BHAGWANT UNIVERSITY, AJMER

Department of Mathematics
Syllabus
For
M. Sc. Statistics

Course Category

PSTA : Post Graduate (M.Sc) in Statistics
CCC: Compulsory Core Course
ECC: Elective Core Course

Contact Hours:

L: Lecture
T: Tutorial
P: Practical or Other

Marks Distribution :

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

First Semester:-

S. No.	Sub. Code	Subject	Course Category	Con. Hrs.per week		EoSE Duration (in Hrs)		Marks Distribution		
				T	P	T	P	IA	EoSE	Tot
1	01PSTA101	Real Analysis	CCC	3	0	3	0	30	70	100
2	01PSTA102	Linear Algebra	CCC	3	0	3	0	30	70	100
3	01PSTA103	Measure Theory & Probability	CCC	3	0	3	0	30	70	100
4	01PSTA104	Sample Survey	CCC	3	0	3	0	30	70	100
5	01PSTA201	Statistics Lab	CCC	0	6	0	6	50	50	100
									Total	500

Second Semester:-

S. No.	Sub. Code	Subject	Course Category	Con. Hrs.per week		EoSE Duration (in Hrs)		Marks Distribution		
				T	P	T	P	IA	EoSE	Tot
1	02PSTA101	COMPLEX ANALYSIS,TRANSFORM & SPECIAL FUNCTIONS	CCC	3	0	3	0	30	70	100
2	02PSTA102	THEORY OF PROBABILITY & LIMIT THEOREMS	CCC	3	0	3	0	30	70	100
3	02PSTA103	LINEAR MODEL & REGRESSION ANALYSIS	CCC	3	0	3	0	30	70	100
4	02PSTA104	MULTIVARIATE ANALYSIS	CCC	3	0	3	0	30	70	100
5	02PSTA201	Statistics Lab	CCC	0	6	0	6	50	50	100
									Total	500

Third Semester:-

S. No.	Sub. Code	Subject	Course Category	Con. Hrs.per week		EoSE Duration (in Hrs)		Marks Distribution		
				T	P	T	P	IA	EoSE	Tot
1	03PSTA101	SART	CCC	3	0	3	0	30	70	100
2	03PSTA102	INFERENCE	CCC	3	0	3	0	30	70	100
3	03PSTA103	BLOCK DESIGNS &THEIR ANALYSIS	CCC	3	0	3	0	30	70	100
4	03PSTA104	ECONOMETAICS	CCC	3	0	3	0	30	70	100
5	03PSTA201	Statistics Lab	CCC	0	6	0	6	50	50	100
									Total	500

Fourth Semester:-

S. No.	Sub. Code	Subject	Course Category	Con. Hrs.per week		EoSE Duration (in Hrs)		Marks Distribution		
				T	P	T	P	IA	EoSE	Tot
1	04PSTA101	Asymptotic Inference	CCC	3	0	3	0	30	70	100
2	04PSTA102	Stochastic Processes	CCC	3	0	3	0	30	70	100
3	04PSTA103	Decision Theory and Bayesian Analysis	CCC	3	0	3	0	30	70	100
4	04PSTA104	Factorial Experiments and Response surfaces	CCC	3	0	3	0	30	70	100
5	04PSTA201	Statistics Practical & Project	CCC	0	6	0	6	50	50	100
									Total	500

First Semester:

01PSTA101 **Real Analysis**

UNIT – I

Metric Space and examples, open sets, closed sets, neighbourhood, unitary space, Euclidean space, Sequences in Metric spaces and convergence.

UNIT- II

Cauchy sequences, complete metric spaces and examples, Baire's theorem, Continuity, spaces of continuous functions, monotonic functions.

UNIT - III

Compactness, sequential compactness, functions continuous on compact sets, Bolzano-Weierstrass property, connectedness, components, Uniform continuity, totally disconnected.

UNIT- IV

Functions of Bounded variation, Total variations, functions of bounded variations expressed as difference of increasing functions, continuous function of bounded variations, Riemann and Riemann-Stieltjes integral.

Text Books:

1. Tom M. Apostol, Mathematical Analysis, Addition –Wesley.

2. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Ltd.

Reference Books:

1. Walter Rudin, Principles of Mathematical Analysis, 3rd edition, McGraw-Hill, Kogakusha, 1976, International Student Edition.

2. S. C. Malik and Savita Arora, Mathematical Analysis, New Age International Publishers.

3. H. L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.

4. D. Somasundram and B. Chaudhary, A first course in Mathematical Analysis, Narosa Publishing House, New Delhi. 5. Terence Tao, Analysis II, Hindustan Book Agency, 2006.

01PSTA102 **Linear Algebra**

UNIT-I

Vector Spaces: Definition and Examples, Subspaces, Linear dependence, Basis and Dimension, Sum and Direct Sum, Quotient spaces, Linear Transformations: Kernel and Image of a Linear Transformation, Rank and Nullity of a Linear Transformation, Matrix Mappings.

UNIT-II

Linear Mappings and matrices: Matrix representation of Linear Transformation, Change of Basis, Similarity. Polynomial of matrices, Characteristic polynomial, Cayley Hamilton Theorem, diagonalization, minimal polynomial, companion matrix.

UNIT-III

Canonical and Bilinear Forms: Triangular form, invariance, Primary decomposition, Jordon canonical form, Rational canonical Form, Bilinear and Quadratic forms.

UNIT-IV

Inner Product Space, examples and properties, Norms and Distances, Orthonormal basis, The GramSchmidt Orthogonalization, Orthogonal complements. The Adjoint of a Linear operator on an inner product space, Normal and self-Adjoint Operators, Unitary and Normal Operators.

Text Books:

Seymour Lipschutz, Marc Lipson: Linear Algebra, Third Edition, Tata McGraw-Hill.

Reference Books:

1. K. Hoffman and R. Kunze: Linear algebra, Second Edition, Prentice Hall.

2. S. Axler: Linear Algebra Done Right, Second Edition, Springer-Verlag, 2004.

3. S. Lang: Undergraduate Texts in Mathematics, Third Edition, Springer-Verlag, NewYork, 2004.

01PSTA103 **Measure Theory & Probability**

UNIT - I

Sets and sequences of sets. Fields, sigma field, minimal sigma field. Borel field in R^k , Monotone classes, Set function, Measure, Probability measure, Properties of measure, Caratheodory extension theorem (without proof). Lebseque measure, Lebesgue-Stieljes measure, Measurable functions and properties. UNIT - II

Sequence of random variables, convergence in probability, convergence in r-th mean, almost sure convergence, convergence in distribution, Interrelationship among different modes of convergences. UNIT - III

Integral with respect to a measure and dominated convergence theorems, Product spaces, Fubini Theorem (without proof), Signed measure, Absolute continuity.

UNIT - IV

Radon-Nikodym Theorem (without proof). Lebesgue decomposition theorem. HellyBray theorem, Expectation of random variables, Conditional expectation, Martingales and simple properties, Jensen, Holder, Schwartz Minkowski's Liapounov's inequalities.

REFERENCES

1. Dudewicz, E.J. and Mishra, S.N. (1988) : Modern Mathematical Statistics, Wiley, Int'l Students' Edition.
2. Rohatgi, V.K. (1984) : An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
3. Rao C.R. (1973) : Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.

ADDITIONAL REFERENCES

1. Pitman, J. (1983) : Probability, Narosa Publishing House. Johnson, S. and Kotz, (1972) : Distributions in Statistics, Vol. I, II and III,
2. Houghton and Miffin. Cramer H. (1946): Mathematical Methods of Statistics, Princeton.

01PSTA104 **Sample Survey**

UNIT - I

Unequal probability sampling: pps wr and wor methods (including Lahiri's scheme) and related estimators of a finite population mean (Hansen-Hurwitz and Desraj estimators for general sample size and Murthy's estimator for a sample of size 2).

UNIT - II

Horvitz-Thompson estimator, its variance and unbiased estimator of variance, IPPS schemes of sampling due to Midzuno-Sen, Rao-Hartley-Cochran and Samphord.

UNIT – III

The Jackknife and Bootstrap : estimate of bias, estimate of variance. Ratio Estimation in reference to Jackrite and bootstraps, Relationship between the jackknife and the bootstrap. Interpenetrating sub sampling.

UNIT - IV

Non-sampling errors. Randomized Response techniques (Warner's method : related and unrelated questionnaire methods).

REFERENCES

1. Chaudhuri, A. and Mukerjee, R. (1988) : Randomized Response : Theory and Techniques, New York :
2. Marcel Dekker Inc. Cochran, W.G. : Sampling Techniques (3rd Edition, 1977).
3. Wiley. Des Raj and Chandak (1998) : Sampling Theory,
4. Narosa. Murthy, M. N. (1977) : Sampling Theory & Methods, Statistical Publishing Society, Calcutta.
5. Sukhatme et al (1984) : Sampling Theory of Surveys with Applications.
6. lowa state University Press & IARS. Singh, D. and Chaudhary, F.S. (1986) : Theory and Analysis of Sample Survey Designs. New Age International Publishers.
7. Gray, H.L., and Schucany(1972) : The generalized jackknife statistic. New York. Marcel Dekker, Inc.

01PSTA201 **Statistics Lab**

STATISTICAL COMPUTING/STATISTICS PRACTICAL

1. Microsoft Excel: i) Spread sheet ii) Descriptive Statistics (Univariate) iii) Regression iv) Different kinds of charts including histogram, pie charts & bar charts. Frequency curves.

2. Calculation of bases

3. Gram-Smidt orthonormalization

4. Inverse of matrix 5. Solution of a set of non-homogeneous equations

6. g-inverse of matrix

7. Characteristics roots and vectors 8. Reduction and classification of quadratic forms

9. Practical on pps. a. to draw samples by cumulative total method/Lahiri method b. to estimate population mean/population total of the characteristics under study using ordered and unordered samples : Desraj, Murthy and H-T estimators.

Second Semester

02PSTA101 **COMPLEX ANALYSIS,TRANSFORM & SPECIAL FUNCTIONS**

UNIT – I

Functions of a complex variable, limit, Continuity, differentiation, Candy-Riemann equations, Power series, Analytic functions.

UNIT – II

Cauchy's theorem and integral formula, Taylor's and Lauret's series, Residue theorem, Evaluation of standard integrals by contour integration.

UNIT - III

Laplace transform and its properties, Laplace transforms of important functions, Inverse Laplace transforms, Convolution theorem, Solution of ordinary differential equations.

UNIT - IV

Gamma, Hypergeornetric Legendre's and Bessel's functions, Elementary properties of these functions.

REFERENCES

1. E.T. Copson : An introduction to the theory of functions of a complex variable.
2. G.F. Simmons : Differential Equations, Tata McGraw Hill.

02PSTA102 **THEORY OF PROBABILITY & LIMIT THEOREMS**

UNIT - I

Weak and strong law of large numbers for independent random variables, Kolmogorov's inequality and theorm, Hazek-Renyi inequality, Levy's inequality and theorem, Uniform integrability.

UNIT - II

Central limit theorems , Lindberg-Levy theorem, Liapounoff theorem, Lindberg-Feller theorem (without proof), Glivenko-Cantelli Theorem.

UNIT - III

Distribution function, Stieltjes integrals and Riemann Integral, Characteristic function and moments, Inversion theorem, continuity theorem and its applications (CLT for iid random variables and Khintechine's weak law etc.).

UNIT – IV

Infinitely divisible distributions, Convergence of infinitely divisible distributions, Borel-Cantellilemma, borel-zero one law.

REFERENCES

1. Ash, Robert (1972): Real analysis and Probability, Academic Press. Billingsley,
2. P. (1986): Probability and Measure, Wiley. Dudley,
3. R.M. (1989): Real Analysis and Probability, Wadsworth and Brooks/Cole. Kingman,
4. J.F.C. and Taylor, S.J. (1966): Introduction to Measure and Probability, Cambridge University Press.
5. Chow, Y.S. & Teicher, H. (1979) : Probability Theory, Narosa Publishing House, New Delhi
6. Bhat, B.R. (1985) : Modern Probability Theory, Wiley Eastern Limited.

