Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce,
Baramati
Autonomous

Course Structure for M.Sc. I (Semester – I) STATISTICS
(2019 Pattern)

Semester	Paper Code	Title of Paper	No. of Credits
I	STAT-4101	Mathematical Analysis	4
	STAT-4102	Linear Algebra	4
	STAT-4103	Probability Distributions	4
	STAT-4104	Sampling Theory	4
	STAT-4105	Practical-I	4
	STAT-4106	Practical-II	4

SYLLABUS(CBCS) FOR M.Sc. STATISTICS (w.e.f. June, 2019)
(2019 Pattern)
Academic Year 2019-2020

Class : M. Sc. (Semester- I)
Paper Code: STAT-4101
Paper : I Title of Paper : Mathematical Analysis
Credit : 4 credits No. of lectures: 60

A) Course Objectives: Students should:

1 Use calculus to analyze and evaluate properties of real valued functions.

2 Have a deeper understanding of mathematical theory.

B) Course Outcome:

CO1 Understand the fundamentals ideas and applications of calculus.

CO2 Employ technology to investigate mathematical concepts and applications.

CO3 Understand the concepts required for further studies in Probability Theory and Asymptotic Inference.

CO4 Use technology appropriately to investigate and solve mathematical and statistical problems.

CO5 Be familiar with several subfields of mathematics (e.g, numerical analysis, topology, operations research).

CO6 Apply mathematical concepts and principles to perform numerical and symbolic computations.

CO7 concept of convergence of sequence of real numbers, pointwise and uniform convergence of sequence of functions.

SYLLABUS (CBCS) FOR M.Sc. STATISTICS (w.e.f. June, 2019)
(2019 Pattern)
Academic Year 2019-2020

Class : M. Sc. (Semester- I)
Paper Code: STAT-4102
Paper : II Title of Paper : Linear Algebra
Credit : 4 credits No. of lectures: 60

A) Course Objectives:

1 Use the basic concepts of vector and matrix algebra
2 Understand real vector spaces and subspaces and apply their properties.
3 Solve systems of linear equations using various methods
4 Understand basic mathematical concepts required in advanced statistical and machine learning techniques.

C) Course Outcome:

By the end of the course, students will be able to:

CO1 Comprehensive knowledge of matrix operations, including addition, subtraction, multiplication, and properties of matrices.
CO2 Proficiency in matrix algebra, including determinant computation, inverse matrices, and their applications.
CO3 Understanding the concept of linear transformations and their representations using matrices.
CO4 Ability to analyze and describe transformations geometrically, algebraically, and computationally.
CO5 learn about eigen values and eigenvectors and their applications in various fields.
CO6 explore inner product spaces, orthogonality and orthogonal projections.
CO7 apply the concept of decomposition of a matrix.

SYLLABUS (CBCS) FOR M.Sc. STATISTICS (w.e.f. June, 2019)
(2019 Pattern)
Academic Year 2019-2020

Class : M. Sc. (Semester- I)
Paper Code: STAT-4103
Paper : III Title of Paper : Probability Distributions
Credit : 4 credits No. of lectures: 60

A) Course Objectives:

1. Providing students with a formal treatment of probability theory.
2. Understand characteristics about discrete and continuous random variable and their probability distributions.
3. Prepare students for modeling real data using distributions
4. Develop understanding of distribution theory related for further advanced topics in statistical inference.

B) Course Outcome:

Students should be able to:

CO1 Develop problem-solving techniques needed to accurately calculate probabilities.

CO2 Apply problem-solving techniques to solving real-world events.

CO3 Apply selected probability distributions to solve problems.

CO4 prepare students for modeling real data using distributions

CO5 develop understanding of distribution theory related for further advanced topics in statistical inference.

CO6 develop problem-solving techniques to solving real-world events.

CO7 apply selected probability distributions to solve problems.

SYLLABUS (CBCS) FOR M.Sc. STATISTICS (w.e.f. June, 2019)
(2019 Pattern)
Academic Year 2019-2020

Class : M. Sc. (Semester- I)
Paper Code: STAT-4104
Paper : IV
Credit : 4 credits

Title of Paper: Sampling Theory
No. of lectures: 60

A) Course Objectives:

1 To introduce the statistical aspects associated with the design and analysis of sample surveys, and to develop your understanding of the principles and methods used to design survey sampling schemes.
2 Distinguish between probability and non-probability sampling.
3 Understand the factors to consider when determining sample size.
4 Understand the steps in developing a sampling plan.
5 Handle the problem of non response or missing data.

B) Course Outcomes:

Students are expected to

CO1 Define principal concepts about sampling
CO2 Explains the advantages of sampling.
CO3 Lists the stages of sampling process
CO4 Categorizes and defines the sampling methods
CO5 Apply the Simple Random Sampling (SRS) method
CO6 To analyze and solve problems
CO7 Use statistical softwares.

