University of Rajasthan
Jaipur

SYLLABUS

M.Sc.

(STATISTICS)

2014-2015 (I & II SEMESTER)

2015-2016 (III & IV SEMESTER)

msc- Statistics 2014-16

2. Eligibility:

A candidate who has secured more than 50% or CGPA of 3.0 in the UGC Seven Point scale [45% or CGPA 2.5 in the UGC Seven Point Scale for SC/ST/Non-creamy layer OBC] or equivalent in the Bachelor degree in Science or Engineering or Technology or Medicine or Pharmaceutical Science shall be eligible for admission to First Semester of a Master of Science course.

Sem.- 2014-16
(I, II, III & IV)

As on website of U.O.R.

3. **Scheme of Examination:**

(1) Each theory paper EoSE shall carry 100 marks The EoSE will be of 3 hours duration. Part 'A' of theory paper shall contain 10 Short Answer Questions of 20 marks, based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Each question will carry one mark for correct answer.

(2) Part "B" of paper will consisting of Four questions with internal choice (except in cases where a different scheme is specifically specified in the syllabus_ of 20 mark each. The limit of answer will be five pages.

(3) Each Laboratory EoSE will be of four/six hour durations and involve laboratory experiments/exercises, and viva-voce examination with weightage in ratio of 75:25.

4. Course Structure:

The details of the courses with code, title and the credits assign are as given below.

Abbreviations Used

Course Category

CCC: Compulsory Core Course
ECC: Elective Core Course
OEC: Open Elective Course
SC. Supportive Course
SSC: Self Study Core Course
SEM: Seminar
PRJ: Project Work
RP: Research Publication

Contact Hours

L: Lecture
T: Tutorial
P: Practical or Other
S: Self Study

Relative Weights

IA: Internal Assessment (Attendance/Classroom Participation/Quiz/Home Assignment etc.)
ST: Sessional Test
EoSE: End of Semester Examination

First Semester

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per week			EoSE Duration (Hrs.)	
					L	T	P	Thy.	P
01	MST 101	Statistical Mathematics	CCC	6	4	2	0	3	0
02	MST 102	Probability Theory	CCC	6	4	2	0	3	0
03	MST 103	Measure Theory	CCC	6	4	2	0	3	0
04	MST 104	Probability Distributions	CCC	6	4	2	0	3	0
05	MST 111	Practical -I	CCC	6	0	0	9	0	4
06	MST 112	Practical -II	CCC	6	0	0	9	0	4

Second Semester

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per week			EoSE Duration (Hrs.)	
					L	T	P	Thy.	P
01	MST 201	Sampling and Bivariate Distributions	CCC	6	4	2	0	3	0
02	MST 202	Statistical Inference-I	CCC	6	4	2	0	3	0
03	MST 203	Design of Experiment-I	CCC	6	4	2	0	3	0
04	MST 204	Sample Surveys-I	CCC	6	4	2	0	3	0
05	MST 211	Practical -III	CCC	6	0	0	9	0	4
06	MST 212	Practical -IV	CCC	6	0	0	9	0	4

Third Semester

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per week			EoSE Duration (Hrs.)	
					L	T	P	Thy.	P
01	MST 301	Multivariate Analysis	CCC	6	4	2	0	3	0
02	MST 302	Statistical Inference-II	CCC	6	4	2	0	3	0

03		Elective Paper-I	ECC	6	4	2	0	3	0
04		Elective Paper-II	ECC	6	4	2	0	3	0
05	MST 311	Practical -V	CCC	6	0	0	9	0	4
06	MST 312	Practical -VI	CCC	6	0	0	9	0	4

Fourth Semesters

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per week			EoSE Duration (Hrs.)	
					L	T	P	Thy.	P
01	MST 401	Design of Experiments-II	CCC	6	4	2	0	3	0
02	MST 402	Sample Surveys-II	CCC	6	4	2	0	3	0
03		Elective Paper-III	ECC	6	4	2	0	3	0
04		Elective Paper-IV	ECC	6	4	2	0	3	0
05	MST 411	Practical -VII	CCC	6	0	0	9	0	4
06	MST 412	Practical -VIII	CCC	6	0	0	9	0	4

Elective Core Courses

Specialization Clusters

A. THIRD SEMESTER A,B

B. FOURTH SEMESTER C,D

Elective Course code	Specialization	Paper Title	Prerequisite	Semester
MST A01		Stochastic Process and Demography		III Ele-I Ele-1
MST A02		Reliability Analysis		III Ele-I
MST A03		Bio-Statistics		III Ele-I
MST B01		Statistical Quality Control and Operations Research		III Ele-II
MST		Statistical Data Mining		III Ele-II

B02				
MST B03		Statistics for Clinical Trials		III Ele.-II
MST C01		Economic Statistics and Econometrics		IV Ele.-III
MST C02		Operation Research-II		IV Ele.-III
MST C03		Non-Parametric and Semi-Parametric Methods		IV Ele.-III
MST D01		Project Work		IV Ele.-IV
MST D02		Actuarial Statistics		IV Ele.-IV
MST D03		Survival Analysis		IV Ele.-IV

MST 101: STATISTICAL MATHEMATICS

Linear Algebra: Inverse and rank of a matrix, solution of linear equations, orthogonal matrix, orthogonal reduction of a real symmetric matrix to a diagonal form, generalized invere and its simple properties, idempotent and nilpotent matrices, solutions of matrix equations.

Bilinear and quadratic forms, reduction to canonical forms, definite and indefinite forms, index and signature, triangular reduction of a positive definite matrix, Hermitian canonical form, characteristic equation, its roots and vectors, Cayley-Hamilton theorem ,beta and gamma integrals.

Real Analysis: Real valued functions, continuous function, uniform continuity, differentiability of a function, maxima-minima of functions, maxima-minima of a function of two independent variables, Lagrange's method of undetermined multipliers.

Interpolation formulae due to Lagrange's, Newton-Gregory, Newton's divided difference, central difference formulae. Numerical differentiation and integration, Trapezoidal, Simpson's 1/3rd and 3/8 rules, Weddle's Rules. Iterative methods for Non-Linear Equation. Numerical solution of ordinary differential equations.

References:

1. Apostol, T.M. (1985):Mathematical Analysis, Narosa Publishing House.
2. Burkill,J.C.(1980):A first Course in Mathematical Analysis, Vikas Publishing House.
3. Cournat, R.and John, F. (1965): Introduction to Calculus and Analysis, John Wiley.
4. Khuri,A.I(1983): Advanced Calculus with Applications in Statistics, John Wiley.
5. Miller,K.S.(1957): Advanced Real Calculus, Harper, New York.
6. Sastry S.S. (1987): Introductory Methods of Numerical Analysis, Prentice Hall.
7. Saxena,H.C (1980).: Calculus of Finite Difference, S. Chand & Co.
8. Searle, S.R.(1982): Matrix Algebra Useful for Statistics, John Wiley
9. Shanti Narayan,(1998):A Textbook of Matrices , S. Chand & Co.

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MST 102: PROBABILITY THEORY

General probability space, various definitions of probability. Combinations of events: additive and multiplicative laws of probability. Conditional probability. Bayes' theorem and its applications.

Concept of random variables, cumulative distribution function and probability density function, joint, marginal and conditional distribution. Brief review of joint, marginal and conditional probability density function, functions of random variables and their distributions using Jacobian of transformation.

Mathematical expectation, moments, conditional expectation, moment generating functions, cumulative generating functions and their applications, Characteristic function, uniqueness theorem, Levy's continuity theorem (statement only). Probability inequalities and their applications: Chebyshev, Markov and-Johnson.

Convergence in probability and convergence in distribution, weak law of large numbers and central limit theorem for a sequence of independent random variables under Lindeberg's condition, central limit theorem for independent and identically distributed random variables with finite variance. Sequence of events and random variables: Zero one law of Borel and Kalmogorov, almost sure convergence in mean squares, Kintchin's weak law of large numbers, Kolmogorov inequality, and strong law of large numbers.

Reference:

1. Kingman J.F. & Taylor.S.J. (1996): Introduction to Measure and Probability, Cambridge Univ.Press.
2. Loeve (1996): Probability Theory, Affiliated East –West Press Pvt. Ltd. New Delhi.
3. Bhatt, B.R.(2000): Probability, New Age International India.
4. Feller,W.(1971): Introduction to Probability Theory and its Applications, Vol. I and II. Wiley, Eastern-Ltd.
5. Rohatgi, V.K (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
6. Billingsley, P. (1986): Probability and Measure, John Wiley Publications.
7. Dudley, R.M. (1989): Real Analysis and Probability, Worlds Worth & Books.
8. Tucket H.G. (1967): A Graduate Course in Probability; Academic Press.
9. Basu, A.K. (1999): Measure Theory and Probability, PHI.

MST 103: MEASURE THEORY

Classes of sets: semi ring, ring, field, sigma field, monotone classes. Sequence of sets, limit supremum and limit infimum of a sequence of sets. Additive set functions, measure, outer measure and their properties.

Cartheodry extension theorem (statement only) definition of complete measure. Lebesgue and Lebsegue Stieltjes measure (one dimension only) Probability measure, distribution function and its correspondence with Lebesgue Stieltjes.

Measurable sets and measurable space. Simple, elementary and measurable functions. Sequence of measurable functions. Integrability of measurable function, properties of integrals.

Lebesgue monotone convergence theorems, Fataous lemma, dominance convergence theorem, Absolute continuity, Random Nikodym theorem (statement only) and applications, product measure (idea only), Fubinies theorem.

Reference:

1. Kingman J.F. & Taylor. S.J.(1996): Introduction to Measure and Probability, Cambridge Univ. Press.
2. Billingsley, P. (1986): Probability and measure, Wiley Publications.
3. Dudley, R.M. (1989): Real Analysis and Probability, Worlds Worth & Books.
8. Tucket, H.G. (1967): A graduate course in Probability, Academic Press.
9. Basu, A.K. (1999): Measure Theory and Probability, PHI.

MST 104: PROBABILITY DISTRIBUTIONS

Measures of location and dispersion, moments, Sheppard's correction, moment and cumulant generating functions, probability generating function.

Bernoulli, binomial (compound and truncated also), poisson (compound and truncated also), negative binomial, geometric, hyper-geometric and multinomial distributions.

Rectangular, normal (truncated also), exponential, lognormal and triangular distributions.

Gamma, beta, Cauchy (truncated also), Laplace distributions, Pearson's distribution (Type I, IV and VI).

References:

1. Goon, Gupta & Das Gupta. (1991): Outline of Statistical Theory. Vol. I, World Press.
2. Hogg, R.V. and Craig, A.T.(1971): Introduction to Mathematical Statistics, McMillan.
3. Johnson, S. and Kotz. (1972): Distribution in Statistics, Vol.I, II. And III, Houghton and Muffin.
4. Kendall, M.G.and Stuart. (1996): An Advanced Theory of Statistics, Vol. I,II. Charls Griffin.
5. Mood,A.M., Graybill, F.A. and Boes, D.C.(1974): Introduction to the Theory of Statistics, McGraw Hill.
6. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency (P) Ltd.
7. Rohatgi, V.K. (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
8. Johnson, S. and Kotz. (1972): Distribution in Statistics, Vol.I, II and III, Houghton and Muffin.

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MST-111 PRACTICAL -I

(Practical Paper Based on MST 101 & MST 104)

List of Practical (MST 101)

1. Determinants - by row and column operations, by partitioning.
2. Inverses of a matrix - by row and column operations, by partitioning
3. Rank of a matrix
4. Solutions of matrix equations
5. Characteristic roots and vectors of a matrix
6. Interpolation using Lagrange's formula, Newton-Gregory formula
7. Interpolation using Newton's divided difference formula
8. Numerical differentiation using Newton's formula
9. Numerical differentiation using Lagrange's formula
10. Numerical integration using trapezoidal formula
11. Numerical integration using Simpson's one-third formula
12. Numerical integration using Simpson's three-eighth formula
13. Numerical integration using Weddle's Rule

(MST 104)

1. Coefficient of variation.
2. Calculation of central moments, coefficient of variation, β_1, β_2 and γ_1, γ_2 coefficients, Sheppard's correction to moments.
3. Plot binomial curve for different values of n and p
4. Fitting of binomial distributions when p is known and when p is unknown.
5. Fitting of Poisson distribution when λ is known and when λ is unknown.
6. Fitting of negative binomial distribution.
7. Fitting of Normal distribution
8. Calculation of areas under normal curve.

