SOLAPUR UNIVERSITY, SOLAPUR.

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

Choice Based Credit System Syllabus

(w.e.f. June 2015-16)

SOLAPUR UNIVERSITY, SOLAPUR

SCHOOL OF COMPUTATIONAL SCIENCES

DEPARTMENT OF STATISTICS

Syllabi of M.Sc. in Statistics (CBCS 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 Paper	01	100	04
• Seminar/Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester II			
• Theory Papers	05	500	20
• Practical Paper	01	100	04
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester III			
• Theory papers	05	500	20
• Practical Paper	01	100	04
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester IV			
• Theory papers	05	500	20
• Practical Paper	01	100	04
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Total marks and credits for M.Sc. Course		**2500**	**100**

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	Paper No.	Title of the Paper	Contact hours/ week	Distribution of Marks for Examination			Credits
				Internal	External	Total	
MST-101	I	Statistical Computing	04	30	70	100	04
MST-102	II	Real Analysis	04	30	70	100	04
MST-103	III	Linear Algebra	04	30	70	100	04
MST-104	IV	Distribution Theory	04	30	70	100	04
MST-105	V	Estimation Theory	04	30	70	100	04
MST-116	---	Statistics Practical-I (Per Batch)	12	30	70	100	04
Seminar			--	25	--	25	01
Total			**32**	**205**	**420**	**625**	**25**

M.Sc. Statistics Semester-II

Paper Code	Paper No.	Title of the Paper	Contact hours/ week	Distribution of Marks for Examination			Credits
				Internal	External	Total	
MST-201	VI	Probability Theory	04	30	70	100	04
MST-202	VII	Linear Models	04	30	70	100	04
MST-203	VIII	Stochastic Processes	04	30	70	100	04
MST-204	IX	Theory of Testing of Hypotheses	04	30	70	100	04
MST-205	X	Sampling Theory	04	30	70	100	04
MST-216	---	Statistics Practical-II (Per Batch)	12	30	70	100	04
Seminar			--	25	--	25	01
Total			**32**	**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 N0. 3 to Question No. 7.
8) Question N0. 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 Code	**Title of the Paper**	**Paper Code**	**Title of the Paper**
I	MST-101	Object Oriented Programming Using C++	MST-101	Statistical Computing
	MST-102	Real Analysis	MST-102	Real Analysis
	MST-103	Linear Algebra	MST-103	Linear Algebra
	MST-104	Distribution Theory	MST-104	Distribution Theory
	MST-105	Theory of Estimation	MST-105	Estimation Theory
II	MST-201	Probability Theory	MST-201	Probability Theory
	MST-202	Linear Models and Design of Experiments	MST-202	Linear Models
	MST-203	Stochastic Processes	MST-203	Stochastic Processes
	MST-204	Theory of Testing Hypotheses	MST-204	Theory of Testing Hypotheses
	MST-205	Sampling Theory	MST-205	Sampling Theory

Paper No. I
Paper Code: MST 101

STATISTICAL COMPUTING

Unit-1: Concept of Random Number Generator, Congruential Method of generating uniform variates, Concept of Simulation, Generation of Binomial, Poisson, Geometric, Negative Binomial & Multinomial variates. Generation of continuous random variables covering Exponential, Normal, Gamma, Chi-square, Bivariate Poisson, Bivariate Normal, Bivariate Exponential distributions and Mixture of distributions. Proofs of related results. **(12 L)**

Unit-2: Programming in C++: Concept of OOP, Data types, Variables, Statements, Expressions, Control structures, Looping, Functions, Pointers, Programming for problems based on Unit-1. **(10 L)**

Unit-3: MS-EXCEL and MINITAB: Introduction to Ms-Excel and exercise on using EXCEL for Statistical analysis covering frequency distribution, histogram, t-test, and test for independence in 2 x 2 contingency tables. Introduction to MINITAB and programming based on MINITAB macros for statistical analysis covering descriptive statistics, regression analysis and bootstrap technique. **(10 L)**

Unit-4: R-Language: Introduction to R, Elementary programming. Application to data analysis: Descriptive statistics, Fitting of distributions, Cross tables, Correlation and Regression, Hypothesis Testing, ANOVA. **(12 L)**

Unit-5: Bias Reduction Methods, Jack-Knife estimator, its properties and limitations. Boot-Strap method and its simple properties. **(6L)**

Reference Books

1. Balagurusamy (2008), Object Oriented Programming with C++ , Tata McGraw-Hill
2. Ryan B. and Joiner, B.L.(2001).MINITAB Handbook, 4th Ed.Duxbury.
3. Thisted R.A.(1998). Elements of Statistical Computing, Chapman and Hall.
4. Kennedy William J. Jr., James E. Gentle (1980), Statistical Computing, Marcel Dekkar
5. Morgan B.J.T. (1984), Elements of Simulation, Chapman and Hall.
6. Purohit, Gore, and Deshmukh (2008), Statistics Using R, Alpha Science International

Paper No. II
Paper Code: 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.

