

SOLAPUR UNIVERSITY, SOLAPUR.



SYLLABUS FOR M.Sc. (Part-I) STATISTICS (Semester I and II) Credit System

**WITH EFFECT FROM ACADEMIC YEAR 2011-12
(JUNE-2011).**

SOLAPUR UNIVERSITY, SOLAPUR
SCHOOL OF COMPUTATIONAL SCIENCES
DEPARTMENT OF STATISTICS
Revised Syllabi of M.Sc. in Statistics (Credit System)

- 1) **Title of the course:** M.Sc. in Statistics.
- 2) **Duration of course:** Two years.
- 3) **Pattern:** Semester and Credit system.
- 4) **Eligibility:** For M. Sc. in Statistics following candidates are eligible.
 - (i) B.Sc. with Statistics as principal level.
 - (ii) B.Sc. with Mathematics as principal and Statistics at subsidiary level.
- 5) **Strength of the Students:** 20

M. Sc. program in Statistics consists of 100 credits. Credits of a course are specified against the title of the course.

A Four Semester M.Sc. Statistics Course

Semester	No. of Papers/ Practicals / Seminar	Marks	Credits
Semester I			
• Theory Papers	05	500	20
• Practical Papers	01	100	04
• Seminar/Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester II			
• Theory Papers	05	500	20
• Practical Papers	01	100	04
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester III			
• Theory papers	05	500	20
• Practical Papers	01	100	04
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester IV			
• Theory papers	05	500	20
• Practical Papers	01	100	04
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Total marks and credits for M.Sc. Course		2500	100

M.Sc.Part-I (Statistics) revised syllabus (according to the Semester Pattern Examination and Credit System) to be effective from the Academic Year 2011-12

Notation: A six-character code is given to each paper. In MST "M" stands for M.Sc. and "ST" stands for Statistics. The first digit following MST is Semester Number. The second digit "0" stands for compulsory theory paper, the digit "1" stands for a Practical Paper and the digit "2" stands for an elective paper /project work. The third digit indicated the serial number of paper in that semester.

M.Sc. Statistics Semester-I

Paper Code	Title of the Paper	Contact hours/week	Distribution of Marks for Examination			Credits
			Internal	External	Total	
MST-101	Object Oriented Programming Using C++	04	30	70	100	04
MST-102	Real Analysis	04	30	70	100	04
MST-103	Linear Algebra	04	30	70	100	04
MST-104	Distribution Theory	04	30	70	100	04
MST-105	Theory of Estimation	04	30	70	100	04
MST-116	Practical-I	12	30	70	100	04
	Seminar	02	25	--	25	01
Total		34	205	420	625	100

M.Sc. Statistics Semester-II

Paper Code	Title of the Paper	Contact hours/week	Distribution of Marks for Examination			Credits
			Internal	External	Total	
MST-201	Probability Theory	04	30	70	100	04
MST-202	Linear Models and Design of Experiments	04	30	70	100	04
MST-203	Stochastic Processes	04	30	70	100	04
MST-204	Theory of Testing of Hypotheses	04	30	70	100	04
MST-205	Sampling Theory	04	30	70	100	04
MST-216	Practical-II	12	30	70	100	04
	Seminar	02	25	--	25	01
Total		34	205	420	625	25

Evaluation Scheme:

Each theory and practical paper will have 100 marks out of which 70 marks will be for Term End examination and 30 marks for Internal Assessment. The candidate has to appear for internal evaluation of 30 marks and external evaluation (University Examination) of 70 marks for each paper/ practical.

Internal Evaluation:

- In case of theory papers internal examinations will be conducted by school.
- In case of practical paper 10 marks shall be for day-to-day journal and internal examination 20 mark will be conducted by the school.

External Evaluation (End of Term University Examination):**I) Nature of Theory question paper:**

- 1) Each Theory paper is of 70 marks.
- 2) Each theory paper will be of 3 hours duration
- 3) There shall be 7 questions each carrying 14 marks.
- 4) Students have to attempt **five questions**.
- 5) Question No.1 is **compulsory** and shall contain 14 objective type sub-questions each carrying 1 mark.
- 6) Question No.2 is **compulsory** and shall contain 4 short answer type sub-questions each carrying 3 or 4 marks.
- 7) Students have to attempt **any three** questions from Question No. 3 to Question No. 7.
- 8) Question No. 3 to Question No. 7 shall contain 2 long answer type sub-questions.