SYLLABUS (CBCS) FOR M.Sc. STATISTICS (w.e.f. June, 2019)
(2019 Pattern)
Academic Year 2019-2020

Class : M. Sc. (Semester- I)
Paper Code: STAT-4105
Paper : V Title of Paper: Practical-I
Credit : 4 credits No. of lectures: 60

A) Course Objectives:

To introduce the statistical aspects associated with the design and analysis of sample surveys, and to develop your understanding of the principles and methods used to design survey sampling schemes

B) Course Outcomes:

Students should be able to:

- **CO1** understand various discrete and continuous probability distributions along with their real-life applications.
- **CO2** understand the concepts of quadratic forms and solve problems.
- **CO3** explore applications of linear algebra in multivariate analysis, linear models etc.
- **CO4** review the core topics in probability and statistics through the study and practice of data analysis and graphical interpretation using statistical software.
- **CO5** solve systems of linear equations using various methods.
- **CO6** plots different probability distributions and draw a model sample from it.
- **CO7** construct the orthogonal matrix, diagonalization of a symmetric matrix etc.

SYLLABUS (CBCS) FOR M.Sc. STATISTICS (w.e.f. June, 2019)
(2019 Pattern)
Academic Year 2019-2020

Class : M. Sc. (Semester- I)
Paper Code: STAT-4106
Paper : VI Title of Paper: Practical-II
Credit : 4 credits No. of lectures: 60

Course Outcomes:

By the end of the course, students will be able to:

- **CO1** Ability to choose appropriate methods for interpolation, optimization, integration, and statistical analysis based on the problem at hand.
- **CO2** Enhanced critical thinking and problem-solving skills in mathematics, statistics, and computational methods.
- **CO3** use statistical software for the analysis and interpretation of the outcomes.
- **CO4** estimate parameters under various sampling techniques.
- **CO5** find solutions of equations using various numerical computing methods.
- **CO6** understand different sampling survey methods and give examples of situations where these methods are useful.
- **CO7** learn R-reporting and developing own R code and use of different R packages.
- **CO8** Proficiency in applying mathematical and computational techniques for data analysis and problem-solving.

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Course Structure for M.Sc. – I (Semester – II) STATISTICS

(2019 Pattern)

Semester	Paper Code	Title of Paper	No. of Credits
II	STAT-4201	Probability Theory	4
	STAT-4202	Parametric Inference	4
	STAT-4203	Multivariate Analysis	4
	STAT-4204	Regression Analysis	4
	STAT-4205	Practical-III	4
	STAT-4206	Practical-IV	4

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4201

Paper : I Title of Paper : Probability Theory

Credit : 4 credits No. of lectures : 60

A) COURSE OUTCOMES:

By the end of the course, students will be able to:

CO1. understand the concepts of random variables, sigma-fields generated by random variables.

CO2. solve the problems based on probability measure, distribution function and expectation.

CO3. understand the concepts of independence of events, random variables.

CO4. understand different modes of convergences

CO5. understand interrelationships between different modes of convergences.

CO6. apply WLLN related to sequence of random variables.

CO7. apply CLT related to sequence of random variables.

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4202

Paper : II Title of Paper : Parametric Inference

Credit : 4 credits No. of lectures : 60

A) Course Outcomes:

By the end of the course, students will be able to:

CO1. Develop a strong theoretical understanding of statistical concepts such as sufficiency, estimation, hypothesis testing, confidence intervals, and Bayesian estimation.

CO2. Develop problem-solving skills using statistical methods and theorems taught in the course in real-world scenarios.

CO3. Grasp the concept of sufficiency according to Fisher and the definitions of sufficient statistic, factorization theorem, joint sufficiency, likelihood equivalence, and minimal sufficiency.

CO4. Apply the factorization theorem to determine sufficient statistics and construct minimal sufficient statistics for given probability distributions, especially within the exponential family and Pitman family.

CO5. Apply Cramer Rao inequality and understand its applications, Rao-Blackwell theorem, completeness, Lehmann-Scheffé theorem, and conditions for Minimum Variance Unbiased Estimators (MVUE).

CO6. Understand UMP tests for one-sided alternatives within the Exponential class of densities and extensions to distributions having Monotone Likelihood Ratio property.

CO7. Understand Confidence Intervals (CI), shortest expected length CI, uniformly most accurate CI, and their properties.

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4203

Paper : III Title of Paper : Multivariate Analysis

Credit : 4 credits No. of lectures: 60

A) Course Outcomes:

By the end of the course, students will be able to:

CO1. carry out an extensive exploratory multivariate analysis for a given multivariate data carry out cluster analysis of given multivariate data.

CO2. create meaningful graphical representations of multivariate data.

CO3. apply the concepts of linear and quadratic forms in multivariate normal variables.

CO4. solve problems involving multivariate normal distribution evaluate.

CO5. carry out statistical inference procedures using the data from a multivariate normal distribution.

CO6. carry out classification of given multivariate data.

CO7. perform hypothesis tests related to the mean vector of a multivariate normal distribution.

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4204

Paper : IV Title of Paper : Regression Analysis

Credit : 4 credits No. of lectures : 60

A) Course outcomes:

By the end of the course, students will be able to:

CO1. Gain proficiency in building regression models to analyze relationships between variables.

CO2. Apply regression analysis techniques to real-world data sets from various domains, such as economics, biology, and social sciences.

CO3. Learn techniques for evaluating the goodness-of-fit of regression models, including the use of residual analysis, R-squared, and adjusted R-squared.

