

**M.Phil - STATISTICS**

*SYLLABUS*  
**2008-2009 and Onwards**

**DEPARTMENT OF STATISTICS  
BHARATHIAR UNIVERSITY  
COIMBATORE – 641 046**

**M.PHIL - STATISTICS ( FULL-TIME / PART –TIME) SYLLABUS – 2008 – 2009 and ONWARDS)**

**PAPER-I**

**TEACHING TECHNIQUES IN STATISTICS**

- UNIT – 1 : Teaching Statistics in Higher Education:**  
Higher Education objectives, Significance of teaching Statistics in higher education – Learning and Teaching – Motivation – Learning hierarchy – Information processing
- UNIT – 2 : Teaching methods and Evaluation**  
Large group techniques: Lecture, Seminar, Symposium, Panel discussion, Project and workshop. Small group techniques: Group discussion, case discussion and assignment. Educational Evaluation : Function of evaluation methods of evaluation – Characteristics of Evaluation and self evaluation – student evaluation and its objectives.
- UNIT – 3 : Listening Skills**  
Communication – Language – Language Skills – LSRW – Listening – Listening to Announcement, News, Foreign accents – Speeches – Listening problems – Tips for effective Listening – Practical.
- UNIT – 4 : Algorithms for solving Statistical Problems:**  
Development of Algorithm for usage of Computer Programs in Acceptance Sampling Plans like, Single Sampling Plan, Double Sampling Plan, Chain Sampling Plan, Plans for Isolated lots, Methods of Least Square, Method of Moments, Kruskal – Wallis, Wilcoxon Rank Sign Test, Kolmogorov Smirnov Test (One Sample & Two Sample), Generation of Random numbers (Uniform, Exponential)
- UNIT – 5 : R-Programming:**  
Simple Manipulations using Numbers and Vectors; Objects & their attributes; Arrays and Matrices; Lists and data frames; Grouping, Loops and Conditions; User defined functions; Probability Distributions; Statistical Models in R

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**REFERENCES**

1. Schiling E.G. Grasp (1978): A General Routine For Attribute Sampling Plan Evaluation, Journal of Quality Technology, 10, pp.125-130
2. Chow B., Dinkinsons C., Hunghes H.A: A Computer Program for the solution of Double Sampling Plans
3. William A. Hailey (1981) : Minimum Size Single Sampling Plans ASQC Annual Tech Congress, Trans San Francis WCO, pp.1108-1155,
4. Synder D. C and Storer R.F (1972): Single Sampling Plans given and AQL-LTPD Producer's and Consumer's Risk, Journal of Quality Technology 4(3), pp.168-171
5. John Braun. W Duncan J. Murdoch (2008): A First Course in Statistical Programming with R, Cambridge University Press
6. John Chambers (2008): Software for data Analysis: Programming with R, Springer
7. Michael J. Crawley (2007): The R Book, John Wiley & Sons (for Unit V)
8. Peter Dalgaard: Introductory Statistics with R, Physica – Verlag (for Unit V)
9. Course Team, Bharathiar University (2008):Communication Skills, Macmillan India Limited, New Delhi, (for Unit III)
10. Vedanayagam, E.G. (1989) Teaching Technology for College Teachers, New Delhi: Sterling Publishers (P) Ltd (for Unit I & II)
11. Swarupe Rani, T (2007). Teaching of Mathematics, A.P.H.Publishing Corporation, New Delhi.( for Unit I & II)

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**PAPER- II  
RESEARCH METHODOLOGY AND TRENDS IN STATISTICS**

- UNIT – 1 : Research Methodology: Concept of Research in Statistics – Selection of Topic for Research – Importance of Literature survey – Reports, Thesis and Assignment writing**
- UNIT – 2 : Computer Oriented Numerical Methods – Algorithms for solving Numerical Algebraic and Transcendental Equations – Method of Bisection – Method of Iteration – Method of Regula Falsi – Newton-Raphson’s Method – Rate of Convergence. Numerical Integration: Trapezoidal and Simpson’s Rule to evaluate the definite integral.**
- UNIT – 3 : Statistical Studies – Significance – Data Measurement Scales, Nominal, Ordinal, Ratio and Interval Scales – Sources of error in Measurement – Tests of Measurement – Technique of Developing Measurement Tools – Scaling Technique – Likert type Scaling – Cumulative Scaling**
- UNIT – 4 : Simulation: Concept and Advantages of Simulation – Event type Simulation – Generation of Random Numbers – Monte-Carlo Simulation Technique – Generation of Random Numbers using uniform (0,1), Exponential, Gamma and Normal random variables – Simulation Algorithm**
- UNIT – 5 : Data Mining and Warehousing: Introduction – KDD & Data Mining, A Statistical Perspective on Data Mining, Machine Learning – Concept Learning – Data Warehouse – Designing Decision Support System – Integration with Data Mining – Client/Server & Data Warehouse Knowledge Discovery Process**

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**REFERENCES**

- 1. Venkataraman, M.K. (1998): Numerical Methods in Sciences and Engineering, The National Publishing Company, Chennai**
- 2. Kanti Swarup, Gupta, P.K., & Man Mohan (2008): Operations Research Sultan Chand & Sons (Publications), New Delhi**
- 3. Kothari, C. (2005), Research Methodology, New Age International Publications, New Delhi**
- 4. Sastry, S.S (2006): Introductory Methods of Numerical Analysis Practice – Hall of India Private Ltd., New Delhi**
- 5. Pieter Adriaani and Dolt Zantinge (2003): Data Mining, Pearson Education (Singapore)**
- 6. Pannerselvam, R. (2006) : Research Methodology, Prentice-Hall of India Private Limited, New Delhi.**

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**PAPER- III : ADVANCED ACCEPTANCE SAMPLING**

**UNIT 1: Basic Concepts of Acceptance Sampling**

Attributes Sampling Plans Single, Double, Multiple and item by item Sequential Sampling Plans , Dodge and Romig LTPD and AOQL Tables, ABC Standard, Philip's System, Golub's Minimization Approach, Sampling Plans for Isolated Lots MAPD Plans, MAAOQ Plans, Incentive Index Plans.

**UNIT 2: Variable Sampling Plans:**

Known and Unknown – Sigma Plans, MIL-STD- 414 .

**UNIT 3: Continuous Sampling Plans:**

CSP-1, CSP-2, CSP-3 and Multilevel Continuous Sampling Plans MIL-STD-1235(ORD)

**UNIT 4: Special Purpose Plans:**

Chain Sampling Plans, Skip-lot Plans, Demerit Rating Plans, Cumulative Results Plan.

**UNIT 5:**

OQPL Plans, RGS Plans, Plans based on the Theory of Runs, Indian Standards, Lot Sensitive Sampling Plans , Tightened-Normal – Tightened Plan with Fixed and Different  $s$  and  $t$ , Quick Switching System, Administration of Sampling Inspection Plan.

**REFERENCES**

S.No.	PORTIONS	Reference material Materials (represented by symbols)
1	Basic Concepts of Acceptance Sampling	(A)
2	Attribute Sampling Plans	
	a. Single, Double, Multiple, Item by Item Sequential Sampling Plans	(B)
	b. Dodge and Romig LTPD and AOQL Tables	(C)
	c. ABC Standards	(D)
	d. Philip's System	(E)
	e. Golub's Minimization Approach	(F)
	f. Sampling Plans for Isolated Lots	(G)
	g. MAPD Plans	(H)
	h. MAAOQ Plans	(I)
	i. Incentive Index Plans	(J)
3	Variables Sampling Plans	(K)
4	Continuous Sampling Plans	(L)

5	Special Purpose Plans	
	a. Chain Sampling Plans	( M )
	b. Skip-Lot Plans	( N )
	c. Demerit Rating Plans	( O )
	d. Cumulative Results Plans	( P )
	e. OQPL Plans	( Q )
	f. RGS Plans	( R )
	g. Plans Based on theory of Runs	( S )
	h. Indian Standards	( T )
	i. Lot Sensitive sampling Plan, Tightened- Normal- Tightened plan with Fixed and Different s and t Quick Switching System	( U )
	j. Administration Sampling Inspection Plan	( V )

**References relating to symbols:**

(A) American Society for Quality Control (1978), American National Standards: Terms, Symbols and Definitions for Acceptance Sampling, ANSI/ASQC A2(1978), American Society for Quality Control, Milwaukee, Wisconsin.

(B) Burr Irving, W., (1976), Statistical Quality Control Methods, Marcel Dekker, Inc., New York  
 Schilling Edward G,(1982), Acceptance Sampling in Quality Control, Statistics: Text Book and Monographs, Vol.42, Marcel Dekker, Inc., New York.

(C) Dodge Harold, F and Romig, H.G., (1959), Sampling Inspection Tables, single and double Sampling, John Wiley, New York.

(D) MIL-STD-105D (1963), Sampling Procedures and Tables for Inspection by Attributes, US Govt., Printing Office, Washington DC.  
 Dodge Harold, F (1969), A General Procedure for Sampling Inspection by Attributes – Based on the AQL Concept. Technical Report 10. The Statistics Centre, Rutgers State University, USA.

(E) Hamaker, H.C., (1949), Lot Inspection by Sampling , Philips Technical Review, Vol.11, No.6, pp. 176-182.  
 Hamaker, H.C., (1950), The Theory of Sampling Inspection Plan, Philips Technical Review, Vol.11, No.9, pp.260-270.  
 Hamaker, H.C., Taudin Chabot, J.J.N. and Willemze, F.G., (1950), The Practical Application of Sampling Inspection Plans and Tables, Philips Technical Review, Vol.11, pp.362-370.

(F) Golub, Abraham (1953), Designing Single Sampling Inspection Plans, when the sample size is fixed, Journal of the American Statistical Association Vol.48, pp. 278-288.

(G) Cameron J.M., (1952), Tables for Constructing and for Computing the Operating Characteristics of Single Sampling Plans, Industrial Quality Control, Vol.9, pp.37-39.

(H) Soundararajan , V., (1975), Maximum Allowable Percent Defective ( MAPD) Single Sampling Inspection by Attributes Plans, Journal of Quality Technology, Vol 7., No.4, pp. 173-182.

(I) Suresh, K.K., and Ramkumar, T.B., (1996): Selection of a sampling Plan Indexed with Maximum allowable Average Outgoing Quality, Journal of Applied Statistics, Vol.23, No.6, pp.645-654.

(J) Suresh,K.K., and Sri Venkataramana, T., (1996): Selection of Single Sampling Plan using Producer and Consumer Quality Level, Journal of Applied Statistical Science, Vol.3, No.4, pp.273-280

(K) Eizenhart, Hastay and Wallis (1947), Techniques of Statistical Analysis, McGraw Hill,London (Chapter 1 Only )  
 MIL \_STD –414 (1977), Sampling Procedure and Tables for Inspection by Variables for Percent Defective, US, Govt., Printing Office, Washington, DC. Duncan, A.J., (1974), Quality Control and Industrial Statistics, 4<sup>th</sup> Edition, Richard D Irwing, Home wood , Illinois.