II) Nature of Practical question paper:

Practical examination will be of 3 hours duration carrying 60 marks. There shall be 6 questions each of 15 marks, of which student has to attempt any 4 questions. VIVA will be for 10 marks.

Equivalence for Theory Papers:

Semester No.	Old Syllabus		Revised Syllabus	
	Paper No.	Title of the Paper	Paper No.	Title of the Paper
I	MST-101	Statistical Mathematics-I	MST-102	Real Analysis
	MST-102	Statistical Mathematics-II	MST-103	Linear Algebra
	MST-103	Distribution Theory	MST-104	Distribution Theory
	MST-104	Theory of Estimation	MST-105	Theory of Estimation
	MST-105	Statistical Computing	MST-101	Object Oriented Programming Using C++
II	MST-201	Probability Theory	MST-201	Probability Theory
	MST-202	Elementary Stochastic Processes	MST-202	Stochastic Processes
	MST-203	Theory of Testing Hypotheses	MST-203	Theory of Testing Hypotheses
	MST-204	Linear Models	MST-204	Linear Models and Design of Experiments
	MST-205	Sampling Theory	MST-205	Sampling Theory

MST 101: OBJECT ORIENTED PROGRAMMING USING C++

1. Algorithm Development : Problem definition, Writing step by step procedure, representation in terms of Flow chart,, Tracing, Testing (2 L)
2. Overview Of C++ : Object Oriented Programming, Introducing C++ Classes, Concepts of Object Oriented Programming, C++ as a superset of C, New style comments, main function in C++, meaning of empty argument list, function prototyping, default arguments and argument matching, User defined data types: enumerated types, use of tag names, anonymous unions, scope of tag names. (4 L)
3. Classes & Objects :Classes, Structure & Classes, Union & Classes, Inline Function, Scope Resolution operator, Static Class Members: Static Data Member, Static Member Function, Passing Objects to Function, Returning Objects, Object Assignment. Friend Function, Friend Classes. (4 L)
4. Array, Pointers References & The Dynamic Allocation Operators: Array of Objects, Pointers to Object, Type Checking C++ Pointers, The This Pointer, Pointer to Derived Types, Pointer to Class Members, References: Reference Parameter, call by reference and return by reference Passing References to Objects, Returning Reference, Independent Reference, C++'s Dynamic Allocation Operators, Initializing Allocated Memory, Allocating Array, Allocating Objects. (5 L)
5. Constructor & Destructor: Introduction, Constructor, access specifiers for constructors, and instantiation, Parameterized Constructor, Multiple Constructor in A Class, Constructor with Default Argument, Copy Constructor, Destructor. (4 L)
6. Overloading as polymorphism : Function & Operator Overloading : Function Overloading, Overloading Constructor Function Finding the Address of an Overloaded Function, Operator Overloading: Creating A Member Operator Function, Creating Prefix & Postfix Forms of the Increment & Decrement Operation, Overloading The Shorthand Operation (I.E. +=,-= Etc), Operator Overloading Restrictions, Operator Overloading Using Friend Function, Overloading New & Delete, Overloading Some Special Operators, Overloading[], (), -, Comma Operator. (6 L)
7. Inheritance : Base Class Access Control, Inheritance & Protected Members, Protected Base Class Inheritance, Inheriting Multiple Base Classes, Constructors, Destructors & Inheritance, When Constructor & Destructor Function are Executed, Passing Parameters to Base Class Constructors, Granting Access, Virtual Base Classes . (6 L)
8. Virtual Functions & Polymorphism : Virtual Function, Pure Virtual Functions, Early Vs. Late Binding, Templates and Exception Handling. (4 L)
9. Templates: Reason for templates compactness and flexibility, function template examples explicit specialization, class templates, out of class definition of member functions (2 L)
10. The C++ I/O System Basics : C++ Streams, The Basic Stream Classes C++ Predefined Streams, Formatted I/O: Formatting Using The Ios Members, Setting The Formal Flags, Clearing Format Flags, An Overloaded Form Of Setf (), Using Width() Precision() and Fill(), Using Manipulators to Format I/O, Creating Your own Manipulators. (4 L)
11. Working with files : Introduction, Classes for file stream operations, Opening and Closing file, Open(): File Modes, File pointers and their Manipulations, Sequential Input and Output Operations, Updating a File: Random Access , Error Handling During File Operations (4 L)

Reference books:

- 1) C++ The Complete Reference By *Herbert Schildt - Tmh*
- 2) C++ By *Balguruswami – Tata Mcgraw Hills*
- 3) C++ By M. Kumar, Tata Mcgraw

MST 102: REAL ANALYSIS

Unit-1: Set of real numbers, countable and uncountable sets, countability of rationals and uncountability of the interval $(0, 1)$, Supremum and Infimum of bounded sets, limit point of a set, open, closed, dense and compact sets. Bolzano- Weierstrass and Heine-Borel Theorems (Statements only). Applications of these theorems. (10 L)

Unit-2: Sequence of real numbers, convergence, divergence, Cauchy sequence. Convergence of bounded monotone sequence. Limit inferior and limit superior of the sequences. (10 L)

Unit-3: Series of numbers, tests for convergence (without proof), test for absolute convergence, convergence of sequences of non-negative terms. (6 L)

Unit-4: Real valued function, continuous function, uniform continuity of sequence of functions, uniform convergence of power series, radius of convergence. (6 L)

Unit-5: Vector and Matrix differentiation, Maxima, minima of functions of several variables. Constrained maxima, minima, Lagrange's method, Taylor's theorem (without proof) and its applications. (6 L)

Unit-6: Reimann, Reimann-Steltjes Integrals, Integration by parts, mean value theorem, their applications in finding functionals of distributions. (6 L)

Unit-7: Multiple Integrals, Change of variables, Improper integrals, Applications in multivariate distributions. Uniform convergence, theorem on differentiation under integral sign (without proof), Lebnitz rule (statement only) and applications. (6 L)

References:

1. Malik S.C. & Arora S. (1991): Mathematical Analysis- Wiley Eastern Limited 2nd edition.
2. Goldberg R.R.(1964): Methods of Real Analysis-Blaisell Publishing company, New York, U.S.A..
3. Bartly G.R. (1976): Element of Real Analysis-Wiley 2nd edition.
4. Bartly G.R. & Sherbert D.R. (2000): Introduction to Real Analysis-John Wiley & Sons Inc.
5. Royden (1988): Principles of Real Analysis-Macmillian.
6. Widder (1989): Advanced Calculus-Dover Publication.
7. Apostol T.M. (1985): Mathematical Analysis-Narosa Publishing House.

MST 103: LINEAR ALGEBRA

Unit-1: Vector space, subspace, linear dependence and independence, basis, dimension of a vector space, example of vector spaces. (10 L)

Unit-2: Null space, Special types of matrices: elementary operations, rank of a matrix. Orthonormal basis and orthogonal projection of a vector, Gram-Schmidt orthogonalisation, Kronekar product. Idempotent matrices, inverse of a matrix, their simple properties, partitioned matrices, Orthogonal matrices. (10 L)

Unit-3: Characteristic roots of a matrix, algebraic and geometric multiplicities, characteristics vectors and their orthogonal property. Caley-Hamilton theorem and applications. (10 L)

Unit-4: Spectral decomposition and G-inverse, Moore-Penrose inverse, Solution of a system of homogenous and non-homogenous linear equations and theorem related to existence of solution. (10 L)

Unit-5: Quadratic forms: definition, reduction, simultaneous reduction of two quadratic forms, maxima and minima of ratio of quadratic forms. (10 L)

References:

