M.Sc. (Final)
Paper- VIII
Multivariate Analysis and Statistical Inference
SECTION-A
(Unit-I)
Multivariate Normal distribution, marginal and conditional distributions joint distribution of linear function of correlated normal variates. Characteristic function of multivariate normal distribution. Maximum likelihood estimator of the mean vector and dispersion matrix and their independence.

(Unit-II)
(24L+12T)

Classification and discrimation procedure for discrimination between two multivariate normal population, sample discriminate function test associated with discriminate functions probabilities of misclassification and their estimation Null distribution of Hostelling T^2 and its applications Wishart matrix-its distribution (without proof)and it properties. Null distribution (without proof) of partial Correlation. multiple correlations and sample regression coefficient ant its applications.

Section-B
(24L+12T)
(Unit-I)
Proof of the properties of M.L.E . Pitman Family of distributions and their M.L.E properties. Huzur Bazaar theorem. Consistent Asymptotic Normal (CAN) estimator, Invariance of CAN estimator. Likelihood ratio tests. Asymptotic Distribution of Likehood Ratio Statistic, Similar Regions

(Unit-II)
(24L+12T)

Generalized Neyman Pearson lemma. Elements of statistical decision function: Formulation of the problem. Loss function. Risk functions. Convex sets convex function, hyper plane convex null convex polyhedral and its relevant theorem. Concepts of admissibility of Baye's rules and minimax sequential decision rule. Bartlett's Test for homogeneity of variances.

References:

1. Anderson. T.W. An Introduction to Multivariate Statistical Analysis. 2nd ed. Wiley
2. Cramer H: Mathematical Methods of Statistics.
3. Ferguson. F.S. Mathematical Statistics, Academic Press
4. Gibbons. Non-Parametric Statistical Inference.
5. Hogg and Craig: Introduction to Mathematical Statistics.
6. Kendall. M.G. and Stuart. A : Advanced Theory of Statistic Vol. I and II.
7. Mood. Graybill and Bose: Introduction to the Theory of Statistics 3rd ed.
8. Rao. C.R : Linear Statistical Inference and its Applications 2nd ed. Wiley.
9. Rohatgi. V.K.: An Introduction to Probability theory and Mathematical Statistics. Wiley Eastern.
10. Srivastava. M.S. and Khatri. C.G: An Introduction to Multivariate Statistics. North Holland
11. Wald. A. Sequential Analysis.
12. Zacks. S. Theory of Statistical Inference. John Wiley.

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Paper-IX

Advanced Sample Survey & Design of Experiments

Section-A

(Unit-I)

Unequal probability sampling: Probability Proportional to size with and without replacement method (PPSWR/PPSWOR) (including Lahri's scheme), related estimators of finite population mean.(Hansen-Horvitz and Desraj's estimators for general sample size & Murthy's estimator for a sample of size of 2). Horvitz. Thompson estimator (HTE) of a finite population total/mean and expression for V(HTE) and its unbiased estimator. Sure on non-negative variance estimation. I.P.P.S Schemes of sampling due to Midzuno-Sen. Brewer. Durbin and JNK Rao (Sample size of 2 only) Rao-Hartley Cochran sampling scheme and their estimation procedure. Theory of multi-stage sampling with varying probabilities with or without replacement. Introduction to super population models.

(24L+12T)

(Unit-II)

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

(24L+12T)

Section-B

(Unit-I)

Linear estimation, Gauss Markoffs theorem. Testing of hypothesis involving several linear functions. test of sub-hypothesis and test involving equality of the parameters. Introduction to one way random model and estimation of variance components. General theory of analysis of experimental designs. Designs for two-way elimination heterogeneity. Desirable properties of a good design: Orthogonality. Connectedness and Balance. Various Optimality criteria and their interpretations. Relation between blocks of incomplete block designs. duality. resolvability and affine resolvability. Theorems on bounds. **(24L+12T)**

(Unit-II)

Group divisible, lattice and linked block designs- intrablock analysis, Latin square and Youden square designs. Combination of result in groups of experiments. Construction of orthogonal Latin square- (i) for prime power numbers and (ii) by Mann-Mecneish theorem, simple methods of construction of BIB designs. Constructions of symmetrical fractional factorial designs.

