University of Rajasthan
Jaipur
SYLLABUS
M.A./M.Sc. STATISTICS
(Annual Scheme)
M.Sc. (Previous) Examination  2021
M.Sc. (Final) Examination  2022

Raj Yad
Dy. Registrar (Acad.)
University of Rajasthan
<table>
<thead>
<tr>
<th>Paper</th>
<th>Title</th>
<th>Marks</th>
<th>Duration</th>
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<tbody>
<tr>
<td>III</td>
<td>Compulsory Papers</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>IX</td>
<td>Multivariate Analysis and Statistical Inference</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>X</td>
<td>Advanced Design of experiments and Sample Theory</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>XI</td>
<td>S.O.C. and O.R</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>XII</td>
<td>Practical based on Paper IX</td>
<td>100</td>
<td>3 Hours</td>
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<td>Paper VIII &amp; X</td>
<td>100</td>
<td>4 Hours</td>
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<td><strong>OPTIONAL PAPERS</strong></td>
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Any two papers of the following with the permission of the institution concerned

<table>
<thead>
<tr>
<th>Paper</th>
<th>Title</th>
<th>Marks</th>
<th>Duration</th>
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<tbody>
<tr>
<td>XIII</td>
<td>Economic Statistics and Demography</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>XIV</td>
<td>Stochastic Process</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>XV</td>
<td>Reliability and Survival Analysis</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>XVI</td>
<td>Advance Multivariate Analysis</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>XVII</td>
<td>Econometrics &amp; Investment System</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td>XVIII</td>
<td>Project Work</td>
<td>100</td>
<td>3 Hours</td>
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</tbody>
</table>

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 Project work/Dissertation of a candidate shall be provided one hour per week towards higher supervision.
3. In all theory papers of M.A. / M.Sc. (Previous and Final) Statistics except Paper XIV the candidates will be required to answer five questions 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 Convergence, Sequences of Functions.

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)
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.

(UNIT-II)

References:
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 Landenbergs 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, semiring, ring, field, sigma field, monotone classes. Sequence of sets, limit supremum and limit inferior of a sequence of sets. Additive set functions, measure, outer measure and their properties. Caratheodory extension theorem (Statement only). Definition of complete measure. Lebesgue and Lebesgue-Stieltjes measure (One dimension only). Probability measure, distribution function and its correspondence with lebesgue Stieltjes.

(24L+12T)

(Unit-II)


(24L+12T)

Reference:
2. Loewe: Probability Theory
3. Bhattacharyya: Probability

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Paper III
Distribution Theory
SECTION A
(Unit-I)

Joint variables and their distributions using Jacobian of transformation. Bernoulli, Binomial, compound
and truncated also. Negative Binomial distributions.

(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.

(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:
    Statistics. Wiley.
    McGraw Hill.
    Calcutta.
    Wiley Eastern.
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 responses, randomized responses for variables, errors in survey, modeling observational
effects, estimation of variance components, application to longitudinal studies (repetitive surveys). Basic
finite population sampling techniques: SRSWOR, Stratified sampling schemes. Allocation problem in
stratified sampling.

(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

SECTION B
(UNIT-I)
Analysis of Experimental model by least square, Cochran’s Theorem and Regression Analysis (Case of
Uniformity, Trails, Randomized experiments, Randomized Blocks, Latin Squares, Balanced Incomplete
Block Design(Intra-Block Analysis), Missing Plot Technique

(UNIT-II)
Factorial Experiments$^2$ & $^3$, total and partial confounding, split-plot designs. Construction of
confounded factorial experiments belonging to $^2$ series

References:

   International Publishers.
   Agricultural Statistics.
10. Sukhatme, P.V., Sukhatme, B.V., Sukhatme S & Ashok, C: Sampling Theory and Surveys II
    Applications
(Unit-I)

Point estimation, Criteria of good estimator, unbiased estimators uniformly minimum variance unbiased estimator (UