SHIVAJI UNIVERSITY
DEPARTMENT OF STATISTICS
KOLHAPUR

M.Sc. (Statistics) syllabus (Revised) to be effective from the Academic Year 2006-2007.

STRUCTURE

The following table gives the scheme of Examination at M.Sc. Statistics according to the Revised Syllabus and pattern of Examination.
Notations : 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 the 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.

Semester No.	Paper No.	Title of the Paper
I	MST-101	Statistical Mathematics I
	MST-102	Statistical Mathematics II
	MST-103	Distribution Theory
	MST-104	Estimation Theory
	MST-105	Statistical Computing
	MST-116	Practical I
II	MST-201	Probability Theory
	MST-202	Theory of Testing of Hypotheses
	MST-203	Multivariate Analysis
	MST-204	Linear Models & Design of Experiments
	MST-205	Sampling Theory
	MST-216	Practical II
III	MST-301	Asymptotic Inference
	MST-302	Elementary Stochastic Processes
	MST-303	Planning and Analysis of Industrial Experiments.
	MST-304	Practical III

Elective Papers from which **Any Two** are to be chosen:

MST-321	Reliability Theory
MST-322	Regression Analysis
MST-323	Statistical Genetics
MST-324	Measure Theory
MST-325	Demography
MST-326	Medical Statistics
MST-327	Advanced Stochastic Processes
MST-328	Actuarial Statistics
MST-329	Dissertation

Semester No.	Paper No.	Title of the Paper
IV	MST-401	Optimization Techniques
	MST-402	Decision Theory
	MST-416	Practical IV and Project

Elective Papers from which **Any Three** are to be chosen:

MST-421	Discrete Data Analysis
MST-422	Survival Analysis
MST-423	Industrial Statistics
MST-424	Time Series Analysis
MST-425	Statistical Ecology
MST-426	Econometrics
MST-427	Advanced Multivariate Analysis
MST-428	Data Mining
MST-429	Dissertation

Note :-

a) Syllabus for some Elective courses has been given. Depending on need and demand, syllabus for other elective courses listed or of new elective courses will be submitted for approval.
b) There shall be CIE pattern in which internal examination will be for 30 marks, while University examination will be for 70 marks. Proposed nature of the Theory and Practical Question Paper at the M.Sc. Statistics course under the Semester Schemes.

1. Nature of the theory question papers.

a) There shall be 7 questions each carrying 14 marks.
b) Question No.1 is compulsory and shall contain 10 short sub-questions each carrying 2 marks. Students have to attempt any 7 sub-questions.
c) Students have to attempt any 4 questions from question No. 2 to 7.
d) Question No. 2 to 6 shall contain 2 to 4 sub-questions.
e) Question No. 7 will be short note type. Students are expected to solve any 4 out of 6, each carrying 3.5 marks.

2. Practical Paper :-

a) Semester I,II,III " Practical MST 116, MST 216, MST 316".
Internal(30) : There shall be 10 marks for day-to-day journal and internal test will be for 20 marks.
End of Term Examination (70): Practical Examination will be of 3 hrs. duration carrying 60 marks. There shall be 8 questions each of 12 marks, of which a student has to attempt any 5 questions. VIVA will be for 10 marks.

b) For Semester IV : MST-416

Internal(30) : There shall be 10 marks for day-to-day journal and internal test will be for 20 marks.

End of Term Examination (70) :

i) Practical Examination will be conducted for 30 marks and is of 1.5 hours (90 Min.) duration. There shall be 5 questions each carrying 10 marks, of which a student has to attempt any 3 questions.

ii) Project work carries 25 marks. Project work consists of collecting data and analyzing the data and preparing report. 10 marks are reserved for VIVA.

iii) There will be a compulsory study tour. Study tour report be submitted along with practical journal, which will be evaluated for 5 marks.

MST 101 : STATISTICAL MATHEMATICS - I

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)
2. Sequence of real numbers, convergence, divergence. Cauchy sequence. Convergence of bounded monotone sequence. Limit inferior and limit superior of the sequences. (12)
3. Series of numbers, tests for convergence (without proof) test for absolute convergence, convergence of sequences of non-negative terms. (6)
4. Real valued function, continuous function, Uniform continuity of sequence of functions, Uniform convergence of power series, radius of convergence. (4)
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 (4)
6. Riemann, Riemann-Steltjes Integrals. Integration by parts, mean value theorem, their applications in finding functionals of distributions. (4)
7. Multiple integrals, Change of variables, Improper integrals, Applications in multivariate distributions. Uniform convergence, theorem on differentiation under integral sign (without proof), Leibnitz rule (statement only) and applications. (5)

References:

1. Malik S. C. & Arora S.(1991) : Mathematical Analysis- Wiley Eastern Limited IInd edition.

2. Goldberg R. R. (1964) : Methods of Real Analysis- Blaisdell Publishing company, New york, U.S.A.
3. Bartle G. R. (1976): Element of Real Analysis- Wiley 2nd edition.
4. Bartle G.R. & Sherbert D. R. (2000): Introduction to Real Analysis- John Wiley & Son Inc.
5. Royden (1988) : Principles of Real Analysis - Macmillian.
6. Widder (1989) : Advanced Calculus - Dover Publication.
7 . Apostol (1985) : Mathematical Analysis - Narosa Publishing House, T.M.

MST 102 : STATISTICAL MATHEMATICS - II

1. Vector space, subspace, linear dependence and independence, basis, dimension of a vector space, example of vector spaces.

(8)

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)

3. Characteristic roots of a matrix, algebraic and geometric multiplicities, characteristic vectors and their orthogonal property. Caley-Hamilton Theorem and applications.

(8)

4. Spectral decomposion 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)

5. Quadratic forms: definition, reduction, simultaneous reduction of two quadratic forms, maxima and minima of ratio of quadratic forms.

(10)

References:

1. Rao A. R. & Bhimashankaram P. (1992) : Linear Algebra. Tata Mc-Graw Hill, New Delhi.
2. Hadely G (1987): Linear Algebra - Narosa Publishing House.
3. Rao C. R. (1973) : Linear Statistical Inference and Its Applications , Second Edition Wiley Eastern.
4. Searl S. B.(1982) : Matrix Algebra Useful for Statistics – Wiley
5. Graybill , F.A (1961) : An introduction to linear Statistical models Vol-I- McGraw-Hill Book company Inc.

MST 103 : DISTRIBUTION THEORY

Unit-1: Brief review of basic distribution theory. Distribution function and its properties, Relation of distribution function with uniform distribution. Decomposition of distribution function into discrete and continuous parts. (6)

Unit-2: Functions of random variables, their distribution in case of univariate random variables and its applications. (6)

Unit-3: Expectation and moments, probability generating function, moment generating function, convolution and examples. (5)

Unit-4: Moment inequalities:- Markov, Chebychev, Holder, Minkowski and Jensen inequalities with their applications. Basic inequality Liapunov's. (6)

Unit-5: Bivariate discrete and continuous distributions, marginal distributions. Examples of many joint with given marginal distributions. Independence, conditional , distributions and examples. Distribution of function of bivariate random variables using Jacobian of transformation. (5)

Unit-6: Multinomial distribution, Bivariate Poisson, Bivariate exponential and Bivariate normal distribution and their properties. Dirichilet distribution. (6)

Unit-7: Symmetric distributions, properties of symmetric distributions, non-regular families, location and scale families and examples. (3)

Unit-8: Order Statistics- distribution of i^{th} order statistic, joint distribution of $(i,j)^{th}$ order statistics, independence of exponential spacing & examples. (3)

References:

1. Rohatagi V.K.& Saleh A. K. Md. E.(2001) : Introduction to Probability Theory and Mathematical Statistics- John Wiley and sons Inc.
2. Johnson N. L. & Kotz. S. (1996) : Distributions in Statistics Vol-I,II and III- John Wiley and Sons New york.
3. Johnson N.L. & S. Kotz. John : Multivariate Distributions - Wiley and sons New york.
4. Casella & Berger (2002) : Statistical Inference - Duxbury advanced series. II^{nd} edition

MST 104 : ESTIMATION THEORY

1. Sufficiency principle, factorization theorem, minimal sufficiency, minimal sufficient partition, construction of minimal sufficient statistics, minimal sufficient statistic for exponential family, power series distribution and non regular families. (10)
2. Completeness, bounded completeness, ancillary statistics, Basu's theorem and applications. (7)
3. Problem of point estimation, unbiased estimators, minimum variance unbiased estimator, Rao- Blackwell theorem and Lehmann-Scheffe theorem and their uses. Necessary and sufficient condition for MVUE and their applications. (8)
4. Fisher information and information matrix, Cramer-Rao inequality, Chapmann-Robinson bounds, Bhattacharya bounds, their applications. (6)
5. Method of maximum likelihood (MLE) and small sample properties of MLE, method of scoring and application to estimation in multinomial distribution. (7)
6. Other methods of estimation: method of moments, minimum Chi square. (3)
7. Non-parametric estimation : Estimability; Kernel; U-Statistics; U-Statistics theorem for one sample and two samples. (statements only). (4)

References

1. Rohatgi V.K.(1976): Introduction to Probability Theory & Mathematical Statistics - John Wiley & sons.
2. Lehmann E. L. (1983) : Theory of Point Estimation - John Wiley & sons.
3. Rao C. R.(1973) : Linear Statistical Inference & its Applications, 2nd Ed wiley.
4. Kale B.K. (2005) : First Course on Parametric Inference, A , 2nd Edition. Narosa Publishing House.
5. George Casella, Roger L. Berger (2001) : Statistical Inference (second edition). Duxbury press.

MST 105: STATISTICAL COMPUTING

1. Concept of random number generator, congruential method of generating uniform variate.
(3)
2. Concept of simulation: Generation of Binomial, Poisson, Geometric, Negative Binomial & Multinomial variate. Proofs of related results.
(5)
3. Generation of continuous random variables covering Exponential, Normal, Gamma, Chi-square, Bivariate exponential, Bivariate Normal distributions, and mixture of distributions.
(5)
4. Programming in C++: Concept of OOP, Data types, Variables, Statements, Expressions, Control structures, Looping, Functions, Pointers. Programming for problems based on Unit 1-Unit 3.
(10)
5. Excel: Introduction to MSEXCEL and exercises on using EXCEL for Statistical analysis covering frequency distribution, histograms, t-test, test for Independence in 2x2 contingency tables.
(6)
6. SYSTAT: Data Editor,opening and saving a data file. Data Manipulation tools:List Sort, Transform. Grouping variable, Category variable, Labeling
Matrix: Read, Save, Standard matrix operations, Inverse, Characteristic roots and vectors, Spectral decomposition.
Graphics: Bar, Histogram. Pie Chart, and Scatter plot.
Descriptive statistics, Fitting of Distributions, Cross Tables, Correlations and Regression, Hypothesis Testing, ANOVA.
(8)
7. R – Language. : Introduction to R, elementary programming, application to data analysis (4)

8. Bias reduction methods, Jack-Knife estimator-its properties and limitations. Boot – Strap method and its simple properties.
(4)

References

1. Morgan B. J. T.(1984) : Elements of Simulation. Chapman and Hall.
2. Kennedy William J.,Jr. james E.Gentle. (1980) : Statistical Computing *Marcel Dekker , Inc. New york and Basel*.
3. Christion P. Robert, George casella (1999) : Monte carlo Statistical Methods, Springer-verlag, New York, Inc.
4. Luc Devroye (1986) : Non- Uniform Random Variate Generation; Springer-Verlag New York Berlin-Heidelberg Tokyo.
5. Rubinstein, R. Y. (1998)Modern Simulation and Modeling (Wiley Series in Probability and Statistics)

MST 116: PRACTICAL –I

1. Linear dependence of Vector and rank a matrix.
2. Gram-Schmidt orthogonalisation method.
3. Solving systems of equations.
4. Determinant, Inverse and g-inverse of a matrix.
5. Applications of Caley-Hamilton theorem.
6. Inverse of a Partitioned matrix.
7. Characteristics roots and vectors and their applications.
8. Classifications and reduction of quadratic forms.
9. Sketching of d.f and p.d.fs.
10. Model sampling from univariate and bivariate.
11. Construction of UMVUE.
12. Methods of Estimation : MML and MLE.
13. Methods of Scoring.
14. Construction of U-Statistics
15. –20. Programming assignments on MST –105 Course.

MST 201: PROBABILITY THEORY

1. Classes of sets: Sequence of sets: limsup, liminf and limit of sequence of sets field, σ-field, σ-field generated by a class, Borel σ-field. (5)
2. Probability measure, Probability space, properties of probability measure – continuity, mixture of probability measures. Lebesgue and Lebesgue - Steltjes measures on R. Independence of events. (5)
3. Measurable function, random variable, distribution function 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)
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. (5)
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 continues transform.(Statements only), convergence in r^{th} mean, interrelationships. (10)
6. Independence: Borel - Cantelli Lemma, Characteristic function simple properties. Inversion theorem and uniqueness property(Statement only). (5)
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), Liaponove's, Lindeberg-Feller Theorems on CLT (Statement only). Applications of the above results. (5)

References:

1. Bhat B. R.(1981) : Modern Probability Theory –IIIrd edition :New age international (P)limited,
2. Alan Karr,(1993) : Probability Theory – Springer Verlag.
3. Billingsley P.(1986) : Probability & Measure –John Wiley and sons

MST 202 : THEORY OF TESTING OF HYPOTHESES

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)
2. Composite hypotheses : Monotone likelihood ratio property, power function of a test, existence of UMP. Tests for one-sided alternatives. UNP tests for two sided alternatives Examples. Their existence and non-existence. (10)
3. Generalized Neyman Pearson lemma : Unbiased test, UMPU test and their existence in the case of exponential families (Statements of the theorems only). Similar tests, test with Neyman structure.

(8)

4. Problem of confidence intervals. Relation with testing of hypotheses problem, UMA and UMAU confidence intervals, shortest length confidence intervals.

(8)

5. Likelihood ratio test. Application to standard distribution , application to contingency table.

6. Non-parametric tests. One and two sample problem; tests on U-Statistics for various hypotheses; the asymptotic distributions of the statistics involved under the null hypotheses (Statements of the theorems only). Sign test, Run test, Signed-Rank test, Wilcoxon Signed-Rank test, Man-Whiteny test.

(6)

7. Goodness of fit tests based on Chi-square distribution. Application to contingency tables.

(3)

References:

1. Kale B.K. (1999) : A First Course on parametric Inference. Narosa , IInd Edition.
2. Rohatgi V.K. (1988): Introduction to Probability and Mathematical Statistics. Wiley Eastem Ltd. New Delhi. Student Edition.
3. Dudewicz E.J. & Mishra S. N. (1988) : Modern Mathematical Statistics. Wiley Seris in Prob., Stat. John. Wiley & Sons. New York. International students edition.
4. Lehman E. L. (1987) : Theory of testing of hypotheses. Students Edition.
5. Ferguson T.S. (1967) : mathematical Statistics. A decision theoretical approach. Academic press.
6. Zacks S. (1971) : Theory of Statistical Inference John Wiley and Sons. New York.

