

**DEPARTMENT OF STATISTICS
SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR**



**SYLLABUS EFFECTIVE FROM: 2017-18
MASTER OF SCIENCE (STATISTICS)**

CBCS Course Structure of M.Sc. Statistics Programme of the University

SEMESTER	Course Code	SUBJECT	Credit	Number of Hours of Teaching	Nature of the Course
I	PS01CSTA21	Probability Theory	4	4	C
	PS01CSTA22	Matrix Algebra	4	4	C
	PS01CSTA23	Distribution Theory	4	4	C
	PS01CSTA24	Statistical Inference I	4	4	C
	PS01ESTA21	Statistical Computing through C++	4	4	EL
	PS01ESTA22	Statistical Computing through R	4	4	EL
	PS01CSTA25	Practicals	4	6	P
	PS01CSTA26	Comprehensive Viva-Voce	1	4	CVV
II	PS02CSTA21	Stochastic Processes	4	4	C
	PS02CSTA22	Linear Models and Regression Analysis.	4	4	C
	PS02CSTA23	Statistical Inference II	4	4	C
	PS02CSTA24	Theory of Sample Surveys	4	4	C
	PS02ESTA21	Official Statistics	4	4	EL
	PS02ESTA22	Operations Research	4	4	EL
	PS02CSTA25	Practicals	4	6	P
	PS02CSTA26	Comprehensive Viva-Voce	1	4	CVV
III	PS03CSTA21	Deign of Experiments	4	4	C
	PS03CSTA22	Multivariate Analysis	4	4	C
	PS03ESTA21	Reliability and Life Testing	4	4	EL
		OR			
	PS03ESTA22	Generalized Linear Models	4	4	EL
	PS03ESTA23	Survival Analysis	4	4	EL

		OR			
	PS03ESTA24	Time Series	4	4	EL
	PS03CSTA23	Practicals	4	6	P
	PS03CSTA24	Practicals.	4	6	P
	PS03CSTA25	Comprehensive Viva-Voce	1	2	CVV
IV	PS04CSTA21	Computer Oriented Statistical Methods	4	4	C
	PS04CSTA22	Statistical Quality Control Techniques	4	4	C
		Financial Statistics			
	PS04ESTA21	Econometrics	4	4	EL
	PS04ESTA22	Actuarial Statistics	4	4	EL
		Biostatistics			
	PS04ESTA23	Bioassays	4	4	EL
	PS04ESTA24	Clinical Trials	4	4	EL
	PS04CSTA23	Practicals	4	6	P
	PS04CSTA24	Project	4	6	PR
	PS04CSTA25	Viva-Voce	1	2	CVV
Total			124	144	

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SYLLABUS EFFECTIVE FROM: 2017-18
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M. Sc (Statistics) FIRST SEMESTER

CODE AND SUBJECT	Credit	Number of Hours of Teaching	Nature of the Course
PS01CSTA21 Probability Theory	4	4	C
PS01CSTA22 Matrix Algebra	4	4	C
PS01CSTA23 Distribution Theory	4	4	C
PS01CSTA24 Statistical Inference I	4	4	C
PS01ESTA21 Statistical Computing through C++	4	4	EL
PS01ESTA22 Statistical Computing through R	4	4	EL
PS01CSTA25 Practicals	4	6	P
PS01CSTA26 Problem Solving +Comprehensive Viva-Voce	1	4	CVV

PS01CSTA21: PROBABILITY THEORY

UNIT 1	Convergence of sequence of sets, fields and sigma fields, monotone class, Borel sets in \mathbb{R} and \mathbb{R}^n . Counting measure, Lebesgue and Lebesgue-Stieltjes measures, probability measures, sigma-finite measures, properties of measures	12L
UNIT 2	Measurable functions, Random variables and arithmetic properties of random variables, Lebesgue Integration of a measurable function with respect to a measure, Expectation of random variables, monotone convergence theorem, Fatou's theorem, Dominated convergence theorem.	12L
UNIT 3	Moments' inequalities like, Holder's inequality, Basic inequality, Jensen's inequality, Liapounov's inequality, sequence of random variables, four modes of convergences, convergence in distribution, convergence in probability, convergence in rth mean and almost sure convergence and their inter relationships	12L
UNIT 4	characteristic function, 5 uniqueness theorem, Borel- Cantelli Lemma, Independence, Weak law and strong law of large numbers for iid sequences, CLT for sequence of iid random variables and independent random variables	12L

Books Recommended:

1. Ash, Robert (1972). Real Analysis and Probability. Academic Press.
2. Basu, A.K. (1999). Measure Theory and Probability. Prentice Hall of India.
3. Bhat, B.R. (2000). Modern Probability Theory, New Age International Publication.
4. Billingsley, P. (1986). Probability and Measure. Wiley.
5. Burrill, C.W. (19). Measure, Probability and Integration.
6. Kingman, J.F.C. and Taylor, S.J. (1966). Introduction to Measure and Probability. Cambridge University Press.
7. Parthasarathy, K.R. (1967). Probability Measures on Metric Spaces. Academic Press.