- (L) Stephens, K.S., (1979): How to perform Continuous Sampling Plan?, ASQC Basic reference series, V-2.  
MIL-STD-1233(ORD) (1962): Single and Multilevel Continuous Sampling Procedures and Tables for Inspection by Attributes, Department of Defence, Washington DC.  
MIL-STD A (1974): Single and Multilevel Continuous Sampling Procedures and Tables for Inspection by Attributes, US Department of Defence, Washington DC.
- (M) Dodge, H.F.,(1955): Chain Sampling Inspection Plan, Industrial Quality Control, Vol.II, No.5, pp. 10-13.  
Soundararajan, V(1978): Procedures and Tables for Construction and Selection of Chain Sampling Plans (ChSP-1) Part – I and II, Journal of Quality Technology, Vol.10, No.2 and 3, pp. 56-60. and pp. 99-103.  
Dodge, H.F., (1955): Skip-Lot Sampling Plans, Industrial Quality Control, Vol.11, No.5, pp.5-6.
- (N) Perry, R.L., (1974): Skip-Lot Sampling Plans, Journal of Quality Technology, Vol.5, pp. 123-130.
- (O) Dodge, H.F., (1956): A Check Inspection and Demerit Rating Plan, Industrial Quality Control, Vol.13, No.1, pp.5-12.
- (P) Cone, A.F., and Dodge, H.F., (1963): A Cumulative Results Plan for Small Sample Inspection, Industrial Quality Control, Vol.21, No.1, pp.4-9.
- (Q) Rhodes, R.C., (1964): An outgoing Quality Probability Limit, (OQPL), Sampling Plan, Industrial Quality Control, Vol.21, No.3, pp.122-130.
- (R) Sherman Robert, E: Design and Evaluation of a Repetitive Group Sampling Plan, Technometrics, Vol.7, No.1, pp. 11-21.
- (S) Praire, R.R. , Zimmer, W.J., and Brook House, T.K., (1962): Some Acceptance Sampling Plans Based on Theory of Runs, Technometrics, Vol.4, No.2, pp. 177-185.  
Vance, L.C., and Mc Donald, G.C., : A Class of Multiple Runs Acceptance Sampling Plan, Technometrics, Vol.21, No.2, pp. 141-146.
- (T) Indian Standard Sampling Inspection Tables – Part-I, Inspection by Attributes and by Count of Defects IS 2500 (Part-I ) 1973.  
Indian Standard Sampling Inspection Tables Part II. Inspection by Variables for percent Defective IS 2500 (Part-II ) 1965.
- (U) Schilling, E.G., (1982): Acceptance Sampling in Quality Control, Marcell Dekker,Inc.,NewYork, pp.474- 488.  
Suresh, K.K., and Balamurali,S (1993) : Designing of Tightened – Normal- Tightened(TNT) Plans Indexed by MAPD, Communications in statistics, Theory and Methods, Vol.22, No.7, pp. 2043-2056,  
Suresh.K.K., and Balamurali, S., (1994) : Construction and Selection of Tightened- Normal- Tightened Plans Indexed by Maximum Allowable Percent Defectives, Journal of Applied Statistics, vol.21, No.6,pp. 589–595.
- (V) Schilling, E.G(1982): Acceptance Sampling in Quality Control, Marcel Dekker, Inc., New York, pp. 564-591.  
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**PAPER- III**  
**STATISTICAL METHODS IN BIOMETRICS RESEARCH**

- UNIT- 1** Genetic constitution of a population , Frequencies of genes and genotypes Hardy – Weinberg Equilibrium, Change in gene frequencies due to mutation, Change in gene frequencies due to selection
- UNIT-2 :** Metric characters – Phenotypic and genotypic value Breeding value of an Individual, Dominance and Interaction Deviations, Genetic and Environment components of variance, Partitioning into Additive, Dominance and Interaction variance
- UNIT-3 :** Diallel crosses for estimation of genetic parameters, Analysis of variance of diallel experiments – Hayman’s approach, General and Specific Combining Abilities – Griffing’s approach, Heritability Co-efficient – broad and narrow senses Estimation of heritability coefficient
- UNIT-4 :** Genotype x Environment interaction, Concept of Stability of a variety or genotype Analysis of G x E interaction effects using finlay-Wilkinson method, Stability analysis of Eberhart Russel and interpretation of the results
- UNIT-5 :** Use of multivariate analysis in biometrical research Concept of distance or Similarity between populations, Measurement of distance – Mahanobis’ Distance Discriminant functions Selection index for selection a genotype using multiple measurements Genetic advance

**REFERENCES**

S.No.	PORTIONS	Reference material Materials (represented by Symbols)
1 a.	Frequencies of genes and genotypes in a population	A
b.	Hardy –weinberg Equilibrium	A
c.	Changes in gene frequencies due to selected and mutation	A
d.	Estimation of gene frequencies – Maximum likelihood- Example of blood groups	B
2 a.	Metric characters- values and means	A
b.	Dominance and interaction deviations	A
c.	Variance components – Phenotypic, genotype and environmental and their implications	A,B
d.	Estimation of genotype and phenotypic correlations and analyzing causal relationships using path coefficient analysis	F
3a.	Analyzing of Diallel experiments – Estimation of genetic components of variation using Hayman’s approach	O,P,R
b.	Estimation of general and specific combining ability of a genotype- Griffing’s approach	Q,R