1. Rao A.R. & Bhimashankaram P. (1972): Linear Algebra-Tata McGraw Hill, New Delhi.
2. Hadely C. (1987): Linear Algebra-Narosa Publishing House.
3. Rao C.R. (1973): Linear Statistical Inference and Application, 2nd edition. John Wiley and Sons, Inc.
4. Searle S.R. (1982): Matrix Algebra useful for Statistics- John Wiley and Sons, Inc.
5. Graybill F.A. (1983): Matrices with application in Statistics- 2nd ed. Wadsworth

MST 104: DISTRIBUTION THEORY

- Unit-1: Brief review of basic distribution theory. Distribution function and its properties, Relation of distribution function with uniform variate. Decomposition of distribution function into discrete and continuous parts. Proofs of results related to generation of discrete and continuous random variables including Binomial, Poisson, Geometric, Negative Binomial, Exponential, Normal, Gamma, and Chi-square. (10 L)
- Unit-2: Functions of random variables, their distributions in case of univariate random variables and its applications. (8 L)
- Unit-3: Expectation and moments, probability generating function, moment generating function, convolution and examples. (6 L)
- Unit-4: Moment inequalities: Markov, Chebychev, Holder, Minkowski and Jensen inequalities with their applications. Basic inequality of Liapunov's. (6 L)
- Unit-5: Bivariate discrete and continuous distributions, marginal distributions. Examples of joint distribution with given marginals, independence, conditional distributions and examples. Distribution function of bivariate random variable using Jacobian of transformation. (5 L)
- Unit-6: Multinomial distribution, Bivariate Poisson, Bivariate exponential and Bivariate Normal distributions and their properties. Dirichlet distribution. Results related to generation of random variables from Multinomial, Bivariate Poisson, Bivariate exponential and Bivariate normal distributions. (7 L)
- Unit-7: Symmetric distributions, properties of symmetric distributions, non-regular families, location and scale families and examples. (4 L)
- Unit-8: Order Statistics: Distribution of i^{th} order statistic, joint distribution of $(i, j)^{\text{th}}$ order statistics, independence of exponential spacing and examples. (4 L)

References:

1. Rohtagi V.K. & Saleh A.K. Md. E (2001): Introduction to Probability Theory and Mathematical Statistics- John Wiley and Sons Inc.
2. Rao C.R.(1973): Linear Statistical Inference and Applications- John Wiley and Sons, Inc.
3. Johnson N.L. and Kotz S. (1996): Distribution in Statistics Vol-I, II and III- John Wiley and Sons, Inc.
4. Johnson N.L.and Kotz S.: Multivariate distributions- John Wiley and Sons, Inc.
5. Casella G. and Berger R.L. (2002): Statistical Inference-Duxbury Advanced Series, 2nd ed.

MST 105: THEORY OF ESTIMATION

- Unit-1: Sufficiency principle, factorization theorem, minimal sufficiency, minimal sufficient partition, construction of minimal sufficient statistic, minimal sufficient statistic for exponential families, power series distribution and non regular families. (10 L)
- Unit-2: Completeness, bounded completeness, ancillary statistic, Basu's Theorem and applications. (5 L)
- Unit-3: Problem of point estimation, unbiased estimators, minimum variance unbiased estimator, Rao-Blackwell and Lehmann-Scheffe theorems and their uses. Necessary and sufficient condition for MVUE and their applications. (10 L)
- Unit-4: Fisher information and information matrix, Cramer-Rao inequality, Chapman-Robinson bound, Bhattacharya bound, their applications. (6 L)
- Unit-5: Methods of Estimation: Method of maximum likelihood (MLE) and small sample properties of MLE, method of scoring and application to estimation in multinomial distribution, method of moments, method of minimum Chi-square. (10 L)
- Unit-6: Bias Reduction Methods, Jack-knife estimator, its properties and limitations. Bootstrap method and its simple properties. (3 L)
- Unit-7: Bayes Estimation: Prior distribution, Posterior distribution, loss function, quadratic and other loss functions, conjugate prior distributions, common examples. (3 L)
- Unit-8: Non-parametric estimation: Estimability, Kernel, U-Statistics, U-Statistics theorem for one sample and two samples (statements only). (3 L)

References:

1. Rohtagi V.K. & Saleh A.K. Md. E (2001): Introduction to Probability Theory and Mathematical Statistics- John Wiley and Sons Inc.
2. Rao C.R.(1973): Linear Statistical Inference and Applications- John Wiley and Sons, Inc.
3. Casella G. and Berger R.L. (2002): Statistical Inference-Duxbury Advanced Series, 2nd ed.
4. Kale B.K. (2005): First Course on Parametric Inference- 2nd ed. Narosa Publishing House.
5. Lehmann E.L. (1983): Theory of Point Estimation- John Wiley and Sons.
6. Ferguson T.S. (1967): Mathematical Statistics, Academic Press.