Series of numbers, tests for convergence (without proof), test for absolute convergence, convergence of sequences of non-negative terms. **(15 L)**

Unit-3: Real valued function, Continuous function, Uniform continuity of sequence of functions, Uniform convergence of power series, Radius of convergence.

Reimann, Reimann-Steltjes Integrals and their common properties. Integration by parts, Fundamental theorem on calculus, mean value theorem, their applications in finding functionals of distributions. **(10 L)**

Unit-4: 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, implicit function theorem and their applications. **(7 L)**

Unit-5: Multiple Integrals, Change of variables, Improper integrals, Applications in multivariate distributions. Theorem on differentiation under integral sign (without proof), Lebnitz rule (statement only) and applications. **(8 L)**

Reference Books:

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.

Paper No. III
Paper Code: 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: G-inverse, Moore-Penrose inverse and its properties, Solution of a system of homogenous and non-homogenous linear equations and theorem related to existence of solution. **(10 L)**

Unit-4: Characteristic roots of a matrix, algebraic and geometric multiplicities, charactristics vectors and their orthogonal property. Caley-Hamilton theorem and applications. Spectral decomposition, singular value decomposition and choleskey decomposition. **(10 L)**

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

Reference Books:

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

Paper No. IV
Paper Code: 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. Truncated distributions (Truncated Binomial, Truncated Poisson, Truncated Normal). Functions of random variables, their distributions in case of univariate random variables and its applications. **(12 L)**

Unit-2: Expectation and moments, probability generating function, moment generating function, convolution and examples. Moment inequalities: Markov, Chebychev, Holder, Minkowski and Jensen inequalities with their applications. Basic inequality of Liapunov's. **(10 L)**

Unit-3: 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. Multinomial distribution, Bivariate Poisson, Bivariate exponential and Bivariate Normal distributions and their properties. Dirichilet distribution.**(12 L)**

Unit-4: Symmetric distributions, properties of symmetric distributions, non-regular families, location and scale families and examples. Order Statistics-their distributions and properties. Joint and marginal distributions of order statistics. Extreme values and their asymptotic distributions (statement only) with applications. **(10 L)**

Unit-5: Sampling distributions of statistics from univariate normal random sample such as linear and quadratic forms, Non-central χ^2, non-central t and F distributions. **(06 L)**

Reference Books:

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.

Paper No. V
Paper Code: MST 105

ESTIMATION THEORY

Unit-1: Sufficiency principle, factorization theorem, minimal sufficiency, minimal sufficient partition, construction of minimal sufficient statistic, minimal sufficient statistic for exponential families, power series family and pitman family. **(8 L)**

Unit-2: Completeness, bounded completeness, ancillary statistic, Basu's theorem and applications. **(6 L)**

Unit-3: Problem of point estimation, unbiased estimators, minimum variance unbiased esimator, Rao-Blackwell and Lehmann-Scheffe theorems and their uses. Necessary and sufficient condition for MVUE. Fisher information and information matrix, Cramer-Rao inequality, Chapmann-Robinson bound, Bhattacharya bound, their applications. **(12 L)**

Unit-4: Methods of Estimation: Method of maximum likelihood estimation (MLE) and small sample properties of MLE, method of scoring and its application to estimation in multinomial distribution, Method of moments, Method of minimum Chi-square. **(12 L)**

Unit-5: Bayesian Estimation: The concept of Prior distributions, various types of priors, Posterior distribution, Posterior distribution conjugate family and standard examples of such families. Bayes and Minimax rules, interpretation for finite parameter space. **(12 L)**

Reference Books:

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.

Practical Paper-I

Paper Code: MST 116

STATISTICS PRACTICAL –I

Use of Statistical Software Packages:

- MINITAB Software
- R Software

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

15-20. Programming assignments based on MST-101 Course.

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Paper No. VI
Paper Code: MST 201

PROBALITY 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. Probability measure, Probability space, properties of probability measure-continuity, mixture of probability measures. Lebesgue and Lebesgue-Steltjes measures on R. Independence of events. **(15 L)**

Unit-2: 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. Integration of a measurable function with respect to a measure. **(9 L)**

Unit-3: expectation of a random variable, independence. Characteristic function, simple properties, Inversion theorem and uniqueness property (Statement only). **(6 L)**

Unit-4: Monotone convergence theorem, Fatous Lemma, Dominated Convergence theorem, Borel-Cantelli Lemma and their applications. Convergence of sequence of random variables, Convergence of distribution, Continuity theorem (Statement only), Almost sure convergence, a characterizing property, convergence in probability, uniqueness of limit. Yule Slutsky results and preservation under continuous transform (Statement only). convergence in r^{th} mean, interrelationships. **(12 L)**

Unit-5: Weak and Strong laws of large numbers, Kolmogorov's three series theorem for almost sure convergence (statement only), Liaponove's Lindeberg-Feller Theorems on CLT (statement only). Application of the above results. **(8 L)**

Reference Books:

1. Bhat B. R. (1999): Modern Probability Theory (3^{rd} 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. Dudly, R.M.(1989): Real Analysis and Probability- Wadsworth and Brooks/ Cole.
6. Ash Robert (1972): Real Analysis and Probability-Academic Press.