PS01CSTA22: MATRIX ALGEBRA

UNIT 1	Vector Spaces, Subspaces, linear independence, spanning set and basis, dimension, linear transformation, kernel, range, gram-schmidt orthogonalization, Orthogonal Projection, Matrix Representation of a linear transformation. Algebra of Matrices, canonical forms, diagonal form, Triangular form. Matrix Factorizations.	12L
UNIT 2	Trace and Rank of a Matrix and their properties. Determinant and Inverse of partition matrices, special matrices, orthogonal and idempotent matrices and their properties. Quadratic forms, definiteness and related results with proofs. Generalized inverses(g-inverses) and related results with proofs	12L
UNIT 3	Eigen Value and Eigen vectors, Spectral decomposition, singular value decomposition	12L
UNIT 4	Methods of constructing g-inverses, general solution to a system of linear equations. Matrix derivatives and Jacobians. Applications in Statistics.	12L

Books Recommended:

1. Basilevsky, A.(1983).Applied Matrix Algebra in the Statistical Sciences, North Holland.
2. Graybill, F.A.(1969).Introduction to matrices with applications in Statistics, John Wiley.
3. Khatri, C.G.(1971).Matrix Algebra(In Gujarathi), Gujarat Granth Nirman Board.
4. Searl, S.R.(1982).Matrix Algebra Useful for Statictics, John Wiley.
5. A.Ramachandra Rao and P.Bhimasankaran(1992). Linear Algebra, Tata McGraw Hill, New Delhi.

PS01CSTA23: DISTRIBUTION THEORY

UNIT 1	Compound, truncated and mixture distributions. Transformation of variables. Sampling distributions of statistics from univariate normal random samples, Non-central χ^2 , t and F distributions and their properties. Regression, multiple and partial correlation coefficients and their inter-relationship,	12L
UNIT 2	Multinomial distribution, marginal and conditional distributions, it's multiple and partial correlation coefficients. Transformation of statistics, Approximation of distributions of statistics, δ –Method with illstartions	12L
UNIT 3	Order statistics: their distributions and properties. Joint and marginal distributions of order statistics. Probability integral transformation, Rank orders and their exact null distributions. One and two sample examples of rank statistics such as sign statistic, Wilcoxon signed rank statistics, Wilcoxon two sample statistics etc., Extreme values and their asymptotic distributions (statement only) with applications.	12L
UNIT 4	Bivariate normal distribution, Distributions of correlation coefficient and regression coefficient. Multivariate normal distributions and their properties, Distributions of linear and quadratic functions under normality and related distribution theory. Fisher-Cochran theorem.	12L

Books Recommended:

- Johnson, N. L., Kotz, S. and Balakrishnan, N. (1995) Continuous Univariate Distributions, Vol.1 & 2, 2nd Edition
1. Hogg, R. V. McKean, J. W. Craig A. T. (2013) Introduction to Mathematical Statistics, Pearson, 7th Edition
 2. Rohatgi, V. K. .Saleh A.K. Md. E (2015). Introduction to Probability Theory and Mathematical Statistics, Wiley, 3rd Edition
 3. Rao, C. R. (1995) Linear Statistical Inference and Its Applications (Wiley Eastern) Second Edition
 4. Cramer, H. (1946) Mathematical Methods of Statistics, (Prinecton).
 5. Stuart, A. and Ord, J.K. (2010) Kendall's Advanced Theory of Statistics (VI Ed.) Distribution Theory, Vol. I, Wiley.
 6. Mood, A. M., Graybill, F. A. and Boes, D. C. (1974). Introduction to the Theory of Statistics, McGraw-Hill

PS01CSTA24: STATISTICAL INFERENCE I

UNIT 1	Sufficiency principle, factorization theorem, minimal sufficiency, minimal sufficient partition, construction of minimal sufficient statistics, minimal sufficient statistic for exponential family, power series family, curved exponential family Pitman family. Completeness, bounded completeness, ancillary statistics, Basu's theorem and applications.	12 L
UNIT 2	Unbiased estimators; Uniformly Minimum Variance Unbiased Estimators(UMVUE); Rao-Black and Lehmann-Scheffee theorems. Problem of point estimation, unbiased estimators, minimum variance unbiased estimator, Rao- Blackwell theorem and Lehmann-Scheffe theorem and their uses. Fisher information and information matrix, Cramer-Rao inequality, Chapman Robinson bounds, Bhattacharya bounds, their applications.	12L
UNIT 3	Method of maximum likelihood (MLE) and small sample properties of MLE, method of scoring and application to estimation in multinomial distribution.MLE in non-regular families. Other methods of estimation: method of moments, minimum Chi square.	12L
UNIT 5	Baye's estimators: Statistical Problems viewed as problems of game theory; loss function; risk function; prior and posterior distributions; Bayes risk; Baye's estimators of parameters and parametric functions for squared error loss functions. Equivariance; the principle of equivariance;location –scale family and their properties; Pitman's minimum risk equivariance estimators. Books Recommended: 1. B. K. Kale , K. Muralidharan(2015).Parametric Inference: An Introduction, Alpha Science International Ltd. 2. Dudewicz, E. J. and Mishra, S.N.(1988) Modern Mathematical Statistics (John Wiley) 3. Roussas, G. G. (1973) First Course in Mathematical Statistics (Addison Wesley) 4. Silvey, S. D. (1975) Statistical Inference (Chapman and Hall) 5. Wilks, S. S. (1962) Mathematical Statistics (John Wiley) 6. Lehmann, E. L. (1986) Testing of Statistical hypothesis (John Wiley) 7. Lehmann, E. L. (1988) Theory of Point Estimation (John Wiley)	12L