02PSTA 103 **LINEAR MODELS & REGRESSION ANALYSIS**

UNIT – I

Generalized inverse, Moore-Penrose generalized inverse. Important results on g-inverse, Use of generalized inverse of matrices, Distribution of quadratic forms for multi-variate normal random vector, Cochran Theorem.

UNIT – II

Linear models of full rank and not of full rank, Normal equations and least squares estimates, BLUE, Gauss-Markov Theorem, Error and estimation spaces, variance and covariances of least squares estimates, estimation of error variance.

UNIT – III

Models containing function of the predictors, including polynominal models, Use of orthogonal models, Hypotheses for one and more than one linear parametric functions, Confidence regions, Analysis of Variance, Power of F-test. Multiple comparison tests due to Tukey and Scheffe, Simultaneous confidence intervals.

UNIT – IV

Selecting the best regression equation : Stepwise regression, backward elimination. Criteria for evaluating equations, residual mean square, Cp and its use, Residuals and their plots. Tests for departure from assumptions of linear models such as normality, homogeneity of variances, Detection of outliers & its remedies, Transformation: Box - Cox transformation. Introduction to non-linear models.

REFERENCES

1. Cook, R.D. and Weisberg, S. (1982): Residual and Influence in Regression.
2. Chapman and Hall. Draper, N.R.and Smith, H. (1998): Applied Regression Analysis, Third Edition Wiley.
3. Guest, R.F. and Mason, R.L. (1980): Regression analysis and its Applications - A Data Oriented Aproach.
4. Marcel and Dekker. Rao, C.R. (1973): Linear statistical inference and its Applications. Wiley Eastern. Weisberg, S. (1985): Applied Linear Regression. Wiley.

02PSTA 104 **MULTIVARIATE ANALYSIS**

UNIT – I

Wishart matrix - its distribution and properties, Distribution of sample generalized variance, Null and non-null distribution of simple correlation coefficient, Null distribution of partial and multiple correlation coefficient, Distribution of sample regression coefficients, Application in testing and interval estimation.

UNIT – II

Null distribution of Hotelling's T2 statistic, Application in tests on mean vector for one and more multivariate normal populations and also on equality of the components of a mean vector in a multivariate normal population.

UNIT – III

Classification and discrimination procedures for discrimination between two multivariate normal populations-sample discriminant function, test associated with discriminant functions, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations, Fisher Behren Problem.

UNIT – IV

Multivariate Analysis of variance (MANOVA) for one way classified data only, Principal components, dimension reduction, Canonical variables and canonical correlations: definition, use, estimation and computation.

REFERENCES

1. Anderson T.W. (1983) : An Introduction to Multivariate Statistical Analysis (Second Edition) Wiley.
2. Giri, N.C. (1977) : Multivariate Statistical Inference. Academic Press. Khsirsagar A.M. (1972): Multivariate analysis.
3. Marcel Dekker. Morrison, D.F. (1976) : Multivariate Statistical methods. 2nd. Ed. McGRAW Hill. Muirhead, R.J. (1982) Aspects of multivariate statistical theory,
4. J.Willey. Rao CR (1973) : Linear Statistical Inference and its Applications 2nd. Ed. Wiley. Seber, G.A.F. (1984) : Multivariate observations.
5. Wiley Sharma, S. (1996) : Applied multivariate techniques.
6. Wiley. Srivastava M.S. & Khatri C.G. (1979) : An Introduction to Multivariate Statistics.

7. North Holland. Johnson, R. and Wychern (1992) : Applied multivariate Statistical analysis, prentice-Hall, 3rd. Ed.

02PSTA 201 **STATISTICS PRACTICAL**

1. Experiments based on multivariate analysis.

2.

Hotelling T^2/D^2 (Discriminant analysis)

(a) To test $H_o : \mu = \mu_o$ from $N(\mu, \sum)$, $\sum$ unknown.