MST 112: PRACTICAL-II

(Paper Based on MS-Excel, C-Programming and its Statistical Applications)

MS-Excel :

1. Fundamental of Operating Systems: Overview of Operating System, Types & Function. Application Software.
2. Database Management System: Data Resource Management. Database and File-Organization and Processing: Direct, Sequential Indexed Sequential File
3. Performing Windows Operations.
4. Creating, Saving & Entering Data into a Worksheet
5. Performing Mathematical & Statistical Computations on Data entered in a worksheet.

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6. Preparing frequency Distribution Table.
7. Creating Charts(2 & 3 Dimensional Charts)

C-Programming:

8. Basics of C Program.
9. **Programs based on**

(i) Arrays(One, Two Dimensional), Character Strings, Standard Library Functions,
(ii) Modular programming – User defined Functions
(iii) Structures.
(iv) Pointers.
(v) Solving a Non-Linear Equations using Iterative methods (Bisection, False Position, Newton-Rephson, Secant Methods).
(vi) Solution of System of Linear Equations (Gauss Elimination method, Gauss Seidel method)
(vii) Numerical Integration- Trapezoidal , Simpson $1/3^{rd}$, $3/8^{th}$ & Weddle's Rules

MST 201: SAMPLING DISTRIBUTIONS AND BIVARIATE DISTRIBUTIONS

Sampling Distributions: Basic concepts, standard error, Chi-Square, t and F distributions (central and non-central) and their applications.

Standard errors of functions of moments. Order statistics: their distributions and properties; joint and marginal distributions of order statistics, sampling distributions of range and median of univariate population.

Bivariate Normal Distribution: Joint, marginal and conditional distributions and their properties. Fisher's Z-distribution and its applications.

Correlation, linear regression, intra-class correlation and correlation ratio. Null and non-null distribution of sample correlation coefficient. Power series distribution.

References:

1. Arnold, B.C. Balakrishnan, N. and Nagaraja,H.N.(1992): A First Course in Order statistics, Wiley.
2. Goon, Gupta & Das Gupta (1991): Outline of Statistical Theory, Vol.I ,World Press.
3. Hogg,R.V. and Craig,A.T.(1971): Introduction to Mathematical Statistics, McMillan.
4. Jonson, S. and Kotz,S. (1972): Distribution in Statistics, Vol.I,II and III, Houghton and Muffin.
5. Kendall, M.G.and Stuart,A. (1996): An Advanced Theory of Statistics, Vol.I,II. Charles Griffin.
6. Mood,A.M., Graybill,F.A. and Boes, D.C.(1974): Introduction to the Theory of Statistics, McGraw Hill.
7. Mukhopadhyay P.(1996):Mathematical Statistics , New central Book Agency(P)Ltd. Calcutta.
8. Rao, C.R. (1973): Linear Statistical Inference and its Applications,2/e, Wiley Eastern,
9. Rohatgi, V.K. (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

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MST 202: STATISTICAL INFERENCE-I

Point estimation, criteria of a good estimator: unbiasedness, consistency, efficiency and sufficiency. Fisher Neyman factorization theorem, Cramer-Rao inequality, Bhattacharyra Bounds, Rao-Blackwell theorem, uniformly minimum variance unbiased estimator.

Methods of Estimation: Maximum likelihood method, moments, minimum Chi-square and modified minimum Chi-square methods. Properties of maximum likelihood estimator (without proof). Confidence intervals: Determination of confidence intervals based on large samples, confidence intervals based on small samples.

Statistical Hypothesis: Simple and composite, critical region, types of errors, level of significance ,power of a test., most powerful test and Neyman-Pearson lemma.

Sequential Analysis: Definition and construction of S.P.R.T. Fundamental relation among α , β ,A and B. Wald's inequality. Determination of A and B in practice. Average sample number and operating characteristic curve.

Non-Parametric Tests: Sign tests, signed rank test, Kolmogorov-Smirnov one sample test. General two sample problems: Wolfowitz runs test, Kolmogorov Smirnov two sample test (for sample of equal size), Median test, Wilcoxon-Mann-Whitney test. Test of randomness using run test based on the total number of runs and the length of a run.

Reference:

1. Cramer, H.(1946) : Mathematical methods of Statistics, Princeton University Press.
2. Goon and others.(1991): Outline of Statistical theory Vol-I, World Press.
3. Gibbons,J.D. (1985): Non- Parametric Statistical Inference, McGraw-Hill.
4. Kendall, M.G. and Stuart, A. (1971): Advanced Theory of Statistic Vol. I and II,Charles Griffin.
5. Mood, Graybill and Boes. (1974): Introduction to the theory of Statistics 3rd ed, McGraw- Hill.
6. Hogg,R.V. and Craig,A.T.((1971): Introduction to Mathematical Statistics, Princeton University Press.

MST 203: DESIGN OF EXPERIMENTS-I

Analysis of experimental model by least square, Cochran's theorem and regression Analysis (case of full rank). Analysis of variance and covariance. Transformations.

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Principles of design of experiments, uniformity trails, randomized experiments, completely randomized design, randomized block design, Latin square design .

Factorial Experiment 2^n and 3^2, total and partial confounding. Construction of confounded factorial experiments belonging to 2^n series.

Analysis of non orthogonal data, analysis of missing plot and mixed plot data. Split plot and strip plot designs. Balanced incomplete block design (intra - block analysis).

