UNIVERSITY OF RAJASTHAN
JAIPUR

SYLLABUS

M.A./M.Sc. STATISTICS

(ANNUAL SCHEME)

M.A./M.Sc. (Previous) Examination 2020

M.A./M.Sc. (Final) Examination 2021

Raj Vas
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University of Rajasthan
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SCHEME OF EXAMINATION
(Annual Scheme)

Each Theory Paper — 3 Hrs. duration — 100 Marks

Dissertation Thesis Survey Report Field Work, if any — 100 Marks

1. The number of papers and the maximum marks for each paper practical shall be shown in the syllabus for the subject concerned. It will be necessary for a candidate to pass in the theory part as well as in practical part wherever prescribed of a subject paper separately.
2. A candidate for a pass at each of the Previous and the Final Examination shall be required to obtain (i) at least 36% marks in the aggregate of all the papers prescribed for the examination, and (ii) at least 36% marks in practical(s) wherever prescribed at the examination, provided that if a candidate fails to secure at ~~least 25% marks in each individual paper at the examination and also in the dissertation survey~~ report fieldwork. Wherever prescribed, he shall be deemed to have failed at the examination not with standing his having obtained the minimum percentage of marks required in the aggregate for the examination. No division will be awarded at the Previous Examination. Division shall be awarded at the end of the Final Examination on the combined marks obtained at the previous and the Final Examination together, as noted below:

First Division	60%	of the aggregate marks taken
Second Division	48%	together of the Previous and the Final Examination

All the rest will be declared to have passed the examination.

3. If a candidate clears any Paper(s)Practical(s)/Dissertation prescribed at the previous and/or Final Examination after a continuous period of three years, then for the purpose of working out his division the minimum pass marks only viz.25%(36%in the case of practical)shall be taken into account in respect of such paper(s) Practical(s).Dissertation are cleared after the expiry of the aforesaid period of three years: provided that in case where a candidate required more than 25% marks in order to reach the minimum aggregate as maximum marks out of those actually secured by him will be taken into account as would enable him to make up the deficiency in the requisite minimum aggregate
4. The Thesis Dissertation Survey Report Field Work shall be typewritten and submitted in triplicate so as to reach the office of the Registrar at least 3 weeks before the commencement of the theory examinations Only such candidates shall be permitted to offer Dissertation/ Field Work Survey Report Thesis (if provided in the scheme of examination) in lieu of a paper as have secured at least 55% marks in the aggregate of all the papers prescribed for the previous examination in the case of annual scheme irrespective of the number of papers in which a candidate actually appeared at examination.

M.A. /M.Sc. STATISTICS
Previous

Paper Number	Nomenclature	Max. Marks	Duration of Exam
Paper I	Mathematical Analysis	100	3 Hours
Paper II	Probability and Measure Theory	100	3 Hours
Paper III	Distribution Theory	100	3 Hours
Paper IV	Sample Surveys & Design of Experiment	100	3 Hours
Paper V	Statistical Inference	100	3 Hours
Paper VI (a)	Computer Programming (Theory)	50	3 Hours
Paper VI (b)	Practical based of paper III and VI (a)	50	4 Hours
Paper VII	Practical based of Paper IV and V	100	4 Hours
	Total	700	

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M.A. /M.Sc. STATISTICS
Final

Compulsory Papers

Paper VIII	Multivariate Analysis and Statistical Inference	100	3 Hours
Paper IX	Advanced Design of experiments and Sample Theory	100	3 Hours
Paper X	S.Q.C. and O.R	100	3 Hours
Paper XI	Practical based on Paper IX	100	4 Hours
Paper XII	Paper VIII & X	100	4 Hours

OPTIONAL PAPERS

Any two papers of the following with the permission of the institution concerned

Paper XIII	Economic Statistics and Demography	Marks 100	3 Hours
Paper XIV	Stochastic Process	100	3 Hours
Paper XV	Reliability and Survival Analysis	100	3 Hours
Paper XVI	Advance Multivariate Analysis and Bayesian Inference	100	3 Hours
Paper XVII	Econometrics & Investment System	100	3 Hours
Paper XVIII	Project Work	100	4 Hours per week

Notes: (1) The project work shall be based on either primary data involving field work or secondary data. The candidates will be required to prepare comprehensive and Critical reports on the same.

(2) The teacher supervising the Projects work/Dissertation of a candidate shall be provided one hour per week towards his/her supervision.

(3) In all theory papers of M.A. /M.Sc. (Previous and Final)Statistics except PaperXIV the candidates will be required to answer five question in all taking at least two questions from each section.

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Syllabus
M.Sc. (Previous)
PAPER I
(MATHEMATICAL ANALYSIS)
SECTION-A
(Unit-I)

Real Analysis: Real Valued Function, Continuous Function, Uniform Continuity, Sequences of Functions, Uniform Convergence

Differentiation, maxima-minima of function, functions of several variables, constrained maxima-minima of functions, Multiple integrals and their evaluation by repeated integration, change of variables in multiple integration, differentiation under the sign of integral-Leibnitz rule, Beta & Gamma integrals.

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

Linear Algebra: Inverse and rank of a matrix, Linear equations, Orthogonal matrix, Orthogonal reduction of a real symmetric matrix to a diagonal form, Hermite canonical form, generalized inverse and its simple properties, Idempotent matrices, Solutions of matrix equations, Kronecker Product.

SECTION-B
(Unit-I)

Bilinear and quadratic forms, reduction to canonical forms, definite and indefinite forms, index and signature, triangular reduction of a positive definite matrix, Characteristic equation, its roots and vectors, Cayley-Hamilton theorem.

(24L+12T)

(Unit-II)

Numerical Analysis: Interpolation formulae (with remainder terms) due to Lagrange's, Newton-Gregory, Newton divided difference, Gauss and Stirling formulae, Inverse interpolation, Numerical differentiation end integration. Trapezoidal, Simpson's 1/3rd and 3/8 rules, Waddle's rules, EulerMaclaurin's Summation Formula. Difference equations of the first order (homogeneous linear difference), homogeneous linear difference equation with constant coefficients.

(24L+12T)

References:

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

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Paper II
Probability and Measure theory
SECTION-A
(Unit-I)

General probability space, various definitions of probability, axiomatic definition of probability, combinations of events, laws of total and compound probability, Conditional probability, Baye's theorem and its applications, Concept of random variables, cumulative distribution function and probability density function, joint, marginal and conditional distribution.

(24L+12T)

(Unit-II)

Mathematical Expectation, moments, conditional expectation, moment generating functions, cumulative generating functions and their applications, Characteristic function, uniqueness theorem, Levy's continuity theorem statement only)Probability inequalities: Chebyshev, Markov and Johnson, Convergence in probability and in distribution, weak law of large numbers and central limit theorem for a sequence of independent random variable under Landenberg's condition central limit theorem for identical independent and identically distributed, random variables: Zero one laws of Borel and Kolmogorov, almost sure convergence in mean square, Kintchin's weak law of large numbers: Kolmogorov inequality, strong law of large numbers.

(24L+12T)

SECTION-B
(Unit-I)

Classes of sets: semi ring, ring, field, sigma field, monotone classes Sequence of sets, limit supremum and limit infimum of a sequence of sets. Additive set functions, measure, outer measure and their properties Cartheodry extension theorem (Statement only) definition of complete measure. Lebsegue and Lebsegue Stieltjes measure (one dimension only). POrobability measure, distribution function and its correspondence with lebsegue Stiltjes.

(24L+12T)

(Unit-II)

Measurable sets and space, measurable space. Simple, elementary and measurable functions. Sequence of measurable functions. Integrability of measurable function, properties of integrals Lebsegue monotone convergence theorems, Fatuous lemma, dominant convergence theorem, Absolute continuity, Random Nikodym theorem, product measure, fubinies theorem.

(24L+12T)

Reference:

1. Kingman J.F. & Taylor. SJ. : Introduction to Measure an Probability.
2. Loeve : Probability Theory.
3. Bhatt. B.R. Probability
4. Feller. W. Introduction to Probability Theory and its Applications Vol. I and II
5. Rohatgi. V.K An Introduction to Probability theory Mathematical Statistics. Wiley Eastern.
6. Billingsley. P Probability and measure Wiley
7. Dudley. R.M real Analysis and Probability

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Paper III
Distribution Theory
SECTION A
(Unit-I)

[illegible] variables and their distributions using Jacobian of transformation Bernoulli, Binomial(compound and truncated also), Negative Binomial distributions.

(24L+12T)

(Unit-II)

Geometric, Hyper-geometric and Multinomial distributions. Rectangular, Normal (truncated also), Exponential, Cauchy (truncated also), Lognormal and Triangular distributions.

(24L+12T)

SECTION B
(Unit-I)

Sampling distributions-Chi-square, t and F distributions (Central and non-central) & their applications. Bivariate normal (including marginal & conditional distribution), Beta and Gamma distributions.

(24L+12T)

(Unit-II)

Linear regression and correlation; intra-class correlation & correlation ratio; null & non-null distributions of sample correlation coefficient, standard errors of functions of moments. Order statistics their distributions and properties; joint & marginal distributions of order statistics; Sampling Distributions of range & median

(24L+12T)

References:

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

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Paper-IV

Sample Surveys & Design of Experiment

SECTION-A

(UNIT-I)

Planning, Execution and analysis of large, small sample surveys with illustrative examples. Non sampling errors and biased reponses, randomized responses for variables, errors in survey, modeling observational errors, estimation of variance components, application to longitudinal studies (repetitive surveys). Basic finite population sampling techniques: SRSWOR, Stratified sampling schemes, Allocation problem in stratified sampling. (24L+12T)

(Unit-II)

Systematic sampling schemes and related results on estimator of mean/total. Cluster sampling, double sampling, two-stage sampling with equal and unequal number of second stage units. Ratio, Product and regression method estimation: Estimators based on SRSWOR method of sampling (24L+12T)

SETCTION-B

(Unit-I)

Analysis of Experimental model by least square, Cochran's Theorem and Regression Analysis (Case of Full rank). Analysis of variance and covariance Transformations. Principles of Experimentation, Uniformity Trails, Randomized experiments, Randomized Blocks, Latin Squares, Balanced Incomplete Block Design(Intra-Block Analysis), Missing Plot Technique (24L+12T)

(Unit-II)

Factorial Experiment 2^n and 3^2, total and partial confounding, split-plot designs, Construction of confounded factorial experiments belonging to 2^n series (24L+12T)

References:

1. Cochran W.G. (1984): Sampling-Techniques (3rd Ed.)Wiley
2. Desraj & Chandak (1998): Sampling Theory, Narosa Publishing House.
3. Murthy M.N. (1977): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
4. Sampath S. (2000) Sampling theory and Methods, Narosa Publishing House.
5. Singh, D. and Chaudhary, F.S (1986). Theory and Analysis of Sample Survey Designs. New Age International Publishers.
6. Sukhatme B.V. (1984): Sample Survey methods and its Applications Indian Society of Agricultural Statistics.
7. Fedrer, W.T. (1975): Experimental Desogn-Theory and Application, Oxford & IBH.
8. Das, M.N.& Giri, N.C. (1979): Design and Analysis of Experiments, Wiley Eastern.
9. Goon, Gupta & Das Gupta (1991): Fundamentals of Statistics Vol. II, world Press, Kolkata
10. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. & Ashok, C: Sampling Theory and Surveys ith Applications

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Paper-V

Statistical Inference

SECTION-A

(Unit-I)

Point estimation, Criteria of good estimator, unbiased estimators uniformly minimum variance unbiased estimator (UMVUE), Cramer Rao Inequality. Consistent estimator, Suffecient estimator, Fisher Neyman factorization theorem, Non uniqueness theorem, Exponential theorem (without proof) Davi's theorems (without proof), Rao- Blackwell efficient estimator. Completeness and Lehmann- Scheffe theorem minimal sufficient statistic, maximum likelihood estimator and its properties (without proof) and the method of estimation (moments, minimum Chi-square and modified minimum Chi-square). (24L+12T)

(Unit-II)

Confidence intervals, Determination of confidence intervals based on large samples, confidence interval based on small samples. Hypothesis- simple and composite, Critical region, error of Ist and IInd kind, power of test, most powerful test, Neyman-Pearson lemma. Derivations of some Common tests of a simple hypothesis against a simple alternative, uniformly most powerful test. (24L+12T)

(SECTION B)

(Unit-I)

Likelihood ratio-method of test construction. Asymptotic distribution of the logarithm of LRT statistic. Definition of S.P.R.T. Fundamental relation among α, β, A and B.Determination of A and B in practice Wald's fundamental identity and the derivation of O.C. and A.S.N. functions (24L12T)

(Unit-II)

Non-Parametric tests. Sign Tests, Singed rank test, Kolmogorov- Smirnov one sample test, General two sample Problem. Wallowitz runs test, Kolmogorov Smirnov two sample test for sample of equal size, Median test, Wilcoxon-Mann-Whitney test. Test of randomness based on runs test based on the total number of runs, test based on the length of longest run. (24L+12T)

Reference:

1. Cramer, H.: Mathematical methods of Statistics.
2. Goon and others. Outline of Statistical theory, Vol.I.
3. Gibbons: Non-Parametric Statistical Inference.
4. Kendall, M.G. and Stuart, A.: Advanced Theory of Statistic Vol.I and II.
5. Mood, Graybill and Boes: Introduction to the theory of Statistics 3rded.
6. Rohtagi, V.K. Introduction to Probability theory and mathematical statistics.
7. Hogg and Craig Introduction to Mathematical Statistics.
8. Wald, A.: Sequential Analysis.

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Paper VI (a)
Computer Programming (Theory)

SECTION-A

Programming Fundamentals: Computer based Problem solving techniques. Flow charts and Algorithm. Structured Programming Techniques. Statistical Computations using MS-Excel.

Programming through C-Language: Introduction, Structure & Execution of a C Program. Character Set. Keywords. Constants & Variables. Data Types. Types of Operators & Precedence. Input & Output Statements. Assignment Expression. Decision making structure. Looping Structures and Branching Structures and related C-Programs.

(24L+12T)

SECTION-B

Arrays, Character Strings. Standard Library Functions. Header Files Modular programming-User defined Functions, Returning values, Parameter passing Mechanism, Structures, Pointers Defining a Pointer. Array Vs Pointers, Dynamic Memory allocation C-Preprocessors, Related Programs. (24L+12T)

Reference:

1. Ram B., Computer Fundamentals- Architecture and Organization New Age International (P) Ltd 3rd Edition.
2. Pelosi M.K. et. al., Doing Statistics for Business with Excel Data, Inference and Decision Making. John Wiley & Sons.
3. Venugopal et. al Mastering C. Tata Mc Graw Hill.
4. Gottfried B.S., Theory and Problems of programming withTMH.

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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 discrimination 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, T.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 Combinatiorial 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.

Section-B
(Unit-I)

(24L+12T)

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 identical 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 2 x n and m x 2 games.

(Unit-II)

(24L+12T)

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) (GD/FCFS).

(24L+12T)

References:

1. Taha H A Operation Research, McMillan Publishing Co. Inc(6th Edition, 1999)
2. Kantiswarup 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 and Schamum's outlines Operation Research, Tata McGraw Hill Edition

Additional References:

1. Thomas G Queueing System, Vol.I Theory John Wiley
2. Mc... 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-Slutsky 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. Brock well, 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. Chenmery, 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
10. Kamitakar & Bhende: Principles of Population Studies. Press Calcutta.
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 to 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 Transformation and 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.

(Unit-II)

(24L+12T)

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. Idhi,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-Wilks-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)

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
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7. Kalbfleisch, 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, tests of linear hypotheses about regression co-efficient. Likelihood Ratio test criterion. Multivariate analysis of variance (MANOVA) one and two way classified data

(24L+12T)

(Unit-II)

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.
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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.
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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 varivles 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.

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

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. Diversitication and Portfolios risk Markovitz portfolio selection. optimal portfolios.

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

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

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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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