Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce,
Baramati
Autonomous
M.Sc. – I Semester – I (Statistics)
(2022 Pattern)
(w. e. from June, 2022)

Name of the Programme : **M.Sc. Statistics**

Program Code : **PSST**

Class : **M.Sc. Part – I**

Semester : **I**

Paper Code	Title of Paper	No. of Credits
PSST111	Mathematical Analysis	4
PSST112	Linear Algebra	4
PSST113	Probability Distributions	4
PSST114	Sampling Theory	4
PSST115	Statistics Practical – I	4
PSST116	Statistics Practical – II	4

M.Sc. Statistics
(2022 Pattern)

(w. e. from June, 2022)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: I
Course Name	: Mathematical Analysis
Course Code	: PSST111
No. of lectures	: 60
Credit	: 4 credits

A) Course Outcomes:

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

CO1. students will develop strong analytical and logical reasoning skills through the study of mathematical analysis.

CO2. comprehend and construct rigorous mathematical proofs, and use deductive reasoning to solve complex mathematical problems.

CO3. Understand the fundamental mathematical concepts which will useful in learning probability theory course.

CO4. acquire the knowledge to analyze mathematical problems in the context of statistics.

CO5. understand the different types of convergence, such as pointwise convergence, uniform convergence.

CO6. construct and understand mathematical proofs on various results.

CO7. Understand the concepts which required for further studies in Probability Theory and Asymptotic Inference.

M.Sc. Statistics
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(w. e. from June, 2022)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: I
Course Name	: Linear Algebra
Course Code	: PSST112
No. of lectures	: 60
Credit	: 4 credits

A) Course Outcomes:

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

CO1. understand the concepts of vectors, matrices, linear transformations, and systems of linear equations.

CO2. familiar with the properties and characteristics of vector spaces, concepts like subspaces, basis, linear independence and dimension.

CO3. learn about eigen values and eigenvectors and their applications in various fields.

CO4. explore inner product spaces, orthogonality and orthogonal projections.

CO5. apply the concept of decomposition of a matrix.

CO6. understand the concepts of quadratic forms and solve problems.

CO7. explore applications of linear algebra in multivariate analysis, linear models etc.

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(w. e. from June, 2022)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: I
Course Name	: Probability Distributions
Course Code	: PSST113
No. of lectures	: 60
Credit	: 4 credits

A) Course Outcomes:

CO1. understand characteristics about discrete and continuous random variable and their probability distributions.

CO2. prepare students for modeling real data using distributions

CO3. develop understanding of distribution theory related for further advanced topics in statistical inference.

CO4. develop problem-solving techniques to solving real-world events.

CO5. apply selected probability distributions to solve problems.

CO6. Present the analysis of derived statistics to all audiences.

CO7. Develop problem-solving techniques needed to accurately calculate probabilities

M.Sc. Statistics
(2022 Pattern)
(w. e. from June, 2022)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: I
Course Name	: Sampling Theory
Course Code	: PSST114
No. of lectures	: 60
Credit	: 4 credits

A) Course Outcomes:

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

CO1. define principal concepts about sampling.

CO2. lists the stages of sampling process.

CO3. understand the distinctive features of different sampling techniques and their related estimation problems.

CO4. learn the practical applications of the various sampling techniques in real life situations.

CO5. lists the stages of sampling process.

CO6. categorizes and defines the sampling methods.

CO7. apply the appropriate sampling method.