References:

1. Fedrer, W.T. (1975): Experimental Design - Theory and Application , Oxford & IBH.

2. Das, M.N. and Giri, N.C. (1979) : Design and Analysis of Experiments , Wiley Eastern.

3. Goon, Gupta, and DasGupta. (1991): Fundamentals of Statistics. Vol.II , World Press, Kolkotta.

4 Kempthorne, O.(1979): The Design and Analysis of Experiments, John Wiley Publications.

5. Cocharan ,W.G. and Cox,G.M.(1950): Experimental Design, Wiley;Chapman & Hall.

MST 204: SAMPLE SURVEYS-1

Planning, exécution and analyses of small large and sample surveys with illustrative examples. Errors in survey, sources of non-sampling errors. Determination of sample size. Role of NSSO, CSO.
Basic finite population sampling techniques: Simple random sampling with and without replacement. Stratified sampling. Sample allocation problems in stratified sampling and related results on estimator of mean/total.
Systematic sampling, cluster sampling, two-stage sampling with equal and unequal number of second stage units.

Use of Auxiliary Information: Ratio, product and regression methods of estimation, their comparisons among them and with sampling without replacement. Concept of double sampling and its use in ratio, product and regression method of estimation

References:

1. Chaudhuri, A. and Mukerjee, R.(1988):Randomized Responses .Theory and Techniques, New York : Marcel Dekker Inc.

2. Cochran ,W.G.(1984):Sampling -Techniques (3rd ed.),Wiley.

3. Des Raj & Chandak (1998): Sampling Theory, Narosa Publishing House.

4. Murthy, M.N. (1977): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.

5. Sampath, S. (2000): Sampling theory and Methods, Narosa Publishing House.

6. Singh,D.and Chaudhary ,F.S.(1986):Theory and Analysis of Sample Survey Designs, New Age International Publishers.

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7. Sukhatme, B.V. (1984): Sample Survey methods and its Applications, Indian Society of Agricultural Statistics.

MST-211PRACTICAL- III
(Practical Paper Based on MST 201 & MST 202)

MST 201

1. Correlation and regression coefficients for Bivariate frequency distributions.
2. Large sample tests.(i)For population mean(ii) equality of two population means.(iii)For population variance(iv) equality of two population variances.
3. Small sample tests viz. t, F, x^2 and Z tests.
4. Bartlett's test for homogeneity of variances.

MST 202

1. Test of significance of sample correlation coefficient
2. Sign, median and run tests for small and large samples.
3. Sequential probability ratio test and calculation of constants and graphical representation for testing simple null against simple alternative for
(i) Binomial (ii) Poission (iii) Normal (iv) Exponential distributions.

MST-212- PRACTICAL- IV
(Practical Paper Based on MST 203 & MST 204)

MST-203

1. One-way classified data
2. Two way classification with single and equal observations
3. Two way classification with unequal observations
4. Analysis of CRD.
5. Analysis of RBD.
6. Analysis of LSD.
7. Analysis of BIBD.
8. Analysis of RBD, LSD with missing observations.
9. Yates method for analys2^n factorial experiments - n=3
10. 2^n factorial experiments – n = 4
11. Total confounding in 2^n, n = 3, 4
12. Partial confounding in 2^n, n = 3, 4
13. 3^2 factorial experiments
14. Analysis of a confounded factorial experiment.
15. Analysis of covariance in one way classified data

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16. Analysis of covariance in two way classified data

MST-204

1. Drawing of random samples from finite populations.
2. Drawing of random samples from Binomial and Normal populations.
3. Estimation of population mean and estimation of variance in SRS with and without replacement.
4. Estimation of mean and variance in stratified sampling under proportional and optimum allocations.
5. Gain in precision due to stratification.
6. Estimation of mean and variance in systematic sampling and comparison with S.R.S.
7. Estimation of mean and variance in cluster sampling and comparison with S.R.S.
8. Estimation of mean and variance by (i) ratio and (ii) regression methods of estimation.

MST 301: MULTIVARIATE ANALYSIS

Multivariate normal distribution, marginal and conditional distributions, joint distribution of linear function of correlated normal variates. Characteristic function of multivariate normal distribution. Distribution of quadratic forms

Maximum likelihood estimator of the mean vector and covariance, their independence and related distributions. Null and non-null distribution of partial and multiple correlation coefficients. Sample regression co-efficient ant its applications.

Classification and discrimination procedure for discrimination between two multivariate normal populations, sample discriminate function, test associated with discriminate functions probabilities of misclassification and their estimation. Classification into more than two multivariate normal population. Multivariate central limit theorem.

Hotelling-T^2 and its properties and applications, Mahanalobis D^2. Wishart distributions and its properties. Asymptotic distribution of Z-tanh (r).

References:

1. Anderson, T .W. (1984): An Introduction to Multivariate Statistical Analysis, 2nd ed, John Wiley.
2. Rao, C.R. (1973): Linear Statistical Inference and its Applications ,2nd ed, Wiley.
3. Srivastava, M.S. and Khatri, C.G. (1970): An Introduction to Multivariate Statistics, North Holland.
4. Morrison, D.F. (1976): Multivariate Statistical Methods, McGraw- Hill.
5. Nuirhead,R.J.(1982): Aspects of Multivariate Statistical Theory, John Wiley.
6. Kshirsagar, A.M. (1972). Multivariate Analysis, Marshell & Decker.
7. Roy, S.N. (1957): Some Aspects of Multivariate Analysis, John Wiley.

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MST 302: STATISTICAL INFERENCE-II

Location Invariance, scale invariance. Pitmann's estimators for location and scale parameters. Proof of the properties of M.L.E, Huzur Bazaar theorem, consistent asymptotic normal (CAN) estimator, invariance property.

Completeness and Lehmann-Scheffe theorem, minimal sufficient statistic, Wilks likelihood ratio tests estimator,invariance of consistent asymptotic normal estimator. Asymptotic distribution of likelihood ratio statistic. Bartlett's test for homogeneity of variances.

Generalized Neyman- Pearson lemma. Randomized tests. Uniformly most powerful tests for two-sided hypothesis. Unbiased tests. Uniformly most powerful unbiased tests. Tests with Neyman's Structures and its relation with complete family of distributions.

Basic Elements of Statistical Decision Problem. Various inference problems viewed as decision problem. Randomization optimal decision rules. Bayes and minimax decision rule. Generalized Bayes rule.

Reference :

1. Cramer, H. (1946): Mathematical methods of Statistics, Princeton University Press.
2. Goon and others. (1991): Outline of Statistical theory, Vol.I, World Press.
3. Kendall, M.G. and Stuart, A.(1971): Advanced Theory of Statistic Vol. I and II, Charles Griffin.
4. Mood, Graybill and Boes. (1974): Introduction to the theory of Statistics 3rd ed, McGraw- Hill.
5. Hogg, R.V. and Craig, A.T.(1971): Introduction to Mathematical Statistics, Princeton University Press.

MST 311- PRACTICAL-V
(Practical Papers Based on MST 301 & Elective Paper-I)

MST 301 Multivariate Analysis

1. Linear combination of correlated normal variates and evaluation of probabilities.
2. Estimation of mean vector and covariance matrix.
3. Estimation and testing of partial and multiple correlation coefficient.
4. Discriminate function.

MST 312-Practical-VI
(Practical Paper Based on MST 302 & Elective Paper-II)

MST 302 Statistical Inference

Power curve for testing one sided Null Hypthesis hypothesis against one sided attentive for

(i) Binomial distribution
(ii) Poisson distribution
(iii) Normal distribution
(iv) Exponential distribution

1. Power curve for testing a null hypnosis against two sided alternative for
(i) Binomial distribution
(ii) Poisson distribution
(iii) Normal distribution
(iv) Exponential distribution

2 Constrnction of Randomical test of a desired size for testing simple null against simple alternative hypnosis for
(i) Bernonlli's trial
(ii) Poisson distribution.

4. Test of hypothesis using Generalized likelihood ratio test for lesing eqnatior of (i) two meana (ii) equality of two variance in normal distributions.

MST 401: Design of Experiments-II

Linear estimation, Gauss-Markoff's theorem. Testing of hypothesis: involving several linear functions, test of sub-hypothesis and test involving equality of the parameters.

General theory of analysis of experimental designs. Desirable properties of a good design: orthogonality, connectedness and balancing. Various optimality criteria and their interpretations. Relation between blocks of incomplete block designs, duality, resolvability and affine resolvability. Theorems on bounds.

Group divisible, lattice and linked block designs-intra-block analysis. Designs for two-way elimination of heterogeneity and Youden square designs. Elementary ideas of response-surface and rota table designs.

Constructions of orthogonal Latin squares - (i) for prime power numbers and (ii) by Mann-Mechneish theorem. Simple methods of construction of BIB designs. Constructions of symmetrical fractional factorial experiments.

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References:

1. Atkinson ,A.C. and Donev.A.N.(1992): Optimal Experimental Design, Oxford University Press.
2. Raghava Rao.(1971): Construction and Combinatorial Problems in Design of Experiments, John Wiley.
3. Chakravarti, M.C.(1962): Mathematics of Design of Experiments, Asia Publishing House.
4. John, P.W.N.(1971): Statistical Design and Analysis of Experiments, Mc Millan.
5. Khuri,A.N. and Cornell, M.(1991): Response Surface Methodology,Marchell & Decker.
6. Shah, K.R. and Sinha, B.K.(1989): Theory of Optimal Design, Springer-Verlog.
7. Dey, Alok,(1987):Theory of Block Designs, John Wiley & Sons

MST 402: Sample Surveys-II

Rational behind the use of unequal probability sampling: Probability proportional to size with and without replacement method (including cumulative total method and Lahri's method) ,related estimators of finite population mean (Hansen-Hourwitz, Desraj's estimators for general sample size & Murthy's estimator for a sample of size of 2).Horvitz Thompson estimator (HTE) of a finite population total/mean and expression for variance of HTE and its unbiased estimator due to Horvitz-Thompson and Yates & Grundy.

P.P.S. Schemes of sampling due to Midzuno-Sen, Brewer, Durbin and JNKRao (sample size of 2 only), Rao-Hartley and Cochran sampling scheme and their estimation procedure. Theory of multi-stage sampling with varying probabilities (with or without replacement) due to Durbin. Narain and Sukhatme sampling schemes.

Quenouille's technique of bias reduction and its application to ratio type estimator, Hartley and Ross unbiased ratio type estimator. Ratio method of estimator under Midzuno scheme of sampling when X is known. Multivariate extension of ratio and regression method of estimator (when population mean of auxiliary variable is known).

Non Sampling Errors: Hansen-Hurwitz approach of estimations from incomplete sample. Politz and Simmon's techniques of estimation, randomized response model due to Warner. Simmons unrelated question randomized response model.

References:

1. Cocharan,W.G.(1997): Sampling Techniques III ed, John Wiley Pub. New Yark.

2. Des Raj and Chandok (1998): Sampling Theory , Norsa Pub. New Delhi.

3. Murthy , M.N. (1962) : Sampling Theory and Methods, Statistical Pub.Society, Kolkata .

4. Chaudhary, A and. Mukherjee R (1988): Randomised Response: Theory & Techniques, Marcel Dekker Inc New Yark.

5. Shukhatme, P.V.et al(1984): Sampling Theory of Surveys in the Applications, Iawa State press & Ind.Soc. of Agri. Stat.

6. Mukhopadhya, P.(1996): Inferencial Problems in Survey Sampling, New Age Intenational.

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7. Singh, D. & Choudhary,F.S.(1986): Theory and Analysis of Sample Surveys and its Applications, New Age international Publication.

MST 411- Practical -VII

(Practical Paper Based on MST 401 & Elective Paper-III)

MST 401:Design of Experiments-II

(i) Testing of Hypotheses regarding equality of some treatment effects in one and two way classifications.
(ii) Analysis of Incomplete block designs without specific from of C matrix.
(iii) Group divisible designs.
(iv) Linked Block designs.
(v) Simple lattice designs with 2 or more replications.

Youden square Designs.

MST-412 Practical-VIII

(Practical Paper Based on MST 402 & Elective Paper-IV)

MST 402 Sample Surveys

1. PPSWR Sampling: Cumulative total method, Lahri's method of sample selection/section , estimation of total and its variance.
2. Horvitz and Thompson's procedure of estimating mean (total) and variance of the population.
3. Yates and Grundy estimator of variance.
4 Midzuno's sampling schemes.
5. Rao-Hartley-Cocharan schemes.
6. Two-stage sampling method where f.s.u. being selected with pps with replacement and s.s.u. with equal prob. without replacement . Estimation of optimum number of s.u. and s.s.u.