(b) To test $H_o : \mu_1^{(1)} = \mu_2^{(2)}$ in $N_p(\mu^{(1)}, \sum), N_p(\mu^{(2)}, \sum)$, $\sum$ unknown.

(c) Discriminant Analysis

(d) Problem of Misclassification

3. Multivariate Analysis of variance (One way classified data only).

4. Principal components

5. Canonical correlations

6. Factor Analysis

Third Semester

03PSTA 101 **SEQUENTIAL ANALYSIS AND RELIABILITY THEORY**

UNIT – I

Need for sequential procedures, SPRT and its properties. Wald's equation and identity, OC and ASN functions optimality of SPRT.

UNIT – II

Sequential estimation, Stein's two stage procedure. Anscombe Theorem. Chow-Robbin's procedure, Asymptotic consistency and risk efficiency, Estimation of normal mean.

UNIT – III

Reliability concepts and measures, components and systems, coherent systems, reliability of coherent systems cuts & paths, Bounds on system reliability. Life distributions, reliability functions, hazard rate, Common life distributions : Exponential, gamma and Weibull, estimation of parameters and tests in these models.

UNIT – IV

Notion of aging IFR, IFRA, NBU, DMRL and NBUE classes. Different types of redundancy and use of redundancy in reliability improvement, Problem of life testing, censored and truncated experiments for exponential models.

REFERENCES

1. James O Berger (1985) : Statistical Decision Theory and Bayesian analysis. Springer
2. Fergusion T.S. (1967) : Mathematical Statistics - A decisions theoretic Approach. Academic Press
3. Rohtagi, V.K. : An Introduction to Probability Theory and Mathematical Analysis, John Wiley.
4. Wald, A. : Sequential Analysis.
5. Whetherill, G.B. : Sequential Methods in Statistics, Methuen & Co. Ltd., New York, John.
6. DeGroot**,** M.H. : Optimal Statistical Decisions. McGraw Hill
7. Leonard T and Hsu J.S.J. : Bayesian Methods. Cambridge University Press.
8. Bernardo, J.M. and Smith AFM : Bayesian Theory. John willey.
9. Raiffa, h. & Schlaifer, r. (1961) : Applied Statistical Decision Theory.
10. Barlow R E and Proschen F (1985) : Statistical Theory of Reliability and Life Testing, Holt,
11. Lawless J F (1982) : Statistical models and methods of life Time Data. John Wiley.
12. Bain L J and Engelhardt (1991) : Statistical Analysis of Reliability and life testing models.

03PSTA 102 **INFERENCE**

UNIT – I

Likelihood function, Sufficiency, Factorization Theorem, Minimal sufficient statistics, Completeness Exponential families of distributions and their properties. Distribution admitting sufficient Statistics, Extension of results to multiparameter case.

UNIT – II

Cramer-Rao bounds, Bhattacharya bounds. Minimum variance unbiased estimators, Rao-Blackwell Theorem. Lehman-Scheffe theorem and their applications.

UNIT – III

Non-randomized and randomized tests. Size, power functions. unbiasedness. NP-Lemma and its applications in construction of MP tests for simple null hypotheses. MLR families.

UNIT – IV

UMP tests for one sided null hypotheses against one-sided composite alternative. Generalized NP lemma, Locally best test, UMPU tests, Similar tests, Neyman structure, UMPU tests against one-sided and two-sided alternatives, Confidence set estimation, Relation with hypothesis testing, optimum parameteric confidence sets.

REFERENCES

1. Kale, B. K.(1999) : A first course on parametric inference, Narosa Publishing House.
2. Rohatagi, V. (1988): An Introduction to probability and mathematical Statistics . Wiley
3. Eastern Ltd. New Delhi (Student Edition)

ADDITIONAL REFERENCES

1. Lehmann, E.L.(1986) : Theory of point. Estimation (Student Edition)
2. Lehmann, E.L.(1986) : Testing statistical hypotheses (Student Edition).
3. Rao, C.R. (1973) : Linear Statistical inference.
4. Dudewicz, E.J. and Mishra, S.N. (1988) : Modern Mathematical Statistics. Wiley Series in
5. Prob. Math. Stat., John Wiley and sons, New Yark (International Student Edition).
6. Ferguson T. S. (1967) : Mathematical Statistics. Academic press.
7. Zacks, S. (1971) : Theory of statistical Inference, John Wiley & Sons, New Yark.