MST 203 : MULTIVARIATE ANALYSIS

Unit-1: Multivariate normal distribution, two definitions and their equivalence , singular and nonsingular normal distribution, characteristic function, moments, marginal and conditional distributions.

(10)

Unit-2: Maximum likelihood estimators of the parameters of the multivariate normal distribution and their sampling distributions.

(6)

Unit-3: Wishart matrix and its distribution of properties of Wishart distribution, distribution of generalized variance.

(6)

Unit-4: Hotelling's T^2 Statistic and its distribution. Applications of T^2 statistics and its relationship with Mahalanobis' D^2 statistic. Confidence region for the mean vector.

(6)

Unit-5: Discrimination and classification. Fisher's discriminant function and likelihood ratio procedure, minimum ECM rule, Rao's U statistics and its use in tests associated with discriminant function, classification with three populations.

(6)

Unit-6: Principal components. Dimension reductions, Canonical Correlation and canonical variables.

(4)

Unit-7 : Introduction to factor analysis, Cluster analysis, Heirarchical and non-Heirarchical clustering. Single, Complete, average linkage method and K-means clustering.

(10)

Reference:-

1. Kshirsagar A. M.(1972) : Multivariate Analysis. Maral-Dekker.
2. Johnosn, R.A. and Wichern . D.W (2002) : Applied multivariate Analysis. 5th Ad. Prentice –Hall.
3. Anderson T. W. (1984) : An introduction to Multivariate statistical Analysis 2nd Ed. John Wiely.
4. Morrison D.F. (1976) : Multivariate Statistical Methods McGraw-Hill.

MST 204 : LINEAR MODELS AND DESIGN OF EXPERIMENTS

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.

   (8)
2. Distribution of quadratic forms for normal variables: related theorems (without proof). Tests of hypothesis in general linear models.

   (4)
3. 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, Tukey's test of additivity.

   (8)
4. Multiple comparisons: Three types of errors, Tukey , Sheffe and Bonferroni producer.

   (3)
5. Analysis of Covariance: estimation of parameters, related tests of hypothesis. General theory and application of one way and two way set up.

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

   (9)
7. BIBD : Definition, parametric relationship, Inter and Intra Block analysis, Symmetric BIBD.

   (7)

References:

1. Kshirsagar A. M.(1983) : Course in Linear Models - Marcel dekker.
2. Joshi D. D.(1987) : Linear Estimation and Analysis of Experiments - Wiley Estern Ltd.
3. Giri N. S. & Das M. N.(1979) : Design and Analysis of Experiments - Wiley Estern Ltd.
4. Searle S. R. (1971): Linear Models - John Wiley & Sons. New York.
5. Chakravarti . M. C.(1962) : Mathematics of Design of Experiments - Asia Publishing House , Bombay.

MST 205: SAMPLING THEORY

1. Concept of population and sample, Need for Sampling, census & sample surveys, basic concepts in sampling and designing of large-scale surveys design, sampling scheme and sampling strategy. Basic methods of sample selection: SRSWR, SRSWOR.

   (6)
2. Stratification, Allocation and estimation problems. Construction of Strata: deep stratification, method of collapsed strata.

   (6)
3. Systematic sampling: The sample mean and its variance, comparison of systematic with random sampling, comparison of systematic sampling with stratified sampling, comparison of systematic 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.

   (9)
4. PPSWR methods: Cumulative total method, Lahiri's method related estimation Problems and PPSWOR methods and related estimation of a finite population mean (Horwitz- Thompson and Des Raj estimators for a general sample size and Murthy's estimator for a sample of size 2), Midzuno sampling.

   (8)
5. Use of supplementary information for estimation: ratio and regression estimators and their properties. Unbiased and almost unbiased ratio type estimators, Double sampling.

   (6)
6. Cluster sampling. Two – stage sampling with equal number of second stage units.

   (5)
7. Non - sampling errors: Response and non- response errors. Hansen – Horwitz and Demig's techniques.

   (4)

References

1. Sukhatme P. V., Sukhatme S. & Ashok C : Sampling Theory of surveys and applications – Piyush publications
2. Des Raj and Chandhok. P. (1998) : Sample Survey Theory - Narosa publication.
3. William G. Cochran. (1977) : Sampling Techniques- IIIrd edition –John and Wieley sons Inc.
4. Parimal Mukhopadhyay (1998) : Theory and methods of survey sampling -Prentice Hall of India private limited.
5. Murthy M.N. (1977) : Sampling Theory of Methods - Statistical Publishing Society, Calcutta.

MST 216- PRACTICAL –II

1. Sampling from multivariate distribution.
2. Multiple and partial correlation.
3. Application of Hotelling's T^2 statistics.
4. Discriminant Analysis.
5. Canonical correlation and variance.
6. Principle component analysis.
7. Factor Analysis.
8. Cluster Analysis
9. M.P. Tests
10. UMP Tests
11. UMPU Tests.
12. Likelihood ratio tests.
13. Confidence Intervals.
14. Non-parametric Tests.
15. Linear Estimation: Estimation and Hypothesis testing.
16. ANOVA : One way and two way orthogonal data without interaction.
17. ANOVA: Two way orthogonal data with interaction
18. Two way non-orthogonal data without interaction
19. Analysis of BIBD.
20. Analysis of general block design.
21. Basic sampling designs.
22. Ratio, regression, Horvitz-Thompson method of estimations.
23. Stratified, Systematic and cluster Sampling.
24. Multi-stage sampling
25. Non-sampling errors.