M.Sc. Statistics
(2022 Pattern)
(w. e. from June, 2022)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: I
Course Name	: Statistics Practical – I
Course Code	: PSST115
No. of lectures	: 60
Credit	: 4 credits

Course Outcomes:

Students should be able to:

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

M.Sc. Statistics
(2022 Pattern)
(w. e. from June, 2022)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: I
Course Name	: Statistics Practical – II
Course Code	: PSST116
No. of lectures	: 60
Credit	: 4 credits

Course Outcomes:

Students should be able to:

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

Anekant Education Society's
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Autonomous
M.Sc. – I Semester – II (Statistics)
(2022 Pattern)
(With effect from Academic Year 2022-2023)

Name of the Programme : **M.Sc. Statistics**

Program Code : **PSST**

Class : **M.Sc. Part – I**

Semester : **II**

Paper Code	Title of Paper	No. of Credits
PSST121	Modern Probability Theory	4
PSST122	Statistical Inference	4
PSST123	Applied Multivariate Analysis	4
PSST124	Regression Models	4
PSST125	Statistics Practical – III	4
PSST126	Statistics Practical – IV	4

M.Sc. Statistics
(2022 Pattern)
(With effect from Academic Year 2022-2023)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: II
Course Name	: Modern Probability Theory
Course Code	: PSST121
No. of lectures	: 60
Credit	: 4 credits

A) Course Outcomes:

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 and their interrelationships

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.

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(With effect from Academic Year 2022-2023)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: II
Course Name	: Statistical Inference
Course Code	: PSST122
No. of lectures	: 60
Credit	: 4 credits

A) Course Outcomes:

Students will be able to understand the concept of

CO1 estimation and testing procedures to deal with real life problems.

CO2 Fisher Information matrix, Lower bounds to variance of estimators, MVUE.

CO3 prior and posterior data based modeling and analysis.

CO4 data reduction and different family of distributions

CO5 most powerful test, Neyman-Pearson fundamental lemma, UMP test, UMPU test.

CO6 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.

CO7 Understand UMP tests for one-sided alternatives within the Exponential class of densities and extensions to distributions having Monotone Likelihood Ratio property.

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Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: II
Course Name	: Applied Multivariate Analysis
Course Code	: PSST123
No. of lectures	: 60
Credit	: 4 credits

Course Outcomes:

After completion of this course the students will be able to

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

CO2 carry out cluster analysis of given multivariate data

CO3 solve problems involving multivariate normal distribution Evaluate

CO4 carry out statistical inference procedures using the data from a multivariate normal distribution.

CO5 carry out classification of given multivariate data

CO6 solve problems involving multivariate normal distribution evaluate.

CO7 carry out statistical inference procedures using the data from a multivariate normal distribution.

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(With effect from Academic Year 2022-2023)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: II
Course Name	: Regression Models
Course Code	: PSST124
No. of lectures	: 60
Credit	: 4 credits

Course Outcomes:

Students will be able to

CO1 Excellent familiarity with both linear and nonlinear regression models.

CO2 Understanding of model selection and regression modelling techniques should be demonstrated.

CO3 The relation between dependent and independent variables should be examined.

CO4 Estimate the parameters and fit a model.

CO5 Investigate possible diagnostics in regression modeling and analysis.

CO6 Use confidence intervals and hypothesis testing to validate the model.

CO7 Utilize multinomial and ordinal regression models to analyze and interpret categorical response variables.

M.Sc. Statistics
(2022 Pattern)
(With effect from Academic Year 2022-2023)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: II
Course Name	: Statistics Practical – III
Course Code	: PSST125
No. of lectures	: 60
Credit	: 4 credits

Course Outcomes:

Students should be able to:

CO1 understand the link between multivariate techniques and corresponding univariate techniques,

CO2 analyze multivariate data and the dependence structure of variates to extract the useful information from a massive dataset,

CO3 apply suitable tools for exploratory data analysis, dimension reduction, and classification to formulate and solve real-life problems,

CO4 analyze multivariate data using data reduction techniques like principal component analysis, factor analysis.

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.

M.Sc. Statistics
(2022 Pattern)
(With effect from Academic Year 2022-2023)

Name of the Programme	: M.Sc. Statistics
Program Code	: PSST
Class	: M.Sc. Part – I
Semester	: II
Course Name	: Statistics Practical – IV
Course Code	: PSST126
No. of lectures	: 60
Credit	: 4 credits

Course Outcomes:

Students should be able to:

CO1 Excellent familiarity with both linear and nonlinear regression models.

CO2 Understanding of model selection and regression modelling techniques should be demonstrated.

CO3 Estimate the parameters and fit a model.

CO4 Investigate possible diagnostics in regression modeling and analysis.

CO5 Use confidence intervals and hypothesis testing to validate the model.

CO6 Apply polynomial regression and other nonlinear regression techniques.

CO7 Utilize multinomial and ordinal regression models to analyze and interpret categorical response variables.

CO8 Apply the Central Limit Theorem to demonstrate how the distribution of sample means or sums approximates a normal distribution regardless of the underlying distribution.

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M.Sc. – II Semester – III (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Name of the Programme : **M.Sc. Statistics**

Program Code : **PSST**

Class : **M.Sc. Part – II**

Semester : **III**

Paper Code	Title of Paper	No. of Credits
PSST231	Asymptotic Inference	4
PSST232	Design and Analysis of Experiments	4
PSST233	Time Series Analysis	4
PSST234 (A) PSST234 (B)	Data Mining Or Design and Analysis of Clinical Trials	4
PSST235	Practical Paper -V	4
PSST-236	Practical Paper -VI	4

M.Sc. Part- II Semester III (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Asymptotic Inference
Course Code : PSST231

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. Part- II Semester III (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Design and Analysis of Experiments
Course Code : PSST232

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. Part- II Semester III (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Time Series Analysis
Course Code : PSST233

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. Part- II Semester III (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Data Mining
Course Code : PSST234 (A)

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. Part- II Semester III (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Design and Analysis of Clinical Trials
Course Code : PSST234 (B)

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. Part- II Semester III (Statistics)
(2022 Patern)
(With effect from Academic Year 2023-2024)

Course Name : Practical Paper -V
Course Code : PSST235

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. Part- II Semester III (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Statistics Practical – VI

Course Code : PSST236

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.

Anekant Education Society's
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M.Sc. – II Semester – IV (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Name of the Programme : **M.Sc. Statistics**

Program Code : **PSST**

Class : **M.Sc. Part – II**

Semester : **IV**

Paper Code	Title of Paper	No. of Credits
PSST241	Stochastic Processes	4
PSST242	Statistical Process Control	4
PSST243	Survival Analysis	4
PSST244 (A) PSST244 (B)	Actuarial Statistics Or Optimization Techniques	4
PSST245	Practical Paper-VII	4
PSST246	Project	4

M.Sc. Part- II Semester IV (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Stochastic Processes
Course Code : PSST241

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. Part- II Semester IV (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Statistical Process Control
Course Code : PSST242

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. Part- II Semester IV (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Survival Analysis
Course Code : PSST243

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. Part- II Semester IV (Statistics)

(2022 Pattern)

(With effect from Academic Year 2023-2024)

Course Name : Actuarial Statistics

Course Code : PSST244(A)

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. Part- II Semester IV (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Optimization Techniques
Course Code : PSST244 (B)

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. Part- II Semester IV (Statistics)
(2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Statistics Practical – VII
Course Code : PSST245

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. Part- II Semester IV (Statistics) (2022 Pattern)
(With effect from Academic Year 2023-2024)

Course Name : Project
Course Code : PSST246

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.

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(AUTONOMOUS)

Department of Statistics

M.Sc. – I Data Science

Semester- I

(2022 Pattern)

Paper Code	Course Title	No. of Credits
PSDS111	Linear Algebra in Matlab	04
PSDS112	Probability Distributions	04
PSDS113	Optimization Techniques	04
PSDS114	Statistical Inference	04
PSDS115	Database Management System	04
PSDS116	Introduction to MATLAB and R	04

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- I)
Paper Code	: PSDS111
Paper	: I
Title of Paper	: Linear Algebra in Matlab
Credit	: 4 credits
No. of lectures	: 60

A) Course Outcomes:

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

CO1 Having a clear understanding of the subject related concepts and contemporary issues.

CO2 Having computational thinking.

CO3 Ability to translate vast data into abstract concepts and to understand database reasoning.

CO4 Having problem-solving ability- solving social issues and engineering problems.

CO5 Find the matrix representation of a linear transformation given bases of the relevant vector spaces.

CO6 Compute inner products on a real vector space and compute angle and orthogonally in inner product spaces.

CO7 Understand the use of linear algebra and matrices in several important, modern applications of research and industrial problems involving statistics.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- I)
Paper Code	: PSDS112
Paper	: II
Title of Paper	: Probability Distributions
Credit	: 4 credits
No. of lectures	: 60

A) Course Outcomes:

Student will be able to:

CO1 Develop problem-solving techniques needed to calculate probability and conditional probability.

CO2 Formulate fundamental probability distribution and density functions, as well as functions of random variables, derive the probability density function of transformations.

CO3 Derive the expectation and conditional expectation, and describe their properties.

CO4 Integrate the intrinsic ideas of preliminary and advanced distributions to correlate with the real-world scenarios.

CO5 Understand various types of generating functions used in statistics.

CO6 Present the analysis of derived statistics to all audiences.

CO7 Develop problem-solving techniques needed to accurately calculate probabilities

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- I)
Paper Code	: PSDS113
Paper	: III
Title of Paper	: Optimization Techniques
Credit	: 4 credits
No. of lectures	: 60

A) Course Outcomes:

Students are able to

CO1 Identify and develop operational research models from the verbal description of the real system.

CO2 Understand the characteristics of different types of decision-making environments and decision-making approaches.

CO3 Apply optimization techniques to take correct decision.

CO4 Formulate a real-world problem as a mathematical programming model.

CO5 Develop the model formulation and applications are used in solving decision problems.

CO6 Solve specialized linear programming problems like the transportation and assignment Problems.

CO7 Apply optimization techniques to real world problem.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- I)
Paper Code	: PSDS114
Paper	: IV
Title of Paper	: Statistical Inference
Credit	: 4 credits
No. of lectures	: 60

A) Course Outcomes:

At the end of the course students will be able to:

CO1 Learn the approaches to point estimation of parameters.

CO2 Understand the concept of interval estimation and confidence intervals.

CO3 Basic concepts in tests of hypotheses.

CO4 Get a better understanding of probabilistic models.

CO5 Implement different tree based models.

CO6 Derive inference from different statistical data sets.

CO7 Develop a strong theoretical understanding of statistical concepts such as sufficiency, estimation, hypothesis testing, confidence intervals, and Bayesian estimation.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- I)
Paper Code	: PSDS115
Paper	: V
Title of Paper	: Database Management System
Credit	: 4 credits
No. of lectures	: 60

A) Course Outcomes:

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

1. Be familiar with the fundamentals of database concepts and database management systems.
2. Utilize conceptual modelling techniques, like as the ER model and relational model, to model the data requirements for an application.
3. Write SQL commands to create tables, insert, update, delete and querying data.
4. Developing an understanding of key DBMS principles.
5. Recognize how to create, modify, and query databases for data.
6. Proficiency in designing conceptual database models using the Entity-Relationship (E-R) model.
7. Apply constraints like key constraints and mapping constraints in ER modeling.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- I)
Paper Code	: PSDS116
Paper	: VI
Title of Paper	: Introduction to MATLAB and R
Credit	: 4 credits
No. of lectures	: 60

A) Course Outcomes:

CO1 Students will be able to solve linear algebra problems using MATLAB/R - software.

CO2 Students will be able to draw model sample from distributions.

CO3 Students will understand asymptotic behaviour of the estimators, find and verify the consistent estimator and consistency.

CO4 Understanding how to compute determinants and ranks of matrices using partitioning techniques.

CO5 Apply partitioning methods to efficiently calculate determinants and ranks of higher-order matrices.

CO6 calculate determinants and ranks of matrices using partitioning methods for matrices of higher order.

CO7 Understanding the significance of determinants and ranks in linear algebra and their applications in solving systems of equations.

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

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Department of Statistics

M.Sc. –I Data Science

Semester- II (2022 Pattern)

Paper Code	Course Title	No. of Credits
PSDS121	Design and Analysis of Experiments	04
PSDS122	Regression Analysis and Predictive Models	04
PSDS123	Statistical Quality Control	04
PSDS124	Computational Statistics	04
PSDS125	Bayesian Inference	04
PSDS126	Python and SQL Programming	04

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- II)
Paper Code	: PSDS121
Paper	: I
Title of Paper	: Design and Analysis of Experiment
Credit	: 4 credits
No. of lectures	: 60

Course outcomes:

CO 1. Students will be able to understand basic principles and various terms of Design of Experiments.

CO 2. Students will be able to apply Factorial design, fractional factorial design, confounding in real life problems.

CO 3. Students should be able to analyse the data of various experimental design.

CO 4. Make statistical inferences about population parameters based on experimental results.

CO 5. Demonstrate proficiency in implementing experimental designs using statistical software.

CO 6. Apply statistical methods to assess the significance of interactions between factors

CO 7. Understand and adhere to ethical considerations related to experimental design and data analysis.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- II)
Paper Code	: PSDS122
Paper	: II
Title of Paper	: Regression Analysis and Predictive Modelling
Credit	: 4 credits
No. of lectures	: 60

Course Outcome:

At the end of the course students will be able to:

- **CO 1.** Deep comprehension of the linear and nonlinear regression models.
- **CO 2.** Demonstrate understanding of model selection and regression modeling approaches.
- **CO 3.** The connections between dependent and independent variables should be examined.
- **CO 4.** Estimate the parameters and fit a model.
- **CO 5.** Investigate possible diagnostics in regression modeling and analysis.
- **CO 6.** Validate the model using hypothesis testing and confidence interval approach.
- **CO 7.** Understanding advanced regression techniques, such as logistic regression for binary outcomes or Poisson regression for count data.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- II)
Paper Code	: PSDS123
Paper	: III
Title of Paper	: Statistical Quality Control
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

Students will be able to

CO 1. Describe the DMAIC processes.

CO 2. Perform analysis of process capability and measurement system capability.

CO 3. Demonstrate the ability to design, use, and interpret multivariate control chart, synthetic control chart, non-parametric control chart.

CO 4. Learn about the construction and interpretation of control charts (also known as Shewhart charts) for monitoring process stability over time.

CO 5. Explore different types of control charts, including X-bar charts for the central tendency and R (or S) charts for variability.

CO 6. Learn about the Six Sigma methodology for process improvement.

CO 7. Calculate and interpret statistical tolerance limits to ensure product quality.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- II)
Paper Code	: PSDS124
Paper	: IV
Title of Paper	: Computational Statistics
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

CO 1. Students can employ computational techniques to provide numerical solutions to statistical questions that are challenging or unsolvable analytically.

CO 2. Students can apply numerical techniques for transformations, for function approximation.

CO 3. Students will be able to understand and implement the Monte Carlo Studies in Statistics and random number generators.

CO 4. Construct interpolating polynomials using Lagrange interpolation and Newton's divided difference method.

CO 5. Calculating the estimator by using Jack-knife and Bootstrap, and comparing the average of these estimates to the original estimator, yielding a quantification of bias.

CO 6. Apply numerical methods to solve problems encountered in data science, machine learning, and statistical analysis.

CO 7. Use numerical optimization in the context of machine learning algorithms.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- II)
Paper Code	: PSDS125
Paper	: V
Title of Paper	: Bayesian Inference
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

CO 1. Students can To Construct Bayesian prediction intervals and write appropriate conclusions.

CO 2. Allows the incorporation of existing knowledge or beliefs through the prior distribution.

CO 3. Performs well even with small sample sizes, especially when informative priors are available.

CO 4. Use Bayes' theorem to combine the prior and likelihood, yielding the posterior distribution.

CO 5. Provides probabilistic outputs, allowing for a natural expression of uncertainty in parameter estimates.

CO 6. Apply Bayesian inference to solve real-world problems in various domains, such as finance, healthcare, and social sciences.