03PSTA 103 **BLOCK DESIGNS AND THEIR ANALYSIS**

UNIT – I

Fixed, mixed and random effects models; Variance components estimation : study of various methods, Tests for variance components.

UNIT – II

General block design and its information matrix (C), criteria for connectedness, balance design and orthogonality: Intrablock analysis (estimability, best point estimates/Interval estimates of estimable linear parametric functions and testing of linear hypotheses).

UNIT – III

BIBD - recovery of interblock information, Youden design - intrablock analysis, Analysis of covariance in a general Gauss-Markov model and its applications to standard designs, Missing plot technique - general theory and applications.

UNIT – IV

Finite group and finite field, Finite geometry: projective and Euclidean, Construction of complete set of mutually orthogonal latin square (mols), Construction of BIBD's using mols and finite geometries, Symmetrically repeated differences, Steiner Triples and their use in construction of BIBD, Lattice Design, Split plot design.

REFERENCES

1. Raghava Rao D. (1971) : Construction and Combinatorial problems in Design of experiment.
2. Wiley Aloke Dey (1986) : Theory of Block Designs, Wiley Eastern.
3. Angela Dean and Daniel Voss (1999): Design and Analysis of Experiments, Springer.
4. Das, M.N. & Giri, N.(1979): Design and Analysis of experiments, Wiley Eastern.
5. Giri, N. (1986) : Analysis of Variance, South Asian Publishers.
6. John P.W.M.(1971): Statistical design and analysis of experiments, Mc Millan.
7. Joshi, D.D. (1987) : Linear Estimation and Design of Experiments, Wiley Eastern.
8. Montgomery, C.D.(1976): Design and analysis of experiments, Wiley, New York.
9. Meyer, R.H.(1971) : Response surface methodology. Allyn & Bacon.
10. Pearce, S.C.(1984) : Design of experiments Wiley, New York.
11. Rao, C.R. and Kleffe, J.(1988) : Estimation of Variance Components and applications, NorthHolland.
12. Searle, S.R., Casella, G. and McCulloch, C.E. (1992) : Variance Components, Wiley.
13. Nigm, Puri & Gupta (1987-88) : Characterisation and Analysis of Block Design, WileyEastern.
14. V.K. Gupta & A.K. Nigam (1978-79) : Handbook an analysis of Agricutture Experiment, IASRI Publication.

03PSTA 104 **ECONOMETRICS**

UNIT – I

Natute of econometrics, The general linear model (GLM) and its extensions, Use of dummy varibles and seasonal adjustment, Generalized least squares (GLS) estimation and prediction, Heteroscedastic disturbances, Pure and mixed estimation, Grouping of observations and of equations.

UNIT – II

Auto correlation, its consequences and tests, Theil BLUS procedure: estimation and prediction, Multicollinearity problem, its implications and tools for handling the problem, Ridge regression.

UNIT – III

Linear regression with stochastic regressors, Instrumental variable estimation, Errors in variables, Autoregressive linear regression, Distributed lag models, Simultaneous linear equations model, Examples, Identification problem, Restrictions on structural parameters - rank and order conditions, Restrictions on variances and covariances.

UNIT – IV

Estimation in simultaneous equations model, Recursive systems, 2 SLS Estimators. Limited information estimators, k - class estimators. 3 SLS estimation, Full information maximum likelihood method, Prediction and simultaneous confidence intervals, Monte Carlo studies and simulation.