* Those students who will opt MST404 Elective paper as Project work will give practical based on MST 403 and Viva-voce on their project work.

MST A01: Stochastic Processes and Demography

Introduction of Stochastic Processes: Specifications of stochastic process, Markov process and Markov Chain. Classification of states. Determination of higher order transition probability and its limits. Limit theorems for Markov Chain, stationary distribution, random walk, gambler's ruin's problem.

Stationary processes and its types. Discrete time Markov Chain, order of Markov Chain, Chapman-Kolmogorov equations. Markov-Process : Poisson process and its generalization. Galeton-Watson's branching process, properties of generating function of branching process.

Census and vital statistical data, vital rates and ratio, standardization of rates trends and differentials in mortality and fertility. (Greville's formula for construction ,Reed and Merrell's formula, King's method) T.F.R.,G.R.R.,N.R.R. Projection methods including fitting of logistic curve. Internal and international migration, net migration, internal and postcensal estimates.

The life table: Its construction and properties. Makeham's and Gompertz curves, national life tables, UN model life tables, abridged life- tables. Stationary and stable populations.

References:

1. Adke, S.R. & Manjunath S.M. (1984) : An Introduction of Finite Markov Processes, Wiley Eastern.
2. Bhatt ,B.R. (2000): Stochastic Models: Analysis and applications, New Age International, India
3. Cox,,P.R.(1970): Demography, Cambridge University Press
4. Harris, T.E. (1963): The Theory of Branching processes, Springer-Verlag.
5. Medhi, J (1982): Stochastic Processes, Wiley Eastern.
6. Ballingsley, P (1962) : Statistical Inference for Markov Chains, Chicago University Press, Chicago.
7. Ross, S.M (1983); Stochastic Processes, Wiley.

MST A02: Reliability Analysis

Reliability: Concepts and measures, components and systems, coherent systems, reliability of coherent systems; cuts and paths, modular decomposition, bounds on system reliability, structural and reliability importance of components. Life distributions, reliability function; hazard rate; common life distributions-exponential, Weibull, Gamma etc. Estimation of parameters and tests in these models.

Notions of ageing, IFR, IFRA, NBU, DMRL and NBUE classes and their duals, loss of memory property of the exponential distribution; closures or these classes under formation of coherent systems, convolutions and mixtures. Univariate shock models and life distributions arising out of them; bivariate shock models; common bivariate exponential distributions and their properties.

Reliability estimation based on failure times in variously censored life tests and in tests with replacement of failed items stress-strength reliability and its estimation. Maintenance and replacement policies, availability of repairable systems, modeling of a repairable system by a non-homogeneous Poisson process.

Reliability growth models, probability plotting techniques, Hollander-Proschan and Deshpande tests for exponentiality; tests for HPP vs. NHPP with repairable systems. Basic ideas of accelerated life testing.

REFERENCES

1. Barlow R.E. and Proschan F.(1985): Statistical Theory of Reliability and Life Testing, Holt,Rinehart and Winston.
2. Lawless J.F. (1982): Statistical Models and Methods of Life Time Data, John Wiley.
3. Bain L.J. and Engelhardt (1991): Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker.
4. Nelson, W (1982): Applied Life Data Analysis, John Wiley.
5. Zacks S.(2004): Reliability Theory, Springer.

6. Sinha S.K.(1986): Reliability & Life Testing,Wiley7.Cox, D.R. and Oakes, D (1984): Analysis of Survival Data, Chapman and hall , New York.
7. Kalbfleisch , J.D. & Prentice, R.L. (1980): The Statistical Analysis of Failure Time Data, John Wiley.

MST A03: BIO-STATISTICS

Component of Bio-Assay, Role of Statistics in Bioassay, Types of biological assays. Direct assays. Ratio estimators, asymptotic distributions. Filler's theorem.

Dose Response Relationship. Indirect assay, Regression approaches to estimate dose-response relationships Logit and probit approaches. Quantal response, estimation of Parameters.

Estimation of points on the Quantal Response Function. Dose allocation schemes, Estimation of points on the quantal response function, Robbins-Monro Process & Procedure, Parametric estimation, up and down rule, modified up & down method, sequential up & down methods.

Estimation of Safe Dose. Model of Carcinogenic Rates, MLE of the Parameters, point estimation and confidence intervals for the safe Doses. Mantel-Bryan Model, doses-response relationships based on dichotomous data.

REFERENCES:

1. Govindarajulu, Z.(2000): Statistical Techniques in Bioassay, S. Kargar
2. Finney, D. J.(1971): Statistical Methods in Bioassay, Griffin.
3. Jekel, J.F., Elmore, J.G., Katz, D.L.(1996): Epidemiology. Biostatistics and Preventive Medicine. W B Saunders Co.
4. Friedman,L.M.,Furburg,C.,Demets, D.L.(1998): Fundamentals of Clinical Trials, Springer

MST B01: Statistical Quality Control and Operation Research

Control-Charts: Concept and construction of control charts for variables and attributes and their OC Curve. Modified control limits.

Acceptance Sampling Plans by Attribute: AQL, AOQL, Producer's Risk and Consumer Risk. Rectification and their O.C. function, ASN and ATI . Single and double sampling plans and their mathematical analysis. Idea of Standard sampling tables: Dodge and Romig tables. Sampling Inspection Plans for Variables: One sided specification standard (Known and Unknown Cases),two sided specifications (for known standards).

Operation Research: Definition, scope, phases, principles, models. Linear Programming Problems, Duality Problems. Transportation and Assignment Problems. Replacement Models for items that fail or deteriorate. Monte-Carlo Simulation Technique and its Applications.

Inventory Control System: Inventory models, costs, advantages, EOQ models without shortages, reorder level and optimum buffer stock, EOQ models with shortages. ABC analysis.

Queuing System: Characteristics of queuing system, Poisson process , pure birth and pure death process. Steady state solution of (M/M/1) and (M/M/C) models. (M/G/1) model–Pollaczek Khintchine formula.