(24L+12T)

References:

1. Atkinson. A.C. and Donev.A.N: Optimal Experimental Design.
2. Raghava Rao: Construction and Combinatorial Problems in Design of Experiments.
3. Searle. S.R. Casella.G. And McCulloch.C.E: Varicance Components. John Wiley. New York.
4. Rao. C.R.and Kleffe. J: Estimation of Variance Components and Applications.
5. Chaudhary. A and J.W.E.Vos (1988). Unified Theory and Strategies of Survey Sampling. North Holland Amserdam
6. Hedayat. A.S. and Sinha. B.K. Design and Inference, infinite Population sampling. Wiley.
7. Chaudhary. A and R. Mukherjee: randomized Response. Theory and Techiniques. New York. Marcel Dekker

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Paper X
Statistical Quality Control & Operation Research
Section-A
(Unit-I)

Meaning of specification limits, item quality. Process and product control, objective of SQC, control charts for measurable quality characteristic. Chance variation and assignable variation of process. Distribution of chance variable. Need for detection of assignable causes of variation. Determination of control limits and central line in various situations. Mean ($\bar{x}$) and R control charts. Control charts for defection p, np, c charts. Meaning of Statistical Control and its relation with specification limits. Modified control limits warning limits and tolerance limits. Methods of estimation of rational sub-grouping and successive estimate. Advantages of SQC. Comparison of Mean ($\bar{x}$) and R charts with p-chart for common use.

(24L+12T)

(Unit-II)

Acceptance Sampling by Attribute: Need for sampling inspection, methods for acceptance. Lot Quality and lot by lot acceptance. AQL, AOQL, Producer's risk and Consumer Risk. Rectification, O.C. function, ASN and average total inspection. of an acceptance procedure. Single and double sampling plans and their mathematical analysis. Idea of Standard sampling tables: Dodge and Roming Table and MIL Std. 105A. Sampling inspection plans for production process where lots cannot be formed. Sampling Inspection Plans for Variables-One sided specification standard (Known and Unknown Cases) Two Sided specifications (for known standards). Use of Design of Experiments in Statistical Process Control, Fractional Experiments. Fractional factorial Experiments. Multivariate Quality Control. Control of means and control of process variability.

(24L+12T)

Section-B
(Unit-I)

Definition and scope of Operation Research: Phases, Principles of Operation Research. Models and their Solutions. Monte carlo Simulation Technique & its Applications. Review of Linear Programming Problems. Revised Simplex Method. Dual Simplex Method. Transport Problems and Assignment Problem: Sequencing & Scheduling Problem: 2 machine n-jobs and 3-machines n-jobs problems with indentical machine sequence for all jobs, 2 jobs n-machine problem with different routings. Theory of Games: Pure & Mixed strategies. Minimax (Maximin) criterion. Solution of Games with Saddle Point. Rectangular Games Theorem. m x n games and linear programming 2x2 games without saddle point. Graphical Solution of 2x n and m x 2 games.

(24L+12T)

(Unit-II)

Inventory Control System: Inventory Models, Costs, Advantages, EOQ Models without shortages, Reorder level and Optimum Buffer Stock, EOQ Models with shortages. Multi-item Inventory Models with quantity Discount. Probabilistic Models, Queueing System: Characteristics of Queueing System, Steady State Solution of (M/M/1) and(M/M/C) models. (M/G/1) model Pollaczek-Khintchine Formula, Steady State solution of ($M/E_k/1$) models. Mixed Queueing Model (M/D/1), (M/D/1) (∞/FCFS).

(24L+12T)

References:

1. Taha H.A. Operation Research, McMillan Publishing Co. Inc 6th Edition, 1999)
2. Kantiswaroop et al: Operation research, Sultan chand & Sons.
3. Gross D. & Harris C.M. Fundamentals of Queueing Theory, John Wiley & Sons
4. Sharma S.D. Operation Research, Kedar Nath Pub. Meerut
5. Bronson R. et al: Schamum's outlines Operation Research, Tata McGraw Hill Edition

Additional References:

1. Kleinrock L. Queueing System, Vol.I Theory, John Wiley
2. [illegible] introduction to the theory of games, McGraw Hill

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Paper-XI
Practicals based on Paper IX

Paper XII
Practicals based on Paper VIII & Paper X

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Optional Papers

Paper-XIII

Economic Statistics & Demography

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

Unit-II

(24L+12T)

Meaning and basis of demand. Demand equation, demand curve, relation between demand curve and demand function. Estimation of demand function by leontif's method. Static law of demand and supply. Price elasticity, income elasticity and cross elasticity of demand. Concept of indifference curve, Budget line. Parato's law of ioncome distributions. Engles curve, curves of concentration. Concept of national income and methods of estimating national income intersectoral flows, inter industry table.