REFERENCES

1. Apte PG (1990): Text book of Econometrics. Tata McGraw Hill.
2. Cramer , J.S. (1971) : Empirical Econometrics, North Holland.
3. Gujarathi D. (1979) : Basic Econometrics, McGraw hill.
4. Intrulligator, MD (1980) : Econometric models - Techniques and applications, Prentice Hall of India.
5. Johnston, J (1984) : Econometric methods, 3rd Ed. Mc Graw Hill.
6. Klein, L.R. (1962) : An introduction to Econometrics, Prentice Hall of India.
7. Koutsoyiannis, A (1979) : Theory of Econometrics, Macmillan Press.
8. Malinvaud, E (1966) : Statistical methods of Econometrics, North Holland.
9. Srivastava V.K. and Giles D.A.E. (1987) : Seemingly unrelated regression equations models.
10. Theil, H. (1982) : Introduction to the theory and practice of Econometrics, john Wiley.
11. Walters, A (1970) : An introduction to Econometrics, McMillan & Co.
12. Watherill, G.B. (1986) : Regression analysis with applications, Chapman Hall.

03PSTA 201 **STATISTICS PRACTICAL**

1. Experiments based on BIBD
2. Experiment based on Lattice
3. Analysis of Covariance
4. Missing plot techniques
5. Split plot designs
6. Experiment based on system of Reliability
7. ASN & OC functions for SPRT
8. OLS estimation and prediction in GLM.
9. Use of dummy variables (dummy variable trap) and seasonal adjustment.
10. GLS estimation and prediction.
11. Tests for heteroscdasticity ; pure and mixed estimation.
12. Tests for autocorrelation. BLUS procedure.
13. Ridge regression.
14. Industrumental variable estimation.
15. Estimation with lagged dependent variables.
16. Identification problems - checking rank and order conditions.
17. Estimation in recursive systems.
18. Two SLS estimation.
19. Simulation studies to compare OLS, 2SLS, LISE and FIML methods.

Fourth Semester

04PSTA 101 **ASYMPTOTIC INFERENCE**

UNIT – I

Consistency (mean squared and weak), invariance of consistency under continuous transformation, consistency for several parameters, generating consistent estimators using weak law of large numbers, CAN estimators (single as well as multi-parameter cases), invariance of CAN estimators under differentiable transformations, generation of CAN estimators using central limit theorem.

UNIT – II

Consistency of estimators by method of moments and method of percentiles, Minimum Chi square estimators and their modification and their asymptotically equivalence to maximum likelihood estimators.

UNIT – III

Method of maximum likelihood: special cases as k-parameters exponential family of distribution and multinomial distributions, Computational routines : Newton – Raphson method, method of scoring, Consistency and inconsistency, Cramer Huzurbazar Theorem, Asymptotic efficiency of ML estimators, Best Asymptotically normal estimators. Concept of super efficiency.

UNIT – IV

Large Sample tests : Likelihood ratio (LR) test, asymptotic distribution of LR statistic, Tests based on ML estimators, Wald Test, Score Test. Pearson's chi-square test for goodness of fit and its relation to LR Test, Test consistency, Asymptotic power of test, Generalized likelihood ratio test, special cases such as multinomial distribution and Bartlett's test for homogeneity of variances.

REFERENCES

1. Kale, B.K. (1999) : A First Course on Parametric Inference, Narosa Publishing House.
2. Rohatgi V. (1988) : An Introduction to probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)

ADDITIONAL REFERENCES

1. Lehmann, E.L. (1986) : Testing Statistical hypotheses (Student Edition)
2. Rao, C.R. (1973) : Linear Statistical Inference.
3. Dudewicz, E.J. and Mishra, S.N. (1988) : Modern Mathematical Statistics. Wiley series in
4. prob. Math. Stat., john Wiley and Sons, New Yark (International Student Edition)
5. Ferguson, T.S. (1996) : A course on Large Sample Theory, Chapman and Hall, London.

04PSTA 102 **STOCHASTIC PROCESSES**

UNIT – I

Introduction to stochastic processes (sp's) : Classification of sp's according to state space and time domain, Countable state. Markov chains (MC's), Chapman-Kolmogorov equations, calculation of nstep transition probability and its limit, Stationary distribution, classification of states, transient MC, random walk and gambler's ruin problem.