MST 116: STATISTICS PRACTICAL –I

Use of Statistical Software Packages:

- MINITAB Software
- R Software

1. Introduction to MS-EXCEL
2. Model Sampling from discrete distributions using MS-EXCEL
3. Model Sampling from continuous distributions using MS-EXCEL
4. Model Sampling from bivariate distributions using MS-EXCEL
5. Sketching of distribution functions and probability density functions.
6. Linear dependence of vectors and rank a matrix.
7. Gram -Schmidt orthogonalisation method.
8. Solving systems of equations.
9. Determinant, Inverse and g-inverse of a matrix.
10. Application of Calley- Hamilton Theorem,
11. Inverse of a Partitioned Matrix.
12. Characteristics roots and vector and their application.
13. Classifications and reduction of quadratic forms.
14. Construction of UMVUE.
15. Methods of Estimation: MME and MLE.
16. Method of Scoring.
- 17-20. Programming assignments based on MST-101 Course.

MST 201: PROBABILITY THEORY

Unit-1: Classes of sets, Sequence of sets, limsup and liminf and limit of sequence of sets, field, σ - field, σ - field generated by a class, Borel σ -field. (6 L)

Unit-2: Probability measure, Probability space, properties of probability measure-continuity, mixture of probability measure. Lebesgue and Lebesgue-Stieltjes measures on R. Independence of events. (6 L)

Unit-3: Measurable function, random variable, distribution of a random variable, simple random variable, elementary random variable, liminf, limsup and limit of sequence of random variables. Method of obtaining a random variable as a limit of sequence of simple random variables. (10 L)

Unit-4: Integration of a measurable function with respect to a measure, expectation of a random variable, monotone convergence theorem, Fatous Lemma, Dominated Convergence theorem and their application. (6 L)

Unit-5: Convergence of sequence of random variables, almost sure convergence, a characterizing property, convergence in probability, uniqueness of limit, a characterizing property. Yule Slutsky results and preservation under continuous transform (statement only). convergence in r^{th} mean, interrelationships. (10 L)

Unit-6: Independence: Borel-Cantelli Lemma, Characteristics function, simple properties. Inversion theorem and uniqueness property (statements only). (6 L)

Unit-7: Convergence in distribution, continuity theorem (statement only), Weak and Strong laws of large numbers, Kolmogorov's three series theorem for almost sure convergence (statement only), Liapoune's Lindeberg-Feller Theorems on CLT (statement only). Application of the above result. (6 L)

References:

1. Bhat B. R. (1999): Modern Probability Theory (3rd ed.).New Age International (P) Ltd..
2. Billingsley P.(1986): Probability and Measure-.John Wiley and Sons.
3. Alan Karr (1993): Probability Theory-Springer Verlag.
4. Kingman, J F C and Taylor, S.J.(1966): Introduction to Measure and Probability-Cambridge University Press.
5. Dudley, R.M.(1989): Real Analysis and Probability- Wadsworth and Brooks/ Cole.
6. Ash Robert (1972): Real Analysis and Probability-Academic Press.