MST 301: ASYMPTOTIC INFERENCE

1.Consistency of estimators joint and marginal consistency, Weak and strong consistency, Invariance under continuous transforms, Asymptotic relative efficiency, error probabilities and their rates of convergence. (10)

2. Asymptotic Normality, CAN estimators; invariance of CAN property under non-vanishing differentiable transformation. Methods of obtaining consistent and CAN estimators; Super-efficient estimators. (10)

3 BAN estimators : Cramer regularity conditions and asymptotic properties of the MLE (Cramer-Huzurbazar results) (7)

4. CAN and BAN estimation for multiparameter exponential family. (5)

5. Variance stabilizing transformations; their existence; their applications in obtaining large sample tests and estimators. (3)

6. Asymptotic Distribution of likelihood ratio test statistics, Wald test, Rao's Score test, Pearson Chi-square test for goodness of fit, Barttletts test for homogenity of variances. (10)

References:

1) Kale B.K. (1999) A first course on parametric inference, Narosa Pub.
2) Zacks S. (1971) : Theory of statistical inference, wiley & sons inc.
3) Rohatagi V.K.& Saleh A. K. Md. E.(2001) : Introduction to Probability Theory and Mathematical Statistics- John Wiley and sons Inc.

MST 302 : ELEMENTARY 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. (4)

Unit-2: Definition of Markov chain. Examples of Markov chains, Formulation of Markov chain models initial distribution transition probability matrix, Chapman-Kolmogorov equation. calculation of n-step transition probabilities. (6)

Unit-3: Classification of states, irreducible Markov chain, period of the state, random walk & gambler's ruin problem. First Entrance Theorem, First passage time distribution. (8)

Unit-4: Long-run distributions of Markov chain, relation with mean recurrence time, stationary distribution.

Unit-5: Discrete state space continuous time Markov chain. Poisson process & related results. Birth and death processes and associated cases. M/M/1, M/M/S queuing models and related properties. (10)

Unit-6: Renewal and delayed renewal processes, related theorems, key renewal theorem (without proof) and its application. (6)

Unit-7: Galton-Watson Binaymi Branching process. probability of ultimate extinction. Distribution of population size, and association results. (6)

Unit-8: Simulation of Markov Chain, Poisson process and branching process. (Algorithms) (4)

References

1. Medhi J. (1982) : Stochastic Process- Wiley Eastern.
2 . Parzen E. (1962) : Stochastic Process - Holden-Pay.
3 . Karlin & Taylor : A First Course in Stochastic Process- Vol. -1, Academic Press.
4. Cinlar E.. :Introduction to Stochastic Process - Prentice Hall.
5. Srinivas and Mehta (1976): Stochastic Processes - TaTa McGraw -Hill, Publishing Conpany limited New Delhi.

MST 303 : PLANNING AND ANALYSIS OF INDUSTRIAL EXPERIMENTS

1. A review of basic concepts of designs of experiment. (4)

2. Factorial Experiments : Concepts of main effects, interaction, Analysis of Full 2^n and 3^2 factorial designs, Analysis of single replicate of 2^n and 3^2 design. (6)

3. Confounding : Total and partial confounding, construction and analysis of 2^n and 3^n confounded design. (5)

4. Fractional replication for symmetric factorials, concept of aliasing , resolution and minimum aberration, construction of 2^{n-k} design, analysis of 2^{n-k} replicated and single replicate design. (8)

5. Response surface experiments : linear and quadratic model, stationary point, central composition design. (6)

6. Taguchi methods: Concept of loss function, S/N ratio. Linear graphs, inner and outer arrays, ANOVA. (7)

7. Random effects model for one-way classification. (4)

References

1. . Jeff Wu C.F., Hamada M.(2000) : Experiments : Planning, Analysis and parameter design optimization, John Wiley & Sons.

2. Phadke , M.S. (1989) : Quality Engineering using Robust Design, Prentice-Hall.

3. Montgomery D.C. (2001) : Design and Analysis of Experiments 5th edition, Wiley New York.

MST-321 RELIABILITY THEORY

Unit-1: Structure function, dual of a structure, cuts and paths, Modular decomposition, bounds on system reliability. Associated random variables. Reliability concepts and measures, components & systems, coherent systems, reliability of coherent systems.

(8)

Unit-2: Life time distributions, survival functions, hazard rate, cumulative hazard function, residual life time, survival function of residual life time, mean residual life time, one-one correspondence of these functions. Computation of these function for Common life time distributions : exponential Weibull, Gamma, Makeham, Pareto, Rayleigh, log-normal etc: computation of survival and failure rate function proportional hazard models and proportional hazard model.

(10)

Unit-3: Notions of aging: IFR,IFRA,DMRL, NBU,NBUE classes and their duals , aging properties of common life time distributions, closure Properties under formation of coherent structures, convolutions and mixtures of these classes.