8. Rohatgi, V. K. (1976) Introduction to theory of probability and Mathematical Statistics (John Wiley & Sons)
9. Michael J. Panik (2012). Statistical Inference :A Short Course , John Wiley & Sons, Inc., New
10. Nitis Mukhopadhyay (2000). Probability and Statistical Inference, CRC Press

PS01ESTA21: STATISTICAL COMPUTING WITH C++

UNIT 1	Introductory Concepts: Algorithm, Programming logic. Structure of C++ program, Preprocessors, Header Files, identifiers, keywords; constants: numeric, string and character; Data Types: int, char, float, bool, enumeration. Operators: arithmetic, comparison and logical operators, bitwise operators; I/O statements, manipulators	12L
UNIT 2	Control Statements: if, if else, nested if else, switch, for loop, while loop, do-while loop, break and continue statements, goto statement; conditional and unconditional. Few Programmes control statements	12L
UNIT 3	Arrays: one dimensional and multidimensional, array declaration, array initialization, processing with arrays, etc. Strings as a character array; Scope and lifetime of variables: local, global, static, automatic, external, register. Functions : introduction, defining function, return statement, types of functions, recursive functions, multifunction function overloading, call by value and call by reference, using arrays as function arguments, functions having default arguments.	12L
UNIT 4	Pointers: pointer declaration, pointer arithmetic, pointers and functions, pointers and arrays. <u>Practicals</u> : Writing some useful C++ programs for Statistical Computing.	12L

Books Recommended:

1. Robert Lafore : Object Oriented Programming With C++, Galgotia Publishers.
2. John Hubbard (2000). Programming with C++, 2nd Edition, McGraw-Hill (Schaum's Outline Series).
3. Cay Hortsman (1999) : Computing Concepts with C++ Essentials, 2nd Edition, John Wiley & Sons.
4. Ravinchandran, D. (2011). Programming with C++, Ed. III, Tata McGraw Hill Education Pvt. Ltd., New Delhi
5. Venugopal, K. R., Rajkumar, B., RaviShankar, T. (2006). Mastering C++, Tata McGraw Hill Education Pvt. Ltd., New Delhi.

6. Balagurusamy, E. (2013). Object Oriented Programming with C++, Ed. VI, McGraw Hill Education.

PS01ESTA22: STATISTICAL COMPUTING THROUGH R LANGUAGE

UNIT 1 Introduction to R - A programming language and environment for data analysis and graphics. 12L

Syntax of R expressions: Vectors and assignment, vector arithmetic, generating regular sequence, logical vector, character vectors, Index vectors; selecting and modifying subsets of data set

Data objects: Basic data objects, matrices, partition of matrices, arrays, lists, factors and ordered factors, creating and using these objects; Functions- Elementary functions and summary functions, applying functions to subsets of data.

Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes.

UNIT 2 Importing data files: import.data function, read.table function; Exporting data: export.data function, cat, write, and write.table functions; Outputting results - sink function, formatting output - options, and format functions; Exporting graphs - export.graph function. 12L

Graphics in R: creating graphs using plot function, box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart multiple plot layout, plot titles, formatting plot axes.

Interactively adding information of plot - Identifying the plotted points, adding trend lines to current scatter plot, adding new data to current plot, adding text and legend

UNIT 3 Loops and conditional statements: Control Statements; if statement, if else Statement. Looping statement; for loop, repeat, while loop 12L

Developing simple programs in R for data analysis tasks, saving programs, executing stored programs, defining a new binary operator, assignment within function, more advanced examples, object oriented programme. Creating function libraries- library function, attaching and detaching the libraries

Random numbers from various distributions like uniform, Normal, gamma, exponential, beta, F, Poisson, binomial, Weibull etc.

UNIT 4 Performing data analysis tasks: Reading data with scan function, Exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests, Defining Statistical Models: Introduction for defining models, Generic functions for extracting model information. 12L

References

1. Chambers J. M. (1998). Programming with Data: A guide to S language, Springer.

2. Venables W N and Ripley B D (2000). S Programming, Springer
3. Everitt B. S. (1994): A handbook of Statistical Analysis using S-Plus, Chapman & Hall.
4. Peter Dalgaard (2002). Statistics and computing: Introductory Statistics with R Springer
- 5 Purohit, G.S., Gore, S.D. and Deshmikh, S.R. (2008). Statistics Using R. Narosa Publishing House
- 6 Maindonald J. and Braum, J. (2007) Data Analysis and Graphics Using R: An example-based approach Second Edition, Cambridge Series in Statistical and Probabilistic Mathematics
- 7 Hey-Jahans, C.(2012) .An R Companion to Linear Statistical Models ,CRC Press