CO4. Extend regression analysis to include nonlinear relationships between variables.

CO5. Apply polynomial regression and other nonlinear regression techniques.

CO6. Utilize multinomial and ordinal regression models to analyze and interpret categorical response variables.

CO7. Apply Poisson regression to model count data.

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4205

Paper : V Title of Paper : Practical-III

Credit : 4 credits No. of lectures : 60

A) Course Outcomes:

By the end of the course, students will be able to:

CO1. Carry out an extensive exploratory multivariate analysis for a given multivariate data carry out cluster analysis of given multivariate data.

CO2. Solve problems involving multivariate normal distribution evaluate.

CO3. Carry out statistical inference procedures using the data from a multivariate normaldistribution.

CO4. Apply likelihood ratio tests to perform hypothesis testing in multivariate scenarios, demonstrating understanding through practical examples.

CO5. Apply multivariate statistical methods to real-world datasets, interpreting and communicating the results effectively.

CO6. Calculate the confidence coefficient associated with a given confidence interval and interpret its meaning in the context of statistical estimation.

CO7. Develop skills in using statistical software/tools to perform computations and analyses related to likelihood ratio tests, discriminant analysis, MANOVA, power calculations, and confidence intervals.

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2019-2020)

Paper Code	: STAT-4206		
Paper	: VI	Title of Paper	: Practical-IV
Credit	: 4 credits	No. of lectures	: 60

A) Course Outcomes:

CO1. Apply regression analysis techniques to real-world data sets from various domains, such as economics, biology, and social sciences.

CO2. Extend regression analysis to include nonlinear relationships between variables.

CO3. Apply polynomial regression and other nonlinear regression techniques.

CO4. Utilize multinomial and ordinal regression models to analyze and interpret categorical response variables.

CO5. Apply the Central Limit Theorem to demonstrate how the distribution of sample means or sums approximates a normal distribution regardless of the underlying distribution.

CO6. Apply modes of convergence in analyzing and interpreting convergence properties of sequences of random variables or functions.

CO7. Develop analytical skills to understand and apply mathematical and statistical concepts related to convergence, laws of large numbers, hypothesis testing, etc.

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Course Structure for M.Sc. - II Semester- III (STATISTICS)
(2019 Pattern)

Semester	Paper Code	Title of the Paper	No. of Credits
III	STAT-5301	Asymptotic Inference	4
	STAT-5302	Design and Analysis of Experiments	4
	STAT-5303	Time Series Analysis	4
	STAT-5304 (A) STAT-5304 (B) STAT-5304 (C)	Data Mining Or Design and Analysis of Clinical Trials Or Optimization Techniques	4
	STAT-5305	Practical-V	4
	STAT-5306	Practical-VI	4

M.Sc.-II Sem.-III STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5301
Paper : I Title of Paper : Asymptotic Inference

A) Course outcomes:

By the end of the course, students will be able to:

CO1. understand concept of Consistent estimator, CAN estimator.
CO2. obtain consistent estimator and their asymptotic distributions.
CO3. choose the ARE estimator among given various consistent estimators.
CO4. obtain asymptotic distributions of moment estimators, percentile estimators.
CO5. determine maximum likelihood estimator and its asymptotic distributions
CO6. derive Likelihood Ratio Test (LRT), large sample test Wald's test, and Score test,
CO7. compute asymptotic confidence interval.

M.Sc.-II Sem.-III STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5302

Paper : II Title of Paper : Design and Analysis of Experiments

A) Course outcomes:

By the end of the course, students will be able to:

CO1. understand basic principles and various terms of Design of Experiments.

CO2. apply factorial design in real life problems.

CO3. apply fractional factorial design in real life problems.

CO4. implicating total confounding and partial confounding in real life problems.

CO5. apply appropriate design in real life situation

CO6. analyze the data of various experimental design.

CO7. understand the concept of Taguchi methods.

M.Sc.-II Sem.-III STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5303
Paper : III Title of Paper : Time Series Analysis

A) Course outcomes:

By the end of the course, students will be able to:

CO1. fit the model on time series data like ARMA, ARIMA, SARIMA, ARCH and GARCH properties.

CO2. apply and understand the techniques for estimating parameters of time series models also the role of maximum likelihood estimation in time series modeling.

CO3. perform diagnostic checks on time series models to assess model adequacy.

CO4. identify and address issues such as autocorrelation and heteroscedasticity.

CO5. analyses time series data and use multivariate time series models such as vector auto regression (VAR).

CO6. Gain proficiency in using ITSM, R and Python to fit an appropriate time series model and infer the results.

CO7. effectively interpret the results of time series analyses, both in written reports and oral presentations.

M.Sc.-II Sem.-III STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5304 (A)
Paper : IV Title of Paper : Data Mining

A) Course outcomes:

By the end of the course, students will be able to:

CO1. understand the basic concepts, goals, and challenges of data mining.

CO2. explore the role of data mining in extracting meaningful patterns and knowledge from large datasets.

CO3. Study and apply a variety of data mining techniques, like CART, SVM, PCA, KNN, etc.