(8)

Unit-4 : Stochastic ordering : usual stochastic ordering , hazarad rate ordering, reverse hazard rate ordering, dispersive ordering, mean residual life ordering and their implications.

(8)

Unit-5: Univariate shock models and life distributions arising from shock models, bivariate exponential distribution, bivariate shock models.

(6)

Unit-6: Availability, interval reliability, availability of a system with a single spare and a repair facility.

(5)

References :

1) Barlow R.E. and Proschan F. (1975): Statistcal Theory of relibilty & Life testing , Holt, Reinhart and Winston.
2) Lawless J.F.(1982) : Statistical Models & Methods of Life Tome Data, John Wiley.
3) Miller R.C. (1981) : Survival Analysis. John Wiley
4) Bain L.J (1978) : Statistical Analysis of reliability & Life testing , Models, Marcel Dekker.
5) Martz H.F. and Waller R.A (1982): Bayesian Ral*ability Analysis , John Wiley.*

MST-322- REGRESSION ANALYSIS

1. Multiple regression model, Least squares estimate (LSE), Properties of LSE (4)
2. Hypothesis testing, confidence and prediction intervals. General linear hypothesis testing. (6)
3. Multiple correlation and adjusted multiple correlation coefficient, Null distribution of sample correlation and multiple correlation coefficient. Partial correlation coefficient and its relation with multiple correlation coefficient. Tests for significance of simple, multiple and partial correlation coefficients. Variable Selection Procedures: Mallows Cp, forward, backward selection methods. (12)
4. Residuals and residual diagnostics. Transformation of Variables: Box-Cox power transformation. (8)
5. Multicollinearity: Consequences, detection and remedies. Autocorrelation: Consequences. Durbin-Watson test, Estimation of parameters in presence of auto-correlation. (10)
6. Dummy variables and their use in regression analysis. (2)
7. Introduction to Nonlinear regression models. (5)

References

1. Draper N.R. and Smith,H. (1998): Applied Regression Analysis.3rd ed Wiley
2. Wiesberg, S.(1985): Applied Linear Regression, Wiley.
3. Kutner, Neter, Nachtsheim and Wasserman (2003): Applied Linear Regression Models, 4th Edition, McGraw-Hill
4. Montgomery, D.C., Peck, E.A.,and Vining, G.(2001): Introduction to Linear Regression Analysis, 3rd Ed .Wiley
5. Cook, R.D. and Wiesberg, S.(1982): Residuals and Influence in Regression. Chapman and Hall.

MST 328 : Actuarial Statistics

1. Basic concepts and Life Tables : Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate 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. (12)

2. Probability Models : 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. (12)

3. Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.
   Life insurance: Insurance payable at the moment's of death and at the end of the year of death-level benefit insurance, endowment insurance, differed insurance and varying benefit insurance, recursions, commutation functions.
   Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportion able annuities-due. (10)
4. Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportion able premiums, commutation functions, and accumulation type benefits. Payment premiums, apportion able premiums, commutation functions accumulation type benefits. (8)
5. Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi continuous basis, reserves based on true monthly premiums, reserves on an apportion able or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions.
   Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses. Claim amount distributions, approximating the individual model, stop-loss Insurance. (10)

References :

1. Actuarial Mathematics', Society of Actuaries, Itasca, IIIinois, U. S. A. Second Edition (1997)
2. Spurgeon E. T. (1972), Life Contingencies, Cambridge University Press.
   Neill, A. Life Contingencies, Heinemann

MST 316- PRACTICAL –III

1. Realization from a Markov Chain.
2. Classification of t.p.m and computation of n-step probability matrix.
3. Classification of State: Computations of absorption probabilities.
4. Stationary distribution and recurrence times.
5. Realization from discrete state space Markov Processes and related estimation.
6. Construction of CAN estimators.
7. Large sample tests using variance stabilizing transformation.
8. Analysis of full replicated unconfounded 2^n and 3^n factorial experiments.
9. Analysis of Single replicate 2^n factorial experiment.
10. Analysis of confounded 2^n factorial experiments: total and partial confounding.
11. Analysis of confounding 3^n factional experiments.
12. Analysis of fractional factorial 2^{n-k} experiment.
13. Analysis of response surface 1^{st} and 2^{nd} order experiments.
14. Analysis of one way classification random effects data.
15. –19 Two practical on each of the optional courses.

MST 401: OPTIMIZATION TECHNIQUES

1. Linear programming problem (LPP): Theorems related to the development of Simplex algorithm, Proof of the theorems related to a basic feasible solution (b.f.s); Reduction of a f.s. to a b.f.s., Improvement of a b.f.s., Existence of unbounded solution, Optimality conditions. For other related theorems, statements only.
(9)
2. Artificial variable technique; two phase and Big M method, the case of redundancy. Revised simplex method.
(8)
3. Concept of Duality, theorems related to duality, complementary slackness property and development of dual simplex algorithm.
(7)
4. Sensitivity Analysis: Changes in the cost vector, requirement vector and non basic activity vector; addition of new variables and addition of new constraints.
(6)
5. Theory of games: two person zero sum games, minimax and maximin principles, Saddle point, mixed strategies; rules of dominance, solution of 2 x 2 game by algebraic method, Graphical method, Reduction of the game problem as LPP, Minimax and maximin theorem (without proof).
(5)
6. Integer Linear Programming Problem (ILPP): The concept of cutting plane, Gomory's method of cutting plane for all ILPP and mixed ILLP, Branch and Bound method.
(6)
7. Quadratic programming: Kuhn-Tucker conditions of optimality, methods due to Beale, Wofle.
(4)

References:

1) Hadley G.(1969): Linear Programming ,*Addison Wesley*
2) Taha H. A.(1971): Operation Research An Introduction- *Macmillan N.Y.*
3) Kanti Swaroop & Gupta M. M.(1985): Operations Research, *Sultan Chand & Co.*
4) Operation Research theory and Applications. (2003) IInd *edition J.K.Sharma Macmillan India ltd.*

MST 402 DECISION THEORY

1. Decision theory – Description of the problem, Estimation, Testing and interval estimation as decision problems; randomised, non-randomised and behavioural decision rules and their risk functions. (8)

2. The concept of prior distributions, various types of priors, noninformative , Jeffrey's, least favorable prior, posterior distribution; Posterior distribution conjugate family and standard examples of such families. Bayes and minimax rules; geometric interpretation for finite parameter space. (10)

3. Construction of minimax rules using Bayes rules. Bayes rules for estimation, testing and confidence region problems, Relation between minimax and Bayes rules Extended and Generalized Bays rules. (8)
4. Complete and minimal complete classes; essentially complete classes; Admissible rules; related theorems; Bayes and admissible rules Admissibility of aX + b for EX. inadmissibility of sample mean vector for the mean vector of normal distribution. (13)

5. Invariance, Maximal invariance of a function. Invariant decision problem. Invariant rule. Invariant estimators and tests UMPI tests . (7)

References:

1.Ferguson T. S.(1967): Mathematical Statistics decision theoretic approach, academic press.
2.Degroot H.: Optimal Statistical Decisions.
3.Berger J. O. (1980): Statistical Decision theory – Foundations, Concepts and Methods, Springer Verlag
4. Zacks(1971): Theory of Statistical Inference, John Wiley & Sons, Inc.
5. Lehmann E L Thoery of point estimation

MST 421 : DISCRETE DATA ANALYSIS

1. Log linear model for two and three dimensional contingency tables : Interpretation of parameters, comparison with ANOVA and regression. ML estimation of parameters, likelihood ratio tests for various hypotheses including independence . marginal and conditional independence, partial association, models with quantitative levels (13)

2. Generalized linear models: concept of generalized linear model, Link function, ML estimation, large sample tests about parameters, goodness of fit, analysis of deviance, introduction to Poisson regression. (10)

3. Logistic regression : logit model for dichotomous data with single and multiple explanatory variables, ML estimation, large sample tests about parameters,, variable selection, extension to polytomous data. (10)

4. Non-parametric regression and Interpolating and smoothing splines for simple regression. Use of cross-validation applications to logistic and Poisson regression. (12)

References :

1) Yvonne M. Bishop, Stephen E. Fienberg, Paul W. Holland Discrete. (1975): Multivariate Analysis: Theory and Practice

2) Hosmer D.W. and Lemeshow S. (2000) : applied Logistic regression, 2nd ED. Wiley New York.

3) Agesti A. (1990) : Categorical Data Analysis. Wiley , New York.

4) R.Christensen (1997) Log-Linear Models And Logistic Regression. 2nd Ed. Springer. New York.

MST 422 SURVIVAL ANALYSIS

1. Estimation and testing for: Exponential, Gamma, Weibull, Lognormal, Pareto, and Linear failure rate distribution, for complete data. (4)
2. Concept of censoring, various types of censoring, Estimation and Testing of parameters of exponential distribution under various types of censoring. (5)
3. Estimation of survival function: Actuarial Estimator, Kaplan Meir product limit estimator, properties: self-consistency and MLE. (6)
4. Tests for exponentiality against alternatives IFRA, NBU and NBUE. (6)
5. Two-sample problem: Gehen test, Log rank test, Mantel Haenszel test. (4)
6. Semi parametric regression for failure rate – Cox's proportional hazards model. Related estimation and test procedures. (5)

References:

1. 1. Barlow R. E. & Proschann F. (1965) Mathematical Theory of Reliability, John Wiley & Sons, Inc.
2. 2. Lawless J. F.(1982): Statistical Models and Methods of Failure Time Data, John Wiley.
3.Miller R. G.(1981): Survival Analysis, John Wiley and Sons.
4.Bain L. O.(1978): Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker, Inc, N.Y.
5.Nelson W. (1982): Applied Life Data Analysis, Jhon Wiley and Sons Inc.

MST 423 : INDUSTRIAL STATISTICS

1. Basic concept of quality control, process control and product control, seven SPC tools flowchart. Histogram, Check sheet. Ishikawa diagram, Pareto chart, Defect concentration diagram, control chart. Deming's PDCA cycle for continuous improvements and its applications.

(10)

2. Control charts for measurements and attributes $\bar{x}$. R. S, p, np. charts with sub-grouping, CUSUM chart, tabular form and V-mask use of these charts for process control. Moving average and exponentially weighted moving average charts.