UNIT – II

Discrete state space continuous time, Markov Chains: Kolmogorov-Feller differential equations. Poisson process, birth and death process, application to queues and storage problems, Wiener process as a limit of random walk, first-passage time and other problems.

UNIT – III

Renewal theory: Elementary renewal theorem and applications, Statement and uses of key renewal theorem, study of residual life time process, Stationary process, weakly stationary and strongly stationary process, Moving average and auto regressive processes.

UNIT – IV

Branching process: Galton-Watson branching process, probability of ultimate extinction, distribution of population size, Martingale in discrete time, inequality, convergence and smoothing properties. Statistical inference in Markov Chains and Markov processes.

REFERENCES

1. Adke, S.R. and Munjunath, S.M. (1984): An Introduction to Finite Markov Processes, Wiley Eastern.
2. Bhat, B.R. (2000): Stochastic Models : Analysis and Applications, New Age International, India.
3. Cinlar, E. (1975) : Introduction to Stochastic Process, Prentice Hall.
4. Feller, W. (1968): Introduction to probability and its Applications, Vol.1, Wiley Eastern.
5. Harris, T.E. (1963) : The Theory of Branching Processes, Springer - Verlag.
6. Hoel, P.G.. Port, S.C. and stone, C.J. (1972) : Introduction to Stochastic Process, Houghton Miffin & Co.
7. Jagers, P. (1974) : Branching Processes with Biological Applications, Wiley.
8. Karlin, S. and Taylor H.M. (1975) : A First course in stochastic processes, Vol. I Academic press.
9. Medhi, J. (1982) : Stochastic Processes, Wiley Eastern.
10. Parzen E. (1962) : Stochastic Processes. Holden –Day.

04PSTA 103 **DECISION THEORY AND BAYESIAN ANALYSIS**

UNIT – I

Decision problem and two person game, Utility theory, loss functions, Randomized and nonrandomized decision rules, Optimal decision rules – unbiasedness, invariance, Bayes Rule, Minimax rule, concept of admissibility and completeness Bayes rules, Admissibility of Bayes and minimax rules.

UNIT – II

Supporting and separating hyper plane theorems, complete class theorem. Minimax estimators of Normal and Poisson means.

UNIT – III

Subjective interpretation of probability in terms of fair odds, Evaluation of (i) subjective probability of an event using a subjectively unbiased coin (ii) subjective prior distribution of a parameter, Bayes theorem and computation of the posterior distribution, Natural Conjugate family of priors for a model, Hyper parameters of a prior from conjugate family, Bayesian point estimation as a prediction problem from posterior distribution, Bayes estimators for (i) absolute error loss (ii) squared error loss (iii) 0 -1 loss.

UNIT – IV

Bayesian interval estimation : credible intervals, Highest posterior density regions, Interpretation of the confidence coefficient of an interval and its comparison with the interpretation of the confidence coefficient for a classical confidence interval, Bayesian testing Hypothesis : Specification of the appropriate from of the prior distribution for a Bayesian testing of hypothesis problem, Prior odds, Posterior odds, Bayes factor.

REFERENCES

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04PSTA 104 **FACTORIAL EXPERIMENTS AND RESPONSE SURFACES**

UNIT – I

General factorial experiments, factorial effects, symmetric factorial experiments, best estimates and testing the significance of factorial effects; analysis of 2n .

UNIT – II

3n factorial experiments in randomized blocks, Complete and partial confounding, Fractional replication for symmetric factorials.

UNIT – III

Response surface experiments, first order designs and orthogonal designs.

UNIT – IV

Clinical trials, longitudinal data, treatment- control designs, Model validation and use of transformation, Tukey's test for additivity.

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1. Raghava Rao D. (1971) : Construction and Combinatorial problems in Design of experiment.
2. WileyAloke Dey (1986) : Theory of Block Designs, Wiley Eastern.
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04PSTA 201 **STATISTICS PRACTICAL AND PROJECT**

(a). Practical based on Factorial Experiment, Response surfaces & Bayesian Inference.

AND

Other practical based on the topics of papers – 101, 102, 103 & 104.

(b). **Project.**