References:

1. Taha, H.A.(1999): Operation Research, McMillan Publishing Co. Inc 6th Edition,
2. Kanti Swaroop et. al Operation Reseach ,Sultan chand & Sons.
3. Gross, D. & Harris C.M. , Fundamentals of Queueing Theory, John Wiley & Sons.
4. Sharma, S.D. , Operation Research, Kedar Nath Pub. Meerut.
5. Bronso,.R. et.al.(1983) , Schaum's outlines Operation Research, Tata McGraw Hill Edition
6. Klienrock, L.(1975): Queueing System , Vol. 1 Theory , John Wiley.
7. Mckinsey,J.C.C.(1952): Introduction to the theory of games, McGraw Hill

MST B02: STATISTICAL DATA MINING

Review of classification methods from multivariate analysis: Data Mining Functionalities: Data Mining systems, Data Cleaning, Integration & Transformation, Reduction & Discretization. Classification & Prediction, Data Warehousing: Design,Guilines,Metadata,Task Primivtives. Major Issues.

Data Cubes and data Generalization, OLAP Technology,Clustering methods from both statistical and data mining viewpoints; vector quantization. Categorisation of major Clustering Techniques, Mining Streams, Time Series data, Biological Data.

Unsupervised learning from univariate and multivariate data; Supervised learning from moderate to high dimensional input spaces; Artificial neural networks and Extensions of regression models, Regression trees.

Introduction to databases, including simple relational databases; data warehouses and introduction to online analytical data processing. Association rules and prediction: data attributes, applications to electronic commerce. Data Mining & Data warehousing Software.

REFERENCES:

1. Berson, A. and Smith,S.J. (1997): Data Warehousing, Data Mining, and OLAP. McGraw-Hill.
2. Breiman, L., Friedman, J.H. and Oishen,R.A. and Stone C.J. (1984): Classification and Regression Trees. Wands worth and Brooks/Cole.
3. Han, J. and Kamber,M. (2000): Data Mining; Concepts and Techniques. Morgan Gaufmann.
4. T.M. Mitchell (1997): Machine Learning. Mc Graw-Hill.
5. B.D. Ripley (1996): Pattern Recognition and Neural Networks. Cambridge University Press.

MST B03: STATISTICS FOR CLINICAL TRIALS

Introduction to clinical trials: the need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I-IV trials, multi-center trials. Data management: data definitions, case report forms, database design, data collection systems for good clinical practice.

Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, review of factorial designs, objectives and endpoints of clinical trials.

Design of Phase I trials, design of single-stage and multi-stage Phase II trials, design and monitoring of Phase III trials with sequential stopping, design of bioequivalence trials.
Reporting and analysis: analysis of categorical outcomes from Phase I-III trials, analysis of survival data from clinical trials. Surrogate endpoints: selection and design of trials with surrogate endpoints, analysis of surrogate endpoint data. Meta analysis of clinical trials.

REFERENCES:

1. C. Jennison and B.W.Turnbul (1999). Group Sequential Methods with Applications to Clinical Trials, CRC Press.
2. E. Marubeni and M.G. Valsecchi (1994). Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley and Sons.
3. J.L. Fleiss (1989). The Design and Analysis of Clinical Experiments. Wiley and Sons.
4. L.M.Friedman,C.Furburg,D.L.Demets(1998). Fundamentals of Clinical Trials, Springer Verlag.
5. S. Piantadosi (1997). Clinical Trials: A Methodologic Perspective. Wiley and Sons.

MST C01: Economic Statistics and Econometrics

Time series: Concept, its components and methods of their determination . Variate difference method, Yule-Slusky effect. Autoregressive model for first & second order. Periodogram and correlogram analysis .Index number of prices and quantities and their relative merits. Tests for an Ideal index number. Construction of index numbers of wholesale and consumer prices.

Income Distributions: Pareto's law of income distributions. Engles curve, curves of concentration.Concept of national income and methods of estimating national income. Inter-sectoral flows, inter industry table.

Theory and analysis of consumer demand, specifications, and estimations of demand function .Demand and income elasticity. Structure and model. Estimation of parameters in single equation model- classical least square , general least square, heteroscedasticity.

Serial correlation, multi co-linearity, errors invariable models. Simultaneous equation models-identification, rank and other conditions. Indirect least and two stage least square. Short term economic forecasting.

REFERENCES: (29)

1. Anderson, T.W.(1971): The Statistical Analysis of Time series, Wiley, New York.
2. Barclay, (1958): Techniques of Population Analysis,Wiley.
3. Brock well, P.J. and Davis,R.A.(1991): Time Series-Theory and Methods(2nd Ed.) Springer- Verlag.
4. Chatfield, C.(1980): The Analysis of Time Series- An Introduction,(2 Edn.) Chapman and Hall.
5. Croxton,Cowden and Klein (1971):Applied General Statistics, PHI
6. Goon,A.M.,Gupta.M.K.and Dasgupta,B.(1986):Fundamentals of Statistics.Vol.2,World.
7.Montgomery,D.C. and Johnson, L.A.(1977): Forcasting in Time series Analiysis,McGraw- Hill.
8. Kendall Sir Mourice and Ord,J.K.(1990): Time Series, Edwards Arnolds.

MSTC02: Operations Research-II

Duality Theorems, Revised Simplex Method, Dual Simplex Method. Nonlinear programming-Kuhn Tucker conditions, Wolfe's and Beale's algorithms for solving. Quadratic programming problems. Bellman's principle of optimality, general formulation, computational methods and application of Dynamic Programming.

S-S policy for inventory and its derivation in case of exponential demand, Multi Item Models, Models with variable supply and models for perishable items, Estimation of EOQ in some simple case.

M/G/1 queue and Pollazcek Khinchine result. Steady-state solutions of M/Ek/1 and Ek/M/1 queues. Machine interference problem. Replacement Problems: Block and Age Replacement Policies. Replacement of items with Long Run.

Project Management: PERT & CPM, Probability of Project Completion, PERT-Crashing. Flows in Network, Max flow-min cut theorem.

Multi Stage Decision Problems. Integer Programming- Branch & Bound Algorithm and Cutting Plane Problems. Multi Criterion and Goal Programming. Idea of Stochastic Programming.