(10)

3. Process capability C_p, C_{pk} and C_{pm} . Determining process capability with $\bar{x}$ chart. Estimation of process capability.

(5)

4 Sampling Inspection plans : for attribute inspection: Single, double & sequential sampling plans and their properties. Dodge & Roming characterization by OC curve and ARL-Inspection by variables for one or two sided specifications.

(8)

5. Multivariate control charts for measurements data. Hotelling T^2 control charts.

(4)

6. Introduction to Six-Sigma Methodology. DMAIC cycle & case studies.

(4)

7. Simulation of X -bar and R control charts, estimation of ARL and process capability indices.

(4)

References :

1. Guenther W.C (1981) : Sampling Inspection in Statistical Quality Control Charter Grifits.
2. Montgomery D.C. (1996) Introduction to Statistical Quality Control, John Wiley & Sons inc.
3. Kotz S. (1993): Process capability indices. Chapman and Hall.
4. Abraham Bovas(1998) Quality Improvement through statistical methods. Birkhauser.

MST 424 : TIME SERIES ANALYSIS

1. Time-series as discrete parameter stochastic process. Auto covariance and auto correlation functions and their properties. (7)
2. Exploratory Time Series Analysis: Tests for trend and seasonally, Exponential and Moving average smoothing. Hot Wiinters smoothing. Forecasting based on smoothing, adaptive smoothing. (8)
3. Stationary processes: a) moving average) (MA), b) Auto Regressive (AR), c) ARMA and (d) AR integrated MA (ARIMA) models, Box-Jenkins models, Discussion,(without proof) of estimation of mean, auto covariance and auto correlation functions under large sample theory. (10)
4. Choice of AR and MA periods, Estimation of ARIMA models parameters. Forecasting, Residual analysis and diagnostic checking. (10)
5. Introduction to Spectral analysis of weakly stationary process, Periodogram and Correlogram. Introduction to ARCH and GARCH models. (10)

References

1. Anderson, T. W (1971) : The Statistical Analysis of Time Series, Wiley, N.Y.
2. Brockwell, P.J. and Davis, R. A. Time-Series : Theory and Methods
3. (Second Edition), Springer-Verlag.
4. Box, G.E.P. and Jenkins, G.M. (1976) : Time Series Analysis-Forecasting and control, Hodlen-day, San Franciscor.
5. Kendall, Sir Maurice and Ord. J. K. (1990) : Time Series (Third Edition) Edward Arnold.
6. Montgomery, D. C. and Johnson, L. A. (1977) : Forecasting and Time Series Analysis, McGraw Hill.

MST 428 : DATA MINING

1. Review of classification methods from multivariate analysis. Classification and decision trees, regression trees.
(5)

2. Convexity and optimization: Convexity, conjugate functions, unconstrained and constrained optimization, KKT conditions.
(7)

3. Unsupervised learing from univariate and multivariate data; dimension reduction and feature selection, supervised learning from moderate to high dimensional input spaces.
(5)

4. Artificial Neutral Network (ANN): Introduction to ANN, types of activation function, McCulloch-Pitts AN model, single layer network, multilayer feed forward network model, training methods, ANN & regression models.
(7)

5. Support vector machine: Introduction to support vector machine, loss functions, soft margin, optimization hyperplane, support vector classification, support vector regression, linear programming support vector machine for classification and regression.
(7)

6. Association rules and prediction; Apriori Algorithm data attributes, applications to electronic commerce.
(5)

7. Implementation of various data mining algorithm using software R.

References

1. Berson and Smith S.J. (1997) : Data warehousing, Data Mining, and OLAP, McGraw-Hill.
2. B reiman J.H Friedman, R.A. Olshen and stone C.J. (1984) : Classification and Regression Trees, Wadsworth and Brooks / Cole.
3. Han and Kamber (2000) : data Mining ; Concepts and Techniques. Morgan Gaufmann.
4. Mitchell T.M. (1997) : Machine Learning , McGraw-Hill.
5. Ripley B.D. (1996) : Pattern Recognition and Neural Networks. Cambridge University Press.
6. Vapnik V.N. the nature of Statistical learning theory Springer.

7. Cristianini N. and Shawe-Taylor J. An Introduction to support vector machines.
8. Data set source: http://www.ICS.uci.edu/~mlearn/MLRepository.html
9. Elements of Statistical Learning
10. Mehrika K Mohan C and Ranka (1997) Elements of Artificial neural networks. Penram international.
11. Hastie T, Tibshirani R, Friedmant J, (2009): The elements of statistical Learning Springer.

MST 416- PRACTICAL –IV

Practical based on : MST –401 and MST-402.

1. Solution to LPP using graphical methods and simplex method.
2. Revised Simplex method and Dual Simplex Method.
3. Game Theory.
4. Quadratic & integer programming.
5. Loss function, risk functions of decision rules, sketching of risk Sets. When parameter space consists of two values.
6. Prior and posterior distribution.
7. Bayes rules.

In addition to the above, at least TWO practical from each elective courses be conducted.

Project Report should be based on Problem definition, Data collection, Data Analysis, Interpretation, Major findings, Report writing