Section-B

(Unit-I)

Demography: Census and Vital statistical data. Vital rates and ratio, standardization of rates trends and differentials in mortality and fertility. Stationary and stable populations. Population estimation and projection. The life table: its construction and properties. Makeham's and Gompertz curves. National life tables. UN model life tables, Abridged life tables, (Greville's formula for construction, reed and Merrell's formula. King's method) T.F.R., G.R.R., N.R.R.

(Unit-II)

(24L+12T)

Demographic trends in India. Labour force analysis, Birth & Death stochastic process. Stochastic population models. logistics model. bivariate growth models. migration models. fertility analysis model, mortality analysis models. Decennial population census in India.

(24L+12T)

REFERENCES:

1. Anderson, W (1971): The Statistical Analysis of Time series. Wiley, New York.
2. Barclay Techniques of Population Analysis
3. Brockwell, P.J. and Davis, R.A.: Time series-An Indroduction (2 Edn) Springer-Verlag
4. Chatfield, C (1980): The Analysis of Time Series-An Introduction. (2 Edn) Chapman and Hall
5. Chenery, H.B. Inner Industrial Economics
6. Cox, P.R (1970): Demography, Cambridge University Press
7. Croxton, Cowden and Klein(1971) Applied General Statistics, PHI
8. G Ganguly and others: Studies in Consumer's Behaviour.
9. Goon, A.M., Gupta, M.K and Dasgupta, B(1986): Fundamentals of Statistics, Vol.2 World Press Calcutta.
10. Kamitakar & Bhende: Principles of Population Studies.
11. Kendall, M.G. and & Stuart, A.(1996): The Advanced Theory of Statistics, Vol.3 charles Griffin, London
12. Srivastava, O.S.(1983): A text book of Demography Vikas Publishing House, N. Delhi.

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Paper XIV
STOCHASTIC PROCESSES
Section-A
(Unit-I)

Introduction of Stochastic Processes: Definition. Classification of Stochastic Processes according to state space and time domain. Markov Process and Markov chain. Stationary Processes and its types. Laplace Transformations of Probability Distribution. Difference Equations in Probability Theory. Differential Difference Equations

(Unit-II)

Markov Chains: Discrete Time Markov Chain, Order of Markov Chain, Chapman-Kolmogorov Equations. Determination of Higher order Transition Probability and its limit. Classification of States and Chains. Limit Theorems for Markov Chain, Stationary Distribution, Random Walk-Gambler's Ruin's Problem. Applications of Discrete Time Markov Chains. Time-Reversal Markov Chains. Markov Chains with Continuous State Space.

(24L+12T)

Section-B
(Unit-I)

Markov Process: Poisson Process and its generalization, Yule-Furry process, Birth-Death Process Definition. Markov Process with Discrete State Space-Kolmogrov Differential Equation, Erlangian Process. Markov Process with Continuous State Space-Wiener Process. Kolmogorov Diffusion Equations. Renewal Theory-Renewal Processes, Renewal Function and its properties, Elementary renewal theorem and applications. Delayed Renewal Process. Renewal Reward Process. Regenerative Stochastic Process and its Limits.

(24L+12T)

(Unit-II)

Stationary Process and Time Series- Weakly Stationary and Strongly Stationary Processes, Moving average and Auto-Regressive Processes. Stationary Processes of different Time series models. Branching Processes: Galeton-watson's Branching Process, Properties of Generation Function of BP's, Probability of ultimate extinction. Distribution of population size. Idea of Martingles.