CO4. understand and implement supervised learning algorithms for classification and regression tasks, and explore unsupervised learning techniques, including clustering algorithms.

CO5. Explore ethical issues related to data mining, including privacy concerns and bias in algorithms.

CO6. apply data mining techniques to real-world datasets, and interpret the results and draw actionable insights from the analysis.

CO7. gain practical experience by working with data mining tools and software like, R, Python.

M.Sc.-II Sem.-III STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5304(B)

Paper : IV Title of Paper : Design and Analysis of Clinical Trials

A) Course outcomes:

By the end of the course, students will be able to:

CO1. understand the principles of Good Clinical Practice.

CO2. demonstrate an understanding of the essential principles of modern bio-statistical methods and statistical software and how to apply them.

CO3. learn methods for determining the appropriate sample size for a clinical trial.

CO4. understand the purpose and importance of clinical trials in medical research.

CO5. explore the phases of clinical trials and their objectives.

CO6. learn about ethical guidelines and regulatory requirements governing clinical trials.

CO7. develop and implement statistical analysis plans for clinical trials, and understand the principles of intention-to-treat analysis.

M.Sc.-II Sem.-III STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5304(C)

Paper : IV Title of Paper : Optimization Techniques

A) Course outcomes:

By the end of the course, students will be able to:

CO1. understand the fundamental concepts of optimization, and differentiate between constrained and unconstrained optimization problems.

CO2. explore optimization problems with integer constraints, and understand methods for solving integer and mixed-integer programming problems.

CO3. apply optimization techniques to solve problems in operations research, such as network optimization, transportation problems, and scheduling.

CO4. apply optimization techniques to real-world problems, demonstrating the ability to formulate and solve practical optimization challenges.

CO5. study optimization problems with nonlinear objective functions or constraints.

CO6. effectively communicate the results of optimization analyses, both in written reports and oral presentations.

CO7. gain proficiency in using programming languages like R and Python for solving optimization problems also apply optimization libraries and tools available in these languages.

M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5305
Paper : V Title of Paper : Practical-V

A) Course outcomes:

By the end of the course, students will be able to:

CO1. apply factorial design in real life problems.
CO2. apply fractional factorial design in real life problems.
CO3. implicating total confounding and partial confounding in real life problems.
CO4. understand the concept of Taguchi methods.
CO5. obtain and verify consistent estimator and their asymptotic distributions.
CO6. derive Likelihood Ratio Test (LRT), large sample test Wald's test, and Score test.
CO7. plotting likelihood function and obtain the MLE by scoring method.

M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5306

Paper : VI Title of Paper : Practical-VI

A) Course outcomes:

By the end of the course, students will be able to:

CO1. fit the model on time series data like ARMA, ARIMA, SARIMA, ARCH and GARCH properties.

CO2. apply and understand the techniques for estimating parameters of time series models also the role of maximum likelihood estimation in time series modeling.

CO3. perform diagnostic checks on time series models to assess model adequacy.

CO4. identify and address issues such as autocorrelation and heteroscedasticity.

CO5. develop skills in time series forecasting using appropriate models.

CO6. gain proficiency in using ITSM, R and Python to fit an appropriate time series model and infer the results.

CO7. effectively communicate the results of time series analyses, both in written reports and oral presentations.

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Course Structure for M.Sc. - II Semester- IV (STATISTICS)
(2019 Pattern)

(With effect from Academic Year 2020-2021)

Semester	Paper Code	Title of the Paper	No. of Credits
IV	STAT-5401	Stochastic Processes	4
	STAT-5402	Statistical Process Control	4
	STAT-5403	Survival Analysis	4
	STAT-5404 (A) STAT-5404 (B) STAT-5404 (C)	Actuarial Statistics Or Reliability Theory Or Statistical Analysis of Micro-Array Data	4
	STAT-5405	Practical-VII	4
	STAT-5406	Project	4

M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5401

Paper : I Title of Paper : Stochastic Processes

A) Course outcomes:

Students will be able to:

CO1. develop a deep understanding of what stochastic processes are, including their definitions, characteristics, and mathematical representations.

CO2. understand stationary processes and its properties.

CO3. develop problem-solving skills of stochastic processes theory to practical problems.

CO4. explore the ethical implications of using stochastic processes in various fields.

CO5. perform stochastic simulations.

CO6. learn statistical packages for modeling and analyzing stochastic processes.

CO7. learn about continuous-time stochastic processes, including the Poisson process, Brownian motion, Wiener process and Renewal process.

M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5402

Paper : II Title of Paper : Statistical Process Control

A) Course Outcomes:

Students will be able to

CO1. describe the DMAIC processes (define measure, analyze, improve, and control).

CO2. perform analysis of process capability and measurement system capability.

CO3. demonstrate the ability to design, use, and interpret synthetic and non-parametric control chart.

CO4. determine the "short" term stability and capability of a process.

CO5. learn about process capability indices (e.g., Cp, Cpk) and their interpretation, also assess the capability of a process to meet specifications.

CO6. learn about advanced control charts, like CUSUM charts and EWMA charts.

CO7. effectively communicate SPC results and recommendations to various stakeholders.

M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5403

Paper : III Title of Paper : Survival Analysis

A) Course outcomes:

After completing this paper, the student will be able to:

CO1. identify applications with time to event outcomes.

CO2. construct a life table using the actuarial approach.

CO3. construct a life table using the Kaplan-Meier approach.

CO4. perform and interpret the log rank test.

CO5. compute and interpret a hazard ratio.

CO6. interpret coefficients in Cox proportional hazards regression analysis.

CO7. learn about censored and truncated data and understand how to handle these issues in survival analysis.

M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5404(A)

Paper : IV Title of Paper : Actuarial Statistics

A) Course outcomes:

By the end of the course, students should be able to:

CO1. identify and analyse consequences of events involving risk and uncertainty.

CO2. calculate survival function, curtate future lifetime, force of mortality.

CO3. calculate various payments from life tables using principle of equivalence, net premiums, prospective and retrospective reserve.

CO4. understand the principles of risk management and how they apply to actuarial practice.

CO5. gain insights into the insurance and financial industries, including current trends, challenges, and opportunities.

CO6. apply actuarial techniques to real-world scenarios and case studies.

CO7. explore ethical considerations and responsibilities in the actuarial profession.

M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5404(B)

Paper : IV Title of Paper : Reliability Theory

A) Course Outcomes:

By the end of the course, students should be able to:

CO1. The students will be able to evaluate system reliability for series, parallel, k out of n systems.

CO2. The students will be able to get idea of important lifetime distributions such as for exponential, Weibull, gamma and lognormal distributions.

CO3. Learn and compute various reliability metrics, including reliability function, failure rate, mean time to failure (MTTF), and mean time between failures (MTBF).

CO4. develop skills in evaluating the overall reliability of complex systems.

CO5. learn to represent and analyze system reliability using reliability block diagrams, and understand the concept of redundancy in improving system reliability.

CO6. understand how to integrate component reliability information into a system reliability assessment.

CO7. develop skills in effectively communicating reliability analysis results, and prepare reports and presentations for diverse stakeholders.

M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5404(C)

Paper : IV Title of Paper : Statistical Analysis of Micro-Array Data

A) Course outcomes:

Students should be able to:

CO1. understand the principles of microarray technology and its application in genomics.

CO2. recognize the types of microarray platforms and their differences.

CO3. apply exploratory data analysis techniques to understand the characteristics of microarray datasets. Also, visualize gene expression patterns and identify outliers.

CO4. learn about the challenges of multiple hypothesis testing in microarray experiments.

CO5. indulge the facts and elements of applications of genomic and proteomics technologies, and functioning.

CO6. apply statistical techniques to analyze differential gene expression pattern and interpret the results generated.

CO7. recognize modern statistical methods and software to solve complex problems in genome data.

M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5405

Paper : V Title of Paper : Practical-VII

A) Course Outcomes:

Students should be able to:

CO1. Understand the applications of stochastic processes in modeling real-world phenomena.

CO2. Learn the fundamentals of stochastic calculus, including Ito's lemma and stochastic differential equations (SDEs).

CO3. Analyze and model various types of stochastic processes, including Poisson processes.

CO4. Understanding the principles and techniques of SPC to monitor, control, and improve processes.

CO5. Proficiency in using statistical tools and charts to analyse process variation and make data- driven decisions for quality improvement.

CO6. Acquire knowledge of actuarial mathematics, including probability theory and mathematical modelling.

CO7. Learn about various actuarial models and techniques for risk assessment and management.

M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5406
Paper : VI Title of Paper : Project

A) Course Outcomes:

CO1. Students will be able to gain practical experience in data collection, data cleaning, and data imputation, which are essential skills in statistics, data analytics and data science.

CO2. Gaining expertise in statistical software packages like R, SAS, or Python and using these tools is valuable for future career opportunities in IT industry and many more filed.

CO3. MSc project serves as a valuable stepping stone, demonstrating research capabilities.

CO4. Statistical analysis may provide insights that can inform policy or decision-making in these areas in a specific social issue or problem, such as healthcare, education, or environmental sustainability.

CO5. MSc projects can identify actionable insights; consider providing recommendations or guidelines for addressing the social issue that were studied.

CO6. Collaborate with experts from other fields (e.g., biology, economics, psychology, garniture, manufacturing industry) to apply statistical methods to interdisciplinary problems, potentially leading to innovative solutions and insights.

CO7. Successful MSc projects can open doors to consulting opportunities where students can apply statistical methods to solve practical problems for businesses or organizations.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- III)
Paper Code	: MICRO5301
Paper	: I
Title of Paper	: Immunology
Credit	: 4
No. of lectures	: 60

Course Outcome:

CO1. Explain the mechanisms of immune response regulation to prevent autoimmunity and excessive immune reactions.
CO2. Understand the roles of regulatory T cells and cytokines in immune regulation.
CO3. Describe the role of the immune system in recognizing and eliminating cancer cells.
CO4. Understand immunotherapeutic approaches for cancer treatment
CO5. Develop critical thinking skills to analyze immunological data and solve problems related to immune responses.
CO6. Effectively communicate immunological concepts through written and/or oral presentations

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- III)
Paper Code	: MICRO5302
Paper	: II
Title of Paper	: Molecular Biology I
Credit	: 4
No. of lectures	: 60

Course outcome:

CO1. Students will demonstrate an in-depth understanding of operons and the various regulatory mechanisms governing gene expression in prokaryotic and eukaryotic systems.