Paper No. VII
Paper Code: MST 202

LINEAR MODELS

Unit-1: General linear model: Definition, assumptions, concept of estimability, least squares estimation, BLUE, error space, estimation space, Guass-Markov theorem, variances and covariances of BLUEs. Distribution of quadratic forms in normal variables, related theorems (without proof). Tests of hypothesis in general linear models. **(12 L)**

Unit-2: Analysis of variance: one way classification, two way classification without interaction and with interaction with equal number of observations per cell. Estimation and related tests of hypothesis, Tuckey's test of additivity. **(10 L)**

Unit-3: Multiple comparisons: Three types of errors, Fisher's LSD method, Tuckey, Sheefe and Bonferroni methods. **(5 L)**

Unit-4: Analysis of Covariance: Estimation of parameters, related tests of hypothesis. General theory and application to one way and two-way set up. Introduction to mixed and random effect models. **(10 L)**

Unit-5: General Block Design: Two way classification with unequal number of observations per cell (without interaction), connectedness, balancedness, orthogonality, related tests of hypothesis. BIBD: Definition, parametric relationship, inter and intra block analysis, Symmetric BIBD. **(13 L)**

Reference Books:

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

Paper No. VIII
Paper Code: MST 203

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. 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. **(10 L)**

Unit-2: Classification of states of Markov chain, irreducible Markov chain, period of the state, random walk and gambler's ruin problem. First entrance theorem, First passage time distribution. Long run distribution of Markov chain, relation of mean recurrence time and stationary distribution. **(10 L)**

Unit-3: 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-4: Renewal and delayed renewal processes, related theorems, key renewal theorem (without proof) and its application. **(8 L)**

Unit-5: Galton-Watson branching process. Probability of ultimate extinction, distribution of population size and associated results. Simulation of Markov chain, Poisson process, branching process (Algorithms). **(12 L)**

Reference Books:

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 MgGraw-Hill.
6. Adke and Manjunath (1984): An introduction to finite Markov Processes- Wiley Eastern.
7. Bhat B.R. (2000): Stochastic Model: Analysis and Application- New Age International.

Paper No. IX
Paper Code: MST 204

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: Monotone likelihood ratio (MLR) property, power function of a test, UMP tests and their existence 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. **(10 L)**

Unit-4: Interval estimation, confidence level, construction of confidence intervals using pivots, shortest length confidence interval, UMA confidence interval and its relation to UMP test, UMAU confidence interval and its relation with UMPU test. **(10 L)**

Unit-5: Likelihood ratio test, application to standard distributions. Goodness of fit test based on Chi-square distribution, application to contingency tables. Non-parametric tests, One and two sample problem; Sign test, Run test, Wilcoxon Signed-Rank test, Mann- Whitney test. Definition of U-statistics, U-statistics theorem for one sample and two samples (statements only). **(10 L)**

Reference Books:

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. Srivastava M and Srivastava N (2009): Statistical Inference-Testing of Hypotheses, PHI Learning Pvt. Ltd.
6. Shanthakumaran A. (2001): Fundamentals of Testing of Hypotheses, Atlantic Publishers and Distributors.

Paper No. X

Paper Code: MST 205

SAMPLING THEORY

Unit-1: Review of 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. Simple random sampling with and without replacement (SRSWR and SRSWOR). **(12 L)**

Unit-2: Stratified Sampling: Stratification, Allocation and estimation problems, Construction of Strata, deep stratification, method of collapsed strata.

Systematic sampling: The sample mean and its 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. **(12 L)**

Unit-3: PPSWR Methods: Cumulative total method, Lahiri's method, related estimation 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, Rao-Hartley-Cochran sampling strategy, Poisson and modified Poisson sampling strategy. **(10 L)**

Unit-4: Use of supplementary information for estimation: Ratio and Regression estimators and their properties. Unbiased and almost Unbiased ratio type estimators, Double sampling, Cluster sampling, Two-stage sampling with equal number of second stage units. **(10 L)**

Unit-5: Non-sampling errors, Response and non-response errors, Hansen-Hurwitz and Deming's techniques. **(6 L)**

Reference Books:

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 and Methods, Statistical publishing Society, Calcutta.

Practical Paper-II

Paper Code: 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. Basic Sampling Design

15. Stratified Sampling

16. Systematic Sampling

17. Cluster Sampling

18. PPS Sampling

19. Ratio and Regression Estimation

20. Non-sampling Errors

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