MST 202: STOCHASTIC PROCESSES

- Unit-1: Definition of Stochastic process, classification of Stochastic processes according to state space and time domain. Finite dimensional distributions. Examples of various stochastic processes. (5 L)
- Unit-2: Definition of Markov chain, Examples of Markov chains, Formulation of Markov models, initial distribution transition probability matrix, Chapman-Kolmogorov equation, calculation of n-step transition probabilities. (6 L)
- Unit-3: Classification of states, irreducible Markov chain, period of the state, random walk and gambler's ruin problem. First entrance theorem, First passage time distribution. (8 L)
- Unit-4: Long run distribution of Markov chain, relation of mean recurrence time and stationary distribution. (5 L)
- Unit-5: Discrete state space continuous time Markov chain. Poisson process and related results. Birth and death processes and associated cases. M/M/1, M/M/S queuing models and related properties. (10 L)
- Unit-6: Renewal and delayed renewal processes, related theorems, key renewal theorem (without proof) and its application. (6 L)
- Unit-7: Galton-Watson branching process. Probability of ultimate extinction, distribution of population size and associated results. (6 L)
- Unit-8: Simulation of Markov chain, Poisson process, branching process (Algorithms). (4 L)

References:

1. Medhi. J. (1982): Stochastic Process- Wiley Eastern.
2. Parzen E. (1962): Stochastic Process-Holden-Pay.
3. Karlin & Taylor (1975): A First Course in Stochastic Processes-Vol-I Academic Press.
4. Cinlar E. (1975): Introduction to Stochastic Process. Prentice Hall.
5. Srinivas and Mehta (1976): Stochastic Processes-Tata McGraw-Hill.
6. Adke. & Manjunath (1984): An introduction to finite Markov Processes- Wiley Eastern.
7. Bhat B.R. (2000): Stochastic Model: Analysis and Application- New Age International.

MST 203: THEORY OF TESTING OF HYPOTHESES

Unit-1: Problem of testing of hypothesis: Simple and Composite hypotheses. Randomized and non-randomized tests. Most powerful test, Neyman-Pearson Lemma and its applications. Determination of minimum sample size to achieve the desired strengths.

(10 L)

Unit-2: Composite hypotheses: Monotone likelihood ratio (MLR) property, power function of a test, existence of UMP tests for one-sided alternatives. UMP tests for two sided alternatives, their existence and non-existence. Examples.

(10 L)

Unit-3: Generalized Neyman Pearson Lemma: Unbiased test, UMPU tests and their existence in the case of exponential families. (statements of the theorems only), Similar tests, test with Neyman structure.

(8 L)

Unit-4: Problem of confidence intervals, relation with testing of hypotheses problem, UMA and UMAU confidence intervals, shortest length confidence intervals.

(8 L)

Unit-5: Likelihood ratio test, Application to standard distributions. Goodness of fit test based on Chi-square distribution, application to contingency tables.

(6 L)

Unit-6: Non-parametric tests, one and two sample problem, tests on U statistics for various hypotheses, the asymptotic distribution of the statistics involved under the null hypotheses (statements of theorems only), Sign test, Run test, Signed rank-test, Wilcoxon's signed-rank test, Mann Whitney test.

(8 L)

References:

1. Kale B.K. (1999): A first Course on Parametric Inference-Narosa
2. Rohatgi V.K.(1988): Introduction to Probability and Mathematical Statistics, Wiley Eastern Ltd. New Delhi. Student Edition.
3. Dudewicz E.J. & Mishra S.N.(1988): Modern Mathematical Statistics, Wiley Series
4. Lehman E.L. (1987): Theory of Testing of Hypotheses. Student Edition.
5. Ferguson T.S. (1967): Mathematical Statistics: A decision Theoretical Approach. Academic Press.
6. Zacks S.(1971): Theory of Statistics Inference- John Wiley and Sons, New York.

MST 204: LINEAR MODELS AND DESIGN OF EXPERIMENTS

Unit-1: General linear model: Definition, assumptions, concept of estimability, least squares estimation, BLUE, error space, estimation space, Gauss-Markov theorem, variances and covariances of BLUEs. (10 L)

Unit-2: Distribution of quadratic forms in normal variables, related theorems (without proof). Tests of hypothesis in general linear models. (4 L)

Unit-3: Analysis of variance: one way classification, two way classification without interaction and with interaction with equal number of observation per cell. Estimation and related tests of hypothesis, Tuckey's test of additivity. (10 L)

Unit-4: Multiple comparisons: Three types of errors, Tuckey, Sheefe and Bonferroni procedure. (4 L)

