and prepare the data needed for data mining using pre-processing techniques. **CO2:** Understand unsupervised learning techniques for univariate and multivariate data. **CO3:** Understand supervised learning techniques for moderate to high dimensional spaces. **CO4:** Apply classification methods to real life problems in various fields.

STT 406	DIRECTIONAL DATA ANALYSIS	• To learn understanding of data analysis using statistics computational tools on problems of applied nature.	**CO1:** Visualize the large data-set effectively. **CO2:** Understand circular models and concepts of some advanced distributions. **CO3:** Understand the methods of estimation. **CO4:** Apply nonparametric methods to real life problems.
STT 407	ACTUARIAL STATISTICS	• To learn the life tables used in insurance products. • To learn the concept of interest, different life insurance products, life annuities, net premiums. • To motivate students to prepare for exams required for employment in the actuarial science profession.	**CO1:** Understand the utility theory, insurance products and life tables. **CO2:** Understand the concept of interest. **CO3:** Understand the concept of life insurance and the existing insurance products of different insurance company. **CO4:** Know life annuities, net premium and net premium reserves.
STT 408	STATISTICAL TECHNIQUES IN MICROARRAY DATA ANALYSIS	• To learn and develop problem formulations that may be answered by microarray analysis.	**CO1:** Understand and setup for microarray experiments and quantification. **CO2:** Understand statistical inference procedures in comparative experiments for single channel microarray data. **CO3:** Formulate multiple hypotheses testing problems that can be addressed by microarray data analysis. **CO4:** Apply hierarchical cluster analysis in microarray data.
STT 409	CLINICAL TRIALS	• To learn and develop scientific view to study the statistical challenges of clinical comparison of two or more treatments in human subjects. • To Aware of the use of the cross-over design and its limitations.	**CO1:** Understand need and ethics of clinical trials. **CO2:** Apply various designs of clinical trials to the data. **CO3:** Describe optimal cross-over designs experiment with a continuous normally distributed outcome. **CO4:** Understand designs based on clinical endpoints, drug interaction study.
STM-01	Project		**CO1:** Search primary or secondary dataset and collect the data for analysis. **CO2:** Apply the statistical techniques in the project which they had learned in the theory. **CO3:** Interpret and conclude the statistical analysis scientifically. **CO4:** Represent his/her work through power point presentation.

STS 1	DATA ANALYSIS WITH ADVANCED EXCEL	• To learn analysis of various kinds of data using excel.	**CO1:** Handle and process the data using excel. **CO2:** Perform the analysis with analysis tool pack in excel. **CO3:** Customize menus and toolbars in excel. **CO4:** Understand and apply various functions available in excel.
STS 2	STATISTICAL ANALYSIS USING R	• To learn the statistical analysis using ‗R‖ free and open source software.	**CO1:** Understand basics of R environment. **CO2:** Perform various operations on data in R. **CO3**: Do descriptive statistical analysis in R. **CO4:** Compute correlation and regression lines through R.
STS 3	INTRODUCTION TO DATA MINING	• To learn basic data mining techniques and their handling using R software.	**CO1:** Understand fundamentals of data mining. **CO2:** Know feature and applications of data mining. **CO3:** Understand data warehousing, OLAP, OLTP, Data visualization. **CO4:** Implement and interpret the results of data scientifically using R software.
STS 4	DATA ANALYSIS USING SPSS SOFTWARE	• To learn statistical techniques and their implementation using comprehensive SPSS software.	**CO1:** Get familiar with SPSS software and understand SPSS environment. **CO2:** Create and edit the data files, plot graphs using SPSS. **CO3:** Compute descriptive statistics using SPSS. **CO4:** Perform inferential statistical analysis through SPSS.