CO 7. Understand and apply posterior predictive checks to assess the adequacy of Bayesian models in capturing the observed data patterns.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- II)
Paper Code	: PSDS126
Paper	: VI
Title of Paper	: Python and SQL Programming
Credit	: 4 credits
No. of lectures	: 60

Course Outcome:

When students complete Intro to Programming with Python, they will be able to:

CO 1. Build basic programs using fundamental programming constructs like variables, conditional logic, looping, and functions.

CO 2. Work with user input to create fun and interactive programs.

CO 3. Learn about SQL – Structured Query Language , Build database using Data Definition Language Statements Perform basic CRUD operations using Data Manipulation Language statements like Insert, Update and Delete Write and call Stored Procedures and Functions stored in database.

CO 4. Demonstrate a solid understanding of Python's basic syntax, data types, and control structures

CO 5. Utilize NumPy for numerical operations and Pandas for data manipulation and analysis.

CO 6. Connect Python to SQL databases, execute queries, and retrieve results.

CO 7. Comprehend the principles of normalization and apply them in designing relational databases.

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(AUTONOMOUS)

Department of Statistics

M.Sc. – II Data Science

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(2022 Pattern)

Semester- III

Paper Code	Course Title	No. of Credits
PSDS231	Stochastic Models and Applications	04
PSDS232	Exploratory Multivariate Data Analysis	04
PSDS233	Time series analysis and Forecasting	04
PSDS234	Artificial Intelligence	04
PSDS235	Text Mining and Natural Language Processing	04
PSDS236	Data Visualization using Tableau	04

M.Sc. Data Science
(2022 Pattern)
(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- III)
Paper Code	: PSDS231
Paper	: I
Title of Paper	: Stochastic Models and Applications
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

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

CO1. formulate tpm, n-step transition probabilities

CO2. classify of states and perform stochastic simulations.

CO3. familiar with stochastic processes, including Poisson process, Wiener process and Renewal process, etc.

CO4. understand stationary processes and its properties.

CO5. develop problem-solving skills of stochastic processes theory to practical problems.

CO6. explore the ethical implications of using stochastic processes in various fields.

CO7. learn statistical packages for modeling and analyzing stochastic processes.

M.Sc. Data Science
(2022 Pattern)
(With effect from Academic Year 2022-2023)

Class	: M. Sc. Data Science (Semester- III)
Paper Code	: PSDS232
Paper	: II
Title of Paper	: Exploratory Multivariate Data Analysis
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

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

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. Data Science (Semester- III)
Paper Code	: PSDS233
Paper	: III
Title of Paper	: Time Series Analysis and Forecasting
Credit	: 4 credits
No. of lectures	: 60

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. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. Data Science (Semester- III)
Paper Code	: PSDS234
Paper	: IV
Title of Paper	: Artificial Intelligence
Credit	: 4 credits
No. of lectures	: 60

Course Outcome:

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

CO1. develop a solid understanding of the fundamental concepts and principles of artificial intelligence.

CO2. explore techniques for processing.

CO3. aware of knowledge-based systems.

CO4. use fuzzy logic and neural networks.

CO5. learn a variety of AI algorithms and techniques applicable to different domains, and understand the strengths and limitations of various approaches.

CO6. explore the ethical considerations and societal impacts of AI technologies.

CO7. apply AI techniques to real-world problems in different industries, and understand how AI is used in research and development.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- III)
Paper Code	: PSDS235
Paper	: V
Title of Paper	: Text Mining and Natural Process Language
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

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

CO1. grasp the significance of natural language processing in solving real-world problems.

CO2. map the appropriate processing technique to a problem and implement the technique.

CO3. demonstrate required design skills for large collection sets.

CO4. comprehend the state-of-the-art advanced nlp research articles and present them to an audience.

CO5. propose extension of existing nlp techniques for solving a range of problems.

CO6. gain practical experience using text mining tools and libraries.