Unit-5: Analysis of Covariance: Estimation of parameters, related tests of hypothesis. General theory and application to one way and two-way set up. (6 L)

Unit-6: General block design: Two way classification with unequal number of observations per cell (without interaction), connectedness, balancedness, orthogonality, related tests of hypothesis. (9 L)

Unit-7: BIBD: Defination, parametric relationship, inter and intra block analysis, Symmetric BIBD. (7 L)

References:

1. Kshirsagar A.M. (1983): Course in Linear Models- Marcel Dekker.
2. Donald C. Weber & John H. Skillings(2000): A First Course in the Design of Experiments - A linear Model Approach- Weber Skillings.
3. Giri N.S. & Das M.N. (1979): Design and Analysis of Experiments- Wiley Eastern Ltd.
4. Searle S.R. (1971): Linear Models-John Wiley and Sons.
5. Joshi D.D. (1987): Linear Estimation and Analysis of Experiments. Wiley Eastern, New York.
6. Chakravarti M.C. (1962): Mathematics of Design of Experiments-Asia publishing house

MST 205: SAMPLING THEORY

- Unit-1: Concept of population and sample.need for sampling, Census and sample surveys, basic concepts in sampling and designing of large-scale survey design, sampling scheme and sampling strategy. Basic methods of sample selection: SRSWR, SRSWOR. (7 L)
- Unit-2: Stratification, Allocation and estimation problems. Construction of Strata: deep stratification, method of collapsed strata. (7 L)
- Unit-3: Systematic sampling: sample mean and variance, comparison of systematic with random sampling, comparison of systematic sampling with stratified sampling, comparison of systematic sampling with simple and stratified random sampling for certain specified population. Estimation of variance, Two stage sample: equal first stage units, Two stage sample: Unequal first stage units; systematic sampling of second stage units. (10 L)
- Unit-4: PPSWR methods: Cumulative total method, Lahiri's method, related estimation and problems PPSWOR method and related estimation of a finite population mean. (Horvitz-Thompson and Des Raj estimator for general sample size and Murthy's estimator for sample of size 2). Midzuno sampling. (9 L)
- Unit-5: Use of supplementary information for estimation: Ratio and Regression estimators and their properties. Unbiased and almost Unbiased ratio type estimators, Double Sampling. (8 L)
- Unit-6: Cluster sampling. Two-stage sampling with equal number of second stage units. (5 L)
- Unit-7: Non-sampling errors, Response and non-response errors, Hansen-Hurwitz and Deming's techniques. (4 L)

References:

1. Sukhatme P.V., Sukhatme P.V., Sukhatme S. & Ashok C.(1997): Sampling Theory of Surveys and Applications- Piyush Publications.
2. Des Raj and P. Chandhok (1998): *Sample Survey Theory*. Narosa publishing House.
3. William G. Cochran (1977): Sampling Techniques, 3rd edition- John Wiley & Sons.
4. Parimal Mukhopadhyay (1988): Theory and methods of survey sampling-prentice Hall of India Pvt. Ltd.
5. Murthy M.N. (1977): Sampling Theory of Methods-Statistical publishing Society, Calcutta.

MST 216: STATISTICS PRACTICAL-II

Use of Statistical Software Packages:

- MINITAB Software
- MATLAB Software
- R Software

1. Realization from a Markov Chain
2. Estimation of T.P.M. and computation of n-step probability matrix.
3. Classification of states: Computations of absorption probabilities.
4. Stationary distribution and recurrence times.
5. Realization from discrete state space Markov processes and related estimation.
6. Most Powerful Tests.
7. Uniformly Most Powerful Tests.
8. Uniformly Most Powerful Unbiased Tests.
9. Likelihood Ratio Test
10. Confidence Intervals.
11. Non-parametric Tests
12. Linear Estimation: Estimation and Hypothesis testing
12. ANOVA
13. ANOCOVA
14. Analysis of BIBD.
15. Analysis of general block design.
16. Basic sampling design
17. Stratified sampling
- 18 Systematic and Cluster sampling
19. Ratio, Regression, Horvitz-Thompson Method of Estimations.
20. Multi-stage sampling