CO2. Students will comprehend the function and significance of riboswitches in gene regulation and the role of sigma factors in response to phage infections across different bacterial hosts.

CO3. Students will gain a comprehensive understanding of the molecular processes involved in mRNA, rRNA, and tRNA processing, including splicing, modifications, and maturation.

CO4. Students will comprehend the roles and mechanisms of non-coding RNAs, including their involvement in RNA interference pathways and gene silencing.

CO5. Students will demonstrate proficiency in executing various molecular techniques, including gel assays, ChIP, probe designing, DNA and protein detection methods, footprinting assays, and hybridization techniques.

CO6. Students will be able to apply and elucidate the significance of genome analysis tools such as knockout mice, phage display, RFLP, DNA fingerprinting, and methods for measuring transcription rates and RNA interactions in molecular research.

CO7. Students will understand and explain the role of molecular diagnostic tools, particularly PCR-based methods and microarrays, in the detection and diagnosis of diseases, focusing on their applications in cancer diagnostics.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- III)
Paper Code	: MICRO5303
Paper	: III
Title of Paper	: Industrial waste water treatment
Credit	: 4
No. of lectures	: 60

Course Outcome:

CO1. Provide definitions for fundamental terms and concepts associated with treating industrial wastewater.

CO2. Outline the importance of industrial wastewater treatment in safeguarding the environment.

CO3. Capable of identifying elementary wastewater measures, including pH, turbidity, and suspended solids.

CO4. Analyze wastewater characterization information to gauge pollution levels and create treatment approaches.

CO5. Elucidate the fundamental principles governing physical treatment methods.

CO6. Develop an initial design for a physical treatment setup tailored to a particular industrial wastewater.

CO7. Evaluate and interpret data derived from a biological treatment setup, encompassing COD and BOD elimination efficiency.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc.II (Semester- III)
Paper Code	: MICRO5304
Paper	: IV
Title of Paper	: Biophysical Techniques
Credit	: 4
No. of lectures	: 60

Course Outcome:

CO1. Students will gain the ability to understand molecular structure determination
CO2. Student will grasp the fundamental concept of biology, chemistry and physics, understanding how these disciplines interconnect with biology systems.
CO3. Students will effectively operate in the laboratory while adhering to safe practices.
CO4. Students will critically assess primary literature within the field.
CO5. Students will effectively utilize databases, computational tools, and other online resources.
CO6. Students will exhibit awareness of issues in the practice of science.
CO7. Shows a strong grasp of biophysical concept.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc.II (Semester- III)
Paper Code	: MICRO5305
Paper	: V
Title of Paper	: Practical Course: Practical course based on Immunology, Pharmaceutical Microbiology and Industrial waste water treatment
Credit	: 4
No. of lectures	: 60

Course Outcome

CO1. Students should be capable of determining fundamental wastewater parameters, including pH, turbidity, and suspended solids.

CO2. Analyze data on wastewater characterization to evaluate levels of pollution and formulate treatment strategies.

CO3. Evaluate and interpret data obtained from a biological treatment system, specifically focusing on the efficiency of COD and BOD removal.

CO4. Explore the factors that impact the rate of single diffusion and understand their contributions to the overall process.

CO5. Examine practical instances where single diffusion plays a pivotal role, such as in biological membranes, chemical reactions, or materials science.

CO6. Assess experimental methodologies employed in the study of single diffusion critically and interpret the outcomes of experiments

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc.II (Semester- III)
Paper Code	: MICRO5306
Paper	: VI
Title of Paper	: Practical Course: Practical course based on Molecular Biology (I and II) and Microbial Technology
Credit	: 4
No. of lectures	: 60

Course outcome:

After completing this course Students should able to:

CO1. Develop the capability to evaluate and explain the effects of different gel concentrations on the effectiveness and stability of immobilized cells or enzymes in bioconversion processes.

CO2. Acquire the ability to analyze and interpret the influence of various cell concentrations on the speed and output of bioconversion reactions, leading to informed decision-making in process optimization.

CO3. Acquire the ability to analyze and interpret the influence of various enzyme concentrations on the speed and output of bioconversion reactions, leading to informed decision-making in process optimization.

CO4. Attain a comprehensive understanding of the underlying mechanisms involved in biosorption, particularly elucidating the uptake of dyes or metals by utilizing deceased biomass as an absorbent material.

CO5. Develop proficiency in optimizing laboratory-scale production conditions, specifically focusing on manipulating media composition to maximize the yield of exopolysaccharides or bioemulsifiers.

CO6. Gain expertise in employing various techniques and methodologies for characterizing bacterial isolates at a molecular level, including genetic profiling and accurate identification.

CO7. Develop the ability to comprehend and apply the process of gene annotation, including the identification, analysis, and determination of functions, regulatory elements, and potential roles of gene sequences within biological systems.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- III)
Paper Code	: CC029
Title of Paper	: Certificate Course – Research Methodology
Credit	: 2
No. of lectures	: 30

Course outcome:

CO1. Students will demonstrate an understanding of the philosophical principles and paradigms underpinning various research methodologies.