CO7. effectively communicate the results of text mining and NLP analyses in written reports and oral presentations.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- III)
Paper Code	: PSDS236
Paper	: VI
Title of Paper	: Data Visualization Using Tableau
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

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

CO1. understand the importance of data visualization in conveying complex information.

CO2. learn how to connect Tableau to various data sources.

CO3. gain proficiency in using the Tableau software.

CO4. create fundamental visualizations, including bar charts, line charts, scatter plots, and pie charts.

CO5. develop skills in designing interactive dashboards..

CO6. gain knowledge of working with real-time data in Tableau.

CO7. explore ethical considerations in data visualization.

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

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Department of Statistics

M.Sc. – II Data Science

Semester- IV (2022 Pattern)

Paper Code	Course Title	No. of Credits
PSDS241	Machine Learning	04
PSDS242	Discrete Data Analysis	04
PSDS243	Supply Chain & Logistics Analytics	04
PSDS244	Deep Learning	04
PSDS245	Thesis	08

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- IV)
Paper Code	: PSDS241
Paper	: I
Title of Paper	: Machine Learning
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

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

CO1. have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.

CO2. compare the strengths and weaknesses of many popular machine learning approaches.

CO3. develop a solid understanding of the fundamental concepts of machine learning.

CO4. design and implement various machine learning algorithms in a range of real-world applications.

CO5. explore ethical considerations in machine learning, including issues related to bias, fairness, and transparency.

CO6. gain practical experience in implementing machine learning algorithms using programming languages such as Python.

CO7. effectively communicate the results of machine learning analyses in both written reports and oral presentations.

M.Sc. Data Science
(2022 Pattern)
(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- IV)
Paper Code	: PSDS242
Paper	: II
Title of Paper	: Discrete Data Analysis
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

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

CO1. develop a solid understanding of the characteristics and challenges of discrete data.

CO2. develop the ability to critically appraise studies and research papers that utilize discrete data analysis methods.

CO3. learn and apply logistic regression for modelling and analysing the relationship between categorical outcomes and predictor variables.

CO4. gain practical experience using statistical software packages (e.g., R, Python) for discrete data analysis.

CO5. effectively communicate the results of discrete data analyses in written reports and oral presentations.

CO6. estimate the parameters and fit different models to discrete data.

CO7. validate the model such as Poisson regression and Logistic Regression using cross validation techniques.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- IV)
Paper Code	: PSDS243
Paper	: III
Title of Paper	: Supply Chain and Logistics
Credit	: 4 credits
No. of lectures	: 60

Course Outcomes:

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

CO1. understand the various stages of a supply chain, from sourcing raw materials to delivering finished products to end customers.

CO2. understand the structures, decision phases, measures and tools of supply chains.

CO3. understand the strategic, tactical and operational decision tools of supply chains.

CO4. understand knowledge on logistics management and related advanced tools and techniques.

CO5. understand the role of distribution centers, warehouses, and transportation in the supply chain.

CO6. learn about collaborative approaches to planning, forecasting, and replenishing inventory.

CO7. apply supply chain and logistics concepts to real-world case studies.

M.Sc. Data Science

(2022 Pattern)

(With effect from Academic Year 2022-2023)

Class	: M. Sc. (Semester- IV)
Paper Code	: PSDS244
Paper	: IV
Title of Paper	: Deep Learning
Credit	: 4 credits
No. of lectures	: 60

Course Outcome:

CO1. Evaluate, in the context of a case study, the advantages and disadvantages of deep learning neural network architectures and other approaches.

CO2. Implement deep learning models in Python using the PyTorch library and train them with real-world datasets.

CO3. Design convolution networks for handwriting and object classification from images or video.

CO4. Design recurrent neural networks with attention mechanisms for natural language classification, generation, and translation.

CO5. Explore ethical challenges and considerations in the application of deep learning.

CO6. Evaluate the performance of different deep learning models (e.g., with respect to the bias-variance trade-off, over fitting and under fitting, estimation of test error).

CO7. Perform regularization, training optimization, and hyper parameter selection on deep models.