c. Using sib analysis of estimating heritability coefficient	A,R
d. Using parent- offspring regression for estimating heritability	A,R
4a. Genotype x Environment I interactions and implications	I,J
b. Stability analysis of multilocation varietal trials	K, L
c. Analysis of G x E interactions- Finlay – Wilkinson’s approach	K
d. Stability parameters and their interpretation - model of Eberhart Russell	L
5a. Mahalanobis D-square statistics	C,M
b. Fisher’s Discriminant Function	C
c. Discriminant functions for selecting genetically desirable types	C,N
d. Construction of selection index for identifying superior genotypes using multiple measurements	C,G,N
e. Genetic advance	C

## References relating to symbols

- A. Falconer, D.S (1977) – Introduction to Quantitative Genetics, Longman
- B. Kempthorne Oscar (1957) – An introduction to genetic statistics, John Wiley & Sons, New York.
- C. Rao, C.R.(1952)- Advanced Statistical Methods in biometric Research, John Wiley & sons, New York.
- D. Brown, A.H.D (1975) – Efficient experimental designs for the estimation of genetic parameters in plant populations, Biometrics 31:145- 160.
- E. Dudley, J.W. and R.H. Moll (1969) – Interpretation and use of estimates of heritability and genetic variances in plant breeding. Crop Sci. 9 : 257 – 261.
- F. Deway, R and K.H. Lu (1959) – A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron J.51 : 515-518.
- G. Hazel, L.N.(1943) – The genetic basis of construction of selection indices. Genetics 28: 476 – 490.
- H. Manning, H.L.(1956)–Yield improvement from a selection index techniques with cotton. Heridity 10: 303–322.
- I. Knight,R. (1970) – The measurement and interpretation of G x E interaction. Euphytica 19 : 225 – 235.
- J. Freeman, G.H.(1973)–Statistical methods for the analysis of G x E interaction. Heridity 31 : 339 – 354.
- K. Finlay and Wilkinson (1963) – The analysis of adaption in plant breeding programmes. Aus. J. of Agri.Res. 14 : 742 – 754.
- L. Eberhart,R.(1966) – stability parameters for comparing varieties. Crop Sci. 6 : 36 – 40.
- M. Lee, J and P.J. Kaltsikes (1973) - the application of Mahalanobis’D square to measure the genetic divergence in durum wheat. Euphytica 22: 124 – 131.
- N. Smith, H.F. (1939) – Discriminant function for plant selection. Annals of Eugenics.7 : 240 – 250.
- O. Hayman, B.I. (1954a.) - The analysis of variance of diallel crosses. Genetics 39 : 789 – 809.
- P. Hayman,B.I. (1954b)- The analysis of variance of diallel crosses. Biometrics 10 : 235-244.
- Q. Griffing.B (1956) A concept of general and specific combining ability in relation to diallel crossing system. Aust.J.Of Biologica Sci. 9 : 463 – 493.
- R. Prem Narain, V.K. Bhatia and P.K. Malhotra (1979). Handbook of statistical genetics. IASRI (ICAR).

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**PAPER- III**  
**Psychometrics**

Unit- I: Functions and Origins of Psychometrics Testing:

Current used of Psychological tests – The contributions of Francis Galton, Cattell and the early "Mental tests". Grouping testing. Tests of special aptitudes. Differential aptitude batteries. The measurement of personality. Principal characteristics of Psychological tests. What is a Psychological test? Varieties of Psychological tests. Sources of information about tests.

Unit – II: The use of Psychological Tests:

Code of Professional ethics pertaining to psychological tests. Principal reasons for controlling the use of Psychological tests. Motivation and rapport. The influence of practice and coaching upon test performance. Mallinger and cheating. Practical problems of test administration. Problems of scoring. Norms: Their nature and interpretation: Age scores – percentiles, standard scores. The specificity of Norms.

UNIT- III Test Reliability (characteristics of tests)

Test-retest reliability – parallel forms reliability : split-half reliability Inter-rater reliability. Interpreting the reliability coefficient. Forms of reliability and forms of error. Validity. Face validity, content validity, predictive validity. Construct validity standardization to Zscores, Standardization to Tscores. Standardization to stanine scores. Standardization to IQ format scores. Normalization. Algebraic normalization Graphical normalization.

UNIT-IV : Item Analysis:

Item analysis statistics for knowledge based tools tests. Item facility, item discrimination, item analysis for person based tests. Item analysis in criterion referenced testing. Psychological traits, true scores, and internal test structure. Item analysis for more complex situations. The use of factor analysis. Latent trait models and item response theory. Item and the Rasch one parameter model.

UNIT- V : Factor Analysis:

The correlation coefficient, the correlation matrix. The application of factor analysis to test construction. Finding the starting values for estimates of item error. Identifying the number of factors. The Kaiser criterion for selecting the number of factors. The Cattell-Scree technique for identifying the number of factors. Factor rotation. Rotation on simple structure. Orthogonal rotation, Oblique rotation. Special uses of factor analysis in test construction.

**REFERENCES**

1. Modern Psychometrics - John Rust and Susan Golombok
2. Psychological Testing - Anne Anastasi
3. Theory and Practice of Psychological testing - Frank S. Freeman
4. An Easy guide to Factor Analysis - Paul Klines
5. The Handbook of Psychological testing - Paul Klines
6. Statistical Analysis in Psychology and Education - Ferguson.G.A.
7. Psychometrics Methods - Guilford.J.P
8. Statistics in Psychology and Education - Garreff H.E & Wood worth R.S

**PAPER –III**  
**BIOMETRIC TECHNIQUES AND THEIR APPLICATIONS**

**UNIT I:**

Introduction to Biostatistics-Example on statistical problems in Biomedical Research-Types of Biological data-Principles of Biostatistical design of medical studies

**UNIT II:**

Introduction to Bioassays-Structure of Bioassays-Types of Bioassays-Direct assays,Indirect assays-Parellal line assays,-Fiellers theorem-Regression approaches to estimating dose-response-Quantal response assays- Dragstedt-Behren's method-Spearman-karber method, Basics of Probit and logit analyses.

**UNIT III:**

Introduction to Survival analysis-Concept of life time distribution-Continuous models-Discrete models-Other distributions (exponential,Gamma,Weibull,Gompertz-makeham,compound exponential, lognormal distributions)-Hazard function-Censoring and statistical methods-Type of censoring-Type I censoring-Type II censoring-Random censoring.

**UNIT IV:**

HIV virus and its clinical effects-Measuring the Epidemic-Studies of AIDS patients-Statistical methods for partner studies-infectivity-Models for the infectivity-Random effects model for infectivity- Incubation period - Mathematical models for the incubation period distribution-Introduction to Back calculation-Deterministic deconvolution-Statistical deconvolution-Analysis in Discrete time.

**UNIT V:**

The Mathematical Biology and Human Infections- Antigenic variation and Diversity Threshold, Infectivity-Statistical Interpretation of Data from Partner Studies of Heterosexual HIV Transmission.

**References:**

Para in syllabus	Portions	References and study materials (Represented by numbers)
a.	UNIT I	(1),(2)
b.	UNIT II	(3),(4)
c.	UNIT III	(5),(6)
d.	UNIT IV	(7)
e.	UNIT V	(8),(9),(10)

## References in order :

1. Wayne W. Daniel(2006) : Biostatistics:A Foundation for Analysis in the Health sciences, John Wiley & sons.Inc
2. Lioyd D. Fisher , Gerald Van Belle(1993) : Biostatistics: A Methodology for the Health Science, John Wiley &sons.Inc
3. M.N.Das and N.C.Giri(1979):Design and Analysis of Experiments, Wiley Eastern Limited.
4. David J.Finney(1978):Statistical Methods in Biological Assay, Charles Griffin&Company Limited.
5. D.R.Cox and D.Oakes(1984): Analysis of Survival Data, Chapman &Hall.
6. Lawless,J.F(1982) Statistical Models and Methods for Life Time Data, John Wiley&sons inc.
7. Ron Brookmeyer,MitchELL H.Gail(1994) :AIDS Epidemiology:A Quantitative Approach,Oxford University Press ,Inc.
8. Nowak M.A and Robert M.May Mathematical Biology and Human Infections: Antigenic Variation and Diversity Threshold ,Mathematical Biosciences 106:1-21(1991)
- 9.Nowak M.A (1999). The Mathematical Biology of Human Infections. Conserve Ecol 3:12 (online version).
10. Stephen Shiboski(1996),Statistical Interpretation of Data from Partner Studies of Heterosexual HIV Transmission. Technical report #50, Department of Epidemiology and Biostatistics, University of California,San Francisco.

## PAPER - III

### ADVANCED STATISTICAL INFERENCE

#### UNIT I

Concepts of sufficiency, Completeness, Loss and Risk functions, Location Invariance, Scale Invariance, Equivariant Estimation.

#### UNIT II

LRT, SPRT, Testing of hypothesis for Multivariate cases: Hotelling  $T^2$  and Mahalanobis  $D^2$  test – Locally and asymptotically minimax tests – Sphericity Test–Behrens's-fisher testing problem.

#### UNIT III

Distribution free Inference: Binomial test – Wilcoxon signed rank test –Mann whitney U test- Rank sum test – Rank correlation test of Independence–Fisher-Irwin test–McNemer test – Kruskal-Wallis Test.

#### UNIT IV

Bayesian Inference: Notation of prior and posterior distribution-Inference for the Normal distribution – Normal prior and likelihood – several normal observations with a normal prior – Binomial distribution – Reference prior for the binomial likelihood – Jeffrey's rule – Poisson distribution – uniform distribution – Reference prior for the uniform distribution.

#### UNIT V

Robust Estimation-characteristics of Robustness – M-estimators – L-estimators – R-estimators – interrelationships of M-, L-, and R-estimators – Minimaximally Robust Estimators- Applications to linear and non-linear regression.

## **REFERENCES:**

<u>Syllabus</u>	<u>Reference Material</u>
Unit I	(1),(3),(7)
Unit II	(4),(5),(6),(8)
Unit III	(1),(2),(8)
Unit IV	(9),(10)
Unit V	(11) to (17)

## **REFERENCES RELATING TO NUMBERS:**

1. V.K.Rohatgi (1984): *Statistical Inference* , Dover publication , Inc
2. Jean D.Gibbons (1992): *Non parametric Statistics*. Sage publications.
3. Lehmann E.L. and George Casella (1998): *Theory of Point Estimation*, Springer, USA.
4. Narayan C.Giri (2004): *Multivariate statistical Analysis*, Marcel Dekker, Inc.Newyork.
5. T.W.Anderson (1958): *An introduction to multivariate statistical analysis*, John Willey and sons Inc.
6. Hair, Anderson, Tatham and black (1998): *Multivariate Data Analysis*, Pearson Education, Inc.
7. William C .Gunther (1973): *Concepts of statistical inference*, McGraw – Hill, Inc.
8. Lehmann, E.L (1959): *Testing Statistical Hypothesis*, John Wiley and Sons, Inc., Newyork.
9. Peter M.Lee (1997): *Bayesian Statistics*, John willey & sons, Inc.
10. Mood,A.M, Graybill,F.A and Boes,D.C (1974): *Introduction to the theory of Statistics*, McGraw Hill.
11. Sampathkumar,V.S (1989): Some aspects of general M-estimation theory for dependent random variables, *Statistics*,20(1989)1,pp. 95-107.
12. Douglas, S.C & Jih-cheng Chao (2007): Simple, Robust and memory efficient FastICA algorithms using the Huber M-estimator Cost function, *Journal of VLSI Signal Processing*, 48, pp 143-159.
13. Jeffrey M.Wooldridge (2001): Asymptotic properties of Weighted M-estimator for standard stratified samples, *Annals of Statistics*,24,2608-2630
14. Xumiug HE and UI-Man Shao (1996): A general Bahadur representation of M-estimators and its application to linear regression with nonstochastic design, *Econometric Theory*, 17,451-470.
15. Ying Yang (2004): Asymptotic of M-estimation in Non-linear regression, *Acta Mathematica Sinica*, English Series, Vol.20, No.4, pp. 749-760.
16. Pinar, M.C. Ankara (2004): Finite Computation of the  $l_1$  estimator from Huber's M-estimator in Linear Regression, *Computing* 72, pp. 365-384.
17. Jana Jureckova & Jan Picek (2005): *Robust Statistical methods with R*, CRC Press.

# PAPER - III

## STOCHASTIC PROCESSES AND THEIR APPLICATIONS

### UNIT – I

Classification of Stochastic processes, stationary processes, martingales, Markov chains, Markov processes with discrete discrete state space, Markov processes with continuous state space: Brownian motion, Wiener process, Ornstein –Uhlenbeck process.

### UNIT – II

Renewal process, Renewal equation , Wald's equation, Delayed and equilibrium processes, Residual and excess life times process, cumulative renewal process, Renewal theorems : Blackwell's theorem, Smith's theorem, equilibrium renewal process

### UNIT – III

Branching processes, properties of generating functions of Branching processes, Probability of Extinction, Galton–Watson process, yaglom's theorem, Generalisations of the Galton-Watson process.

### UNIT – IV

Concept of Queueing Theory, steady state behaviour and transient behaviour of the model  $M / M / 1$ , Pure Birth process, Birth and Death processes, Non-Birth and Death Queueing processes, Net work of Markovian Queueing system, Non-Markovian models :  $G1 / M / 1$  and  $M / G (a, b) / 1$ .

### UNIT – V

Diffusion process, Diffusion equations for the Wiener process, first passage time, Boundary conditions for homogeneous diffusion process, Jump process, Ruin probability, Levy process

## REFERENCES

S.No	PORTIONS	Reference material (Represented by Numbers)
1.	Concept of Stochastic process	(1) , (2) ,(3)
2.	stationary processes, martingales, Markov chains	(2), (4)
3.	Markov processes with discrete discrete state space	(4), (5)
4.	Brownian motion, Wiener process, Ornstein –Uhlenbeck process	(1), (2),(8)
5.	Renewal process, Renewal equation	(3), (5)
6.	Blackwell's theorem, Smith's theorem, equilibrium renewal process	(3) ,(9)
7.	Branching processes, properties of generating functions	(3), (6)
8.	Galton–Watson process, yaglom's theorem	(3), (6),(7)
9.	Concept of Queueing Theory, steady state behaviour	(10), (11)
10.	$M / M / 1$ Model, Pure Birth process, Birth and Death processes, Non-Birth and Death Queueing processes	(3), (11)

11. Net work of Markovian Queueing system, Non-Markovian models (3), (10), (11)
12. Diffusion process, Diffusion equations for the Wiener process (1), (2)
13. Boundary conditions for homogeneous diffusion process (2),(13),(15)
14. Ruin Theory (1), (13),(14)
15. Jump process, Levy process (2), (13),(14),(15)

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## **PAPER - III**

### **RELIABILITY THEORY AND SURVIVAL ANALYSIS**

#### **Unit I**

Basic concepts in Reliability: Hazard-rate, Mean Residual Life and Mean time to failure and their inter-relationships. Exponential distribution, memory less property. Maximum likelihood estimation and uniformly minimum variance unbiased estimation for the parameter and reliability function.

#### **Unit II**

Gamma and Weibull distributions, Estimation of parameters and reliability function with complete and censored samples. Tests of hypotheses and confidence intervals for the reliability function of exponential, gamma and Weibull distributions.

#### **Unit III**

Bayes estimation for the parameters and reliability function (under different losses) of exponential, gamma and Weibull distributions. Bayesian credible intervals for the parameters and reliability function for exponential, gamma and Weibull distributions.

#### **Unit IV**

Introduction to Survival Analysis, survival distributions and their applications viz. exponential, gamma, weibull, Death density function for a distribution having Bath-Tub shape hazard function.

#### **Unit V**

Tests of goodness of fit for survival distributions, parametric methods for comparing two survival distributions viz. L.R test, Cox's F-test, Non-parametric methods for estimating survival function and variance of the estimator using Kaplan –Meier method.

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