CO2. Students will be able to recognize and differentiate between various types of research publications, comprehending their structures and content.

CO3. Students will develop proficiency in using online referencing tools to create accurate citations and bibliographies.

CO4. Students will understand the concept of plagiarism and adopt strategies to prevent its occurrence in academic and research writing.

CO5. Students will gain an introductory understanding of statistical software, specifically focusing on R software.

CO6. Students will acquire skills in constructing effective titles and composing informative yet concise abstracts for research papers or proposed projects.

CO7. Students will demonstrate the ability to craft diverse sections of a research paper, including materials and methods, results, discussion, conclusion, etc., adhering to academic writing norms.

SYLLABUS (CBCS) FOR M.Sc. I. Microbiology (2019 Pattern)
(w. e. from June, 2019)
Academic Year 2019-2020

Class	: M. Sc. II (Semester- III)
Paper Code	: SD23
Title of Paper	: Skill Development: Spectroscopic Techniques
Credit	: 2
No. of lectures	: 30

Course Outcome:

CO1. Understand the Principles: Students will be able to explain the fundamental principles of UV-Visible spectroscopy, including the interaction of electromagnetic radiation with matter, molecular transitions, and the Beer-Lambert Law.

CO2. Gain proficiency in operating UV-Visible spectrophotometers, understanding the components, and calibrating the instrument for accurate measurements.

CO3. Develop the ability to perform quantitative analysis using UV-Visible spectroscopy, including the determination of concentration and molar absorptivity.

CO4. Interpret UV-Visible spectra to identify functional groups, electronic transitions, and chemical properties of various compounds.

CO5. Acquire skills in developing experimental methods for specific applications using UV-Visible spectroscopy, such as kinetics studies, reaction monitoring, and quality control.

CO6. Learn to troubleshoot common issues associated with UV-Visible spectrophotometers and understand routine maintenance procedures to ensure reliable and accurate results.

CO7. Understand the fundamental principles of Atomic Absorption Spectroscopy, including the theory of atomic absorption, energy levels, and the role of hollow cathode lamps.

CO8. Gain proficiency in operating AAS instruments, handling sample introduction systems, and optimizing instrumental parameters for different elements.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5401
Paper	: I
Title of Paper	: Pharmaceutical Microbiology
Credit	: 4
No. of lectures	: 60

Course Outcome:

CO1. In addition to drug development students will also understand the concepts of drug discovery

CO2. They will be able to know pharmacokinetics and pharmacodynamics.

CO3. Proficiency in various drug screening methods, including high-throughput screening, virtual screening, and biochemical assays.

CO4. They will be able to know medicinal chemistry principles to design and optimize drug candidates.

CO5. An understanding of the pharmacological aspects of drug development, including mechanisms of action, pharmacokinetics, and pharmacodynamics.

CO6. Knowledge of safety assessment procedures and understanding of potential toxicity issues associated with drug candidates.

CO7. Proficiency in developing drug formulations and delivery systems.

CO8. Awareness of the regulatory pathways for drug approval, as well as ethical considerations in drug development.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5402
Paper	: II
Title of Paper	: Molecular Biology II
Credit	: 4
No. of lectures	: 60

Course outcome:

CO1. Students will acquire comprehensive knowledge of diverse gene cloning techniques, including gene and genome library preparation, cDNA libraries, PCR cloning, and alternative methodologies.

CO2. Students will demonstrate an understanding of methods for manipulating large DNA fragments (YAC, BAC, HAC) and gene transfer techniques used to introduce foreign DNA into host cells.

CO3. Students will explore and comprehend the process of synthesizing various commercial products (amino acids, ascorbic acid, antibiotics, peptide antibodies, biopolymers) using recombinant DNA technology.

CO4. Students will understand the process of bioremediation involving the degradation of xenobiotics and the engineering of pathways for degradation in genetically modified organisms.

CO5. Students will comprehend the utilization of starch and cellulose for the production of fructose, alcohol, and silage, utilizing genetically modified organisms.

CO6. Students will critically assess and discuss the social and ethical issues associated with genetically modified organisms.

CO7. Students will explore the various applications of GMOs in medicine, including disease prevention, early detection, therapies, as well as their uses in agriculture. They will analyze the advantages, disadvantages, and instances of transgenic plants producing beneficial molecules.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5403
Paper	: III
Title of Paper	: Microbial Technology
Credit	: 4
No. of lectures	: 60

Course Outcome:

CO1. Thorough comprehension of diverse bioreactor designs and variables in the process.

CO2. Comprehend the basic principles of microbial technology, encompassing microbial physiology, genetics, and metabolism.

CO3. Recognize and categorize various microorganism types, comprehending their functions in diverse industrial processes.

CO4. Show proficiency in techniques employed for microbial isolation, cultivation, and maintenance in laboratory environments.

CO5. Utilize understanding of microbial technology to address practical issues and formulate solutions in biotechnology.

CO6. Examine and interpret data derived from microbial experiments, drawing sound conclusions.

CO7. Assess the ethical considerations and societal repercussions of microbial technology across diverse sectors, including healthcare, agriculture, and environmental remediation.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5404
Paper	: IV
Title of Paper	: Medical Microbiology
Credit	: 4
No. of lectures	: 60

Course Outcome:

CO1. Demonstrate proficiency in laboratory techniques used for the identification and characterization of microorganisms and understand the principles of diagnostic microbiology, including specimen collection, culture, and sensitivity testing.

CO2. Explain the mechanisms by which microorganisms cause diseases in humans and understand host-pathogen interactions and the immune response to microbial infections.

CO3. Analyze the epidemiology of infectious diseases, including transmission modes and risk factors and discuss the role of medical microbiology in public health and disease prevention.

CO4. Describe the mechanisms of action of antimicrobial agents and understand the development of antimicrobial resistance and its implications for treatment.

CO5. Correlate microbiological concepts with clinical manifestations of infectious diseases and apply knowledge to the diagnosis and management of infectious diseases in a clinical setting.

CO6. Develop critical thinking skills in the analysis of scientific literature related to medical microbiology.

CO7. Demonstrate awareness of ethical considerations in the practice of medical microbiology and understand the importance of professional conduct and communication in healthcare settings.

CO8. Communicate microbiological concepts effectively through written and oral presentations.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5405
Paper	: V
Title of Paper	: Dissertation I
Credit	: 4
No. of lectures	: 60

Course outcome:

CO1. Comprehend the research process, encompassing the formulation of research questions, hypotheses, and objectives.
CO2. Identify suitable research designs and methodologies based on specified research questions and objectives.
CO3. Critically assess and select relevant literature for conducting comprehensive literature reviews.
CO4. Develop research proposals outlining the research design, methodology, and ethical considerations.
CO5. Apply varied data collection methods, such as surveys, interviews, experiments, and observations.
CO6. Analyze and interpret both quantitative and qualitative data using suitable statistical and analytical methods.
CO7. Communicate research findings effectively through written reports and oral presentations.
CO8. Demonstrate adherence to guidelines for responsible research practices, exhibiting ethical conduct throughout the research process. Evaluate and critique research studies published in academic journals, identifying their strengths and limitations.
CO9. Cultivate a mindset geared toward research and emphasize the importance of continual learning within the research field.
CO10. Gain an understanding of the philosophy and ethical considerations inherent in research practices.
CO11. Demonstrate the ability to compose research proposals effectively.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology (2019 Pattern)
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5406
Paper	: VI
Title of Paper	: Dissertation II
Credit	: 4
No. of lectures	: 60

Course outcome:

CO1. Comprehend the research process, encompassing the formulation of research questions, hypotheses, and objectives.

CO2. Identify suitable research designs and methodologies based on specified research questions and objectives.

CO3. Critically assess and select relevant literature for conducting comprehensive literature reviews.

CO4. Develop research proposals outlining the research design, methodology, and ethical considerations.

CO5. Apply varied data collection methods, such as surveys, interviews, experiments, and observations.

CO6. Analyze and interpret both quantitative and qualitative data using suitable statistical and analytical methods.

CO7. Communicate research findings effectively through written reports and oral presentations.

CO8. Demonstrate adherence to guidelines for responsible research practices, exhibiting ethical conduct throughout the research process. Evaluate and critique research studies published in academic journals, identifying their strengths and limitations.

CO9. Cultivate a mindset geared toward research and emphasize the importance of continual learning within the research field.

CO10. Gain an understanding of the philosophy and ethical considerations inherent in research practices.

CO11. Demonstrate the ability to compose research proposals effectively.

SYLLABUS (CBCS) FOR M.Sc. I. Microbiology (2019 Pattern)
(w. e. from June, 2019)
Academic Year 2019-2020

Class	: M. Sc. II (Semester- IV)
Paper Code	: SD24
Title of Paper	: Skill Development: Chromatographic Techniques
Credit	: 2
No. of lectures	: 30

Course Outcome:

CO1. Understand the Principles: Students will be able to explain the fundamental principles of UV-Visible spectroscopy, including the interaction of electromagnetic radiation with matter, molecular transitions, and the Beer-Lambert Law.

CO2. Gain proficiency in operating UV-Visible spectrophotometers, understanding the components, and calibrating the instrument for accurate measurements.

CO3. Develop the ability to perform quantitative analysis using UV-Visible spectroscopy, including the determination of concentration and molar absorptivity.

CO4. Interpret UV-Visible spectra to identify functional groups, electronic transitions, and chemical properties of various compounds.

CO5. Acquire skills in developing experimental methods for specific applications using UV-Visible spectroscopy, such as kinetics studies, reaction monitoring, and quality control.

CO6. Learn to troubleshoot common issues associated with UV-Visible spectrophotometers and understand routine maintenance procedures to ensure reliable and accurate results.

CO7. Understand the fundamental principles of Atomic Absorption Spectroscopy, including the theory of atomic absorption, energy levels, and the role of hollow cathode lamps.

CO8. Gain proficiency in operating AAS instruments, handling sample introduction systems, and optimizing instrumental parameters for different elements.