(24L+12T)

References:

1. Adke, S.R. & Manjunath S.M.(1984): An introduction of Finite Markov Processer: Wiley Eastern
2. Bhatt, B.R.(2000): Stochastic Models: Analysis and Applications : New Age International, India
3. Harris, T.E. (1963): The Theory of Branching processes: Springer-Verlag.
4. Mdhi,J.(1982): Statistical Inference for Markov Chains. Chicago University Press, Chicago.
5. Ross, S.M (1983): Stochastic Processes Wiley.

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Paper XV
Reliability & Survival Analysis
Section-A
(Unit-I)

Reliability concepts and measures: components and systems: coherent systems: reliability of coherent systems: cuts and paths, modular decomposition, bounds on system reliability, structural and reliability importance of components. Life distributions, reliability function, hazard rate, common life distributions-exponential, Weibull, gammaetc. Estimation of parameters and test in these models (24L+12T)

(Unit-II)

Notions of ageing: IFR, IFRA, NBU, DMRL and NBUEClasses and their duals, loss of memory property of the exponential distribution, closures or these classes under formation of coherent systems, convolutions and mixtures, Reliability estimation based on failure times in variously censored life tests and in tests with replacement of failed items, Maintenance and replacement policies, availability of repairable systems, modeling of a repairable system by a nonhomogeneous Poisson process, Basic ideas of accelerated life testing (24L+12T)

Section-B
(Unit-I)

Concepts of time. Order and random censoring, likelihood in these case, Life distribution Exponential, Gamma, Weibull Lognormal, Pareto, Linear Failure rate. Parametric inference(Point estimation, Confidence intervals Scores, LR, MLE tests(Rao-Willks-Wald) for these distribution) Life tables failure rate, mean residual life and their elementary properties. Ageing classes and their properties, Bathtub failure rate.

(Unit-II) (24L+12T)

Estimation of survival function-Acturial Estimator, Kaplan Meier estimator, estimation under the assumption of IFR/DFR. Tests of Exponentiality against non-Parametric classes. Total time on test Deshpande test. Two sample problem-Gehan test, log rank test Mantel-Haenszel test Tarone-Ware tests. Rank test for the regression coefficients. Competing resks model, parametric and Non-Parametric inference for this model. Multiple decrement life table. (24L+12T)

References:

1. Barlow R.E. and Proschan/F.(1985): Statistical Theory of Reliability and Life Testing. Holt, Renehart and Winston.
2. Lawless J.F.(1982). Statistical Models and Methods of Life Time Data: John Wiley
3. Bain L.J. and Engelhrdt(1991) Statistical Analysis of reliability and Life Testing Models. Marcel Dekker
4. Nelson W.(1982): Applied Life data analysis. John Wiley
5. Cox. D.R. and Oakes. D(1984). Analysis of Survival Data. Chapman and Hall. New York
6. Miller, R.G.(1981): Survival Analysis. John Wiley
7. Kalbflesisch, J.D. & Prentice. R.L(1980) the Statistical Analysis of Failure Time Data. John Wiley.

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PaperXVI

Advance Multivariate Analysis and Bayesian Inference

Section-A

(Unit-I)

Principal components, dimension reduction, canonical variables and canonical correlation definition, use, estimation and computation, multivariate linear regression model-estimation of parameters, te4sts of linear hypotheses about regression co-efficient. Likelihood Ratio test criterion. Multivariate analysis of variance (MANOVA) one and two way classified data

(Unit-II)

(24L+12T)

Wishart matrix & its distribution. Distribution of sample generalized variance Non-Null distribution of partial and multiple correlation coefficient distribution of sample regression coefficient. Distribution of sample intra-class correlation coefficient in a random sample from a symmetric multivariate normal distribution. Application in testing and interval estimation.

(24L+12T)

Section - B

(Unit-I)

Subjective interpretation of probability in terms of fair odds. Evaluation of (i) subjective probability of an event using a subjectively unbiased com(ii) subjective prior distribution of a parameter. Bayes theorem and computation of the posterior distribution. Bayesian point estimation as prediction problem from posterior distribution. Bayes estimators for(i) absolute error less(ii) sqsuared error less(iii) 0-1 less. Generalization of a common loss functions. Evaluation of the estimate in terms of posterior risk. Bayesian interval estimation Exedible interval. Highest posterior density regions interpretation of the confidence co-efficient for a classical confidence interval.