References:

1. Hardley G. (1964): Non-Linear & Dynamic Programming, Addison Wisley.
2. Murthy K.G. (1976): Linear & Combinatorial Programming , John Wiley.
3. Klienrock L (1975) :Queueing System , Vol. 1 Theory , John Wiley.
4. Saat T.L. (1961): Elements of Queueing Theoru and Applications, McGraw Hill.
5. Taha H.A (1999): Operation Research, McMillan Publishing Co. Inc (6th Edition)
6. Kantiswaroop et. Al (1985) : Operation Reseach ,Sultan chand & Sons.
7. Gross,D &HarrisC.M.(1975):Fundamentals of Queueing Theory, John Wiley & Sons.
8. Sharma S.D (2000): Operation Research. Kedar Nath Pub. Meerut.

Additional References :

9. Mckinsey J.C.C. ,Introduction to the theory of games., McGraw Hill.
10. Starr M.K. and Miller D.W. (1962) Inventory Control-Theory and Practice; Prentice Hall

(22)

MST C03: NON-PARAMETRIC AND SEMI-PARAMETRIC METHODS

Empirical distribution function, Glivenko Cantelli theorem, Kolmogorov goodness of fit test. One sample U-statistic. Kernel and symmetric kernel, two sample U- statistic, asymptotic distribution of U-statistic. UMVUE, property of U-statistic
Asymptotic distribution of linear function of order statistics. Rank tests, locally most powerful rank tests, linear rank statistics and their distributional properties under null hypothesis, Pitman's asymptotic relative efficiency.

One sample location problem, sign test and signed rank test, two sample Kolmogorov Smirnov tests. Two sample location and scale problems. Wilcoxon-mann-Whitney test, normal score test, ARE of various tests based on linear rank statistics.

Kurskal-Wallis K sample test, Cox's proportional hazards model, rank test (partial likelihood) for regression coefficients. Concepts of Jackknifing method of quenouille for reducing bias, Bootstrap methods, confidence intervals.

REFERENCES:

1. Davison,A.C. and Hinkley,D.V.(1997): Bootstrap Methods and their Application, Cambridg University Press.
2. .Fraser ,D.S.A.(1957).. Non Parametric Methods in Statistics, John wiley & sons, inc.
3. Gibbons, J.D.(1985): Non Parametric Statistical Inference, 2nd ed. Marcel Dekker. Inc.
4. .Fraser ,D.S.A.(1957): Non Parametric Methods in Statistics, John wiley & sons, inc.
5. Hajek,J.and Sidak,Z (1967): Theory of Rank Tests, Academic Press.
6. Puri, M.L. and Sen, P.K.(1971): Nonparametric Methods in Multivariate Analysis, John Wiley & Sons Inc.
7. Randles, R.H. and Wolfe, D.A. (1979): Introduction to the Theory of Non Parametric Statistics, John Wiley & Sons,Inc.

MSTD01: Project Work

Guidelines for Project Report

Project Duration: 1st December to 15th May. (Students may start preliminary work related to their project after third semester.)

Project Guide: Teachers from the Department of Statistics . Each project group will be guided by concerned teacher (guide) for one hour per week throughout the semester.

Fieldwork: Students will be given 4 to 6 weeks during last semester for their industrial work/data collection/survey or any other fieldwork involved in the project.

Project Topic: Students in consultation with the guide will decide Project Topic/Area. Topic may be decided after completion of third semester. Project work may be carried out in a group of students depending upon the depth of fieldwork/ problem involved.

Project report: Project report should be submitted as per university norms.

Project Evaluation: Project valuation will be done according to university norms.

(i) Project Report (70marks)
(ii) Presentation by student or group of students. (30 marks)

Project report will be evaluated from the panel of examiners submitted by B.O.S. convener.

MST D02: ACTUARIAL STATISTICS

Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curate future lifetime, force of mortality. Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.
Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws.

Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables. central rates of multiple decrement, net single premiums and their numerical evaluations.

Distribution of aggregate claims, compound Poisson distribution and its applications. Distribution of aggregate claims, compound Poisson distribution and its applications.

REFERENCE:

1. N.L.Bowers, H.U.Gerber,J.C.Hickman, D.A.Jone a C.J.Nesbitt,(1986),'Actuarial Mathematics,' Society of Actuarias, Ithaca, lllinois, U.S.A Second Edition (1997).Section I – Chapters: 1,2,8,9,11

MST D03: Survival Analysis

Concepts of time, order and random censoring, likelihood in these cases. Life distribution-Exponential Gamma, Weibull, Lognormal, Pareto. Linear Failure rate. Accelerated Failure Time Distribution, Log-Logistic Distribution. Censoring techniques.

Parametric inference (Point estimation, Confidence intervals Scores, LR, MLE tests (Rao-Willks-Wald) for these distribution life tables failure rate, mean residual life and their elementary properties. Ageing classes-and their properties, Bathtub failure rate.
Estimation of survival function- Actuarial estimator, Kaplan-Meier estimator, estimation under the assumption of IFR/DFR. Tests of exponentially against non-parametric classes, total time on test, Deshpande test. Two sample problem-Gehan test, log rank test Mantel –Haenszel test, Tarone-Ware tests.

Cox's proportional hazards model with one and several covariates. Rank test for the regression coefficients. Competing risks model, parametric and non-parametric inference for this model. Assumptions, extended Cox model, MLE of Cox PH model, hazard ratio, survival curves.

References:

1. Gross A.J. and Clark, V.A. (1975) : Survival Distribution : Reliability applications in the Biomedical Sciences, John Wiley and Sons.
2. Elandt - Johnson, R.E. Johnson N.L.(1980) : Survival Models and Data Analysis, John Wiley and Sons.
3. Miller, R.G. (1981) : Survival Analysis, John Wiley.
4. Kalbfleisch J.D. and Prentice R.L. (1980): The Statistical Analysis of Failure Time Data, John Wiley.
5. Kleinbaum, D.G. & Klein, Mitchel (2008): Survival Analysis –A Self Learning Text, Springer International Edition, Spinger
6. Cox, D.R. and Oakes, D.(1984): Analysis of Survival Data, Chapman and Hall, New York