(Unit-II)

(24L6+12T)

Bayesian testing of hypothesis Specification of the appropriate form of the prior distribution for a Bayesian tastin of hypothesis problem. Prior odds. posterior odds. Bayes factor for various types of testing hypothesis problems depending upon wheather the null hypothesis and the alternavtive hypothesis are simple or composite. Specification of the Bayes tests in the above cases. Discussion of lindley's paradox for testing a point hypothesis for normal mean against the two sided alternative hypothesis Bayesian predication problem.

Refferances:

1. Anderson. T.W.. An Introduction to Multivariate Statistical Analysis. 2nd ed. Wiley.
2. Ferguson. T.S.: Mathematical Statistics. Academic Press
3. Kendall. M.G. and Stuart. A : Advanced Theory of Statistic. Vol. I and II.
4. Morrison D.F (1976). Multivariate Statistical Methods. Mc Graw Hill
5. Kshirsagar. A.M(1972): Multivariate Analysis. Marcel Dekker.
6. Berger. J.O: Statistical Decision Theory and Bayesian a:nalysis, Springer Verlag.
7. Leonard, T. and Hsu. J S.J: Bayesian Methods. Cambridge University Press.

Additional references:

1. Rao, C.R.: Linear Statistical Inference and its Applications. 2nd ed. Wiley
2. Srivastava. M.S. and Khatri. C.G.: An Introduction to Multivariate Statistics. North Holland
3. Bernando. J.M. & Smith A.F.M : Bayesian Theory. John Wiley and Sons.
4. Box. G.P and Tiao. G.C Bayesian Inference in Statistical Analysis. Addison Wisley

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Paper-XVII
Econometrics & Investment System
Section-A
(Unit-I)

Nature of Econometrics. The general linear model (GLM) and its extensions. Ordinary least squares (OLS) estimation and prediction. 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. Auto correlation, its confequences and tests. Theil BLUS procedure. Estimation and prediction. Multicollinearity problem. Its implications and tools for handling the problem. Ridge regression.

(24L+12T)

(Unit-II)

Linear regression with stochastic regressor. Instrumental variable estimation. Errors in variables. Autoregressive linear regression. Distributed lag models. Use of principal components. Ccanonical correlations and discriminant analyses in econometrics. Simultaneous. Linear equations model. Examples. Identification problem. Restrictions on structural parameters-rank and order conditions. Restrictions on variances and conariances. 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 Carlc studies and simulation.

(24L+12T)

Section-B
(Unit-I)

Main theme: Risk-Return Trade off. Money market. Fixed income, Equity, stocks and bonds Treasury notes. Market indexes. Rates of interest. compound interest. inflation. Risk in a portifolio context. law of one oprice and arbitrage. Risk and risk aversion. Mean variance analysis. allocation between riskd and risk free portfolios. Diversification and Portfolios risk Markovitz portfolio selection. optimal portfolios.

(24L+12T)

(Unit-II)

Capital assest. pricing model. passive strategy. risk premium, index models and diversification. CAPM and index model. Options markets. American and European options, call and put options, open strategies, option like instruments. option valuation, Binomial option pricing. Black-Scholes option valuation, uses of Black-Scholes formula. Futures markets. Mechanics and strategies. Futures prices. expected spot prices

(24L+12T)

REFERENCES:

1. Apte PG (1990): Test book of Economics 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, PHI
5. Johnston. J. (1984): Econometric Methods. Third ed, McGraw hill
6. Klein. L R (1962): An introduction to econometrics. Prentice Hall of India
7. Bodie. Z. Kane. A and Marcus. A.J (1996): Investment 4th Edition. Irvin Chapters: 1,2,4-10,20-22

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1. Theil. H (1982) Introduction to the theory and Practice of Econometrics, John wiley
2. Walters. A (1970) An introduction to Econometrics. McMillan & co.
3. Wetherill. B.B (1986) regression Analysis with Applications, Chapman Hall

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Paper-XVIII
Project work

Important:

1. The project work shall be based on either primary data involving field work or secondary data The candidate will be required to prepare comprehensive and critical reports on the same
2. The teacher supervising the Project work Dissertation of a candidate shall be provided on hour per week towards his her supervision.
3. In all the theory opapers M.A /M.Sc.(Previous & final) Statistics Except paper XVIII the candidate will be required to answer five questions in all taking at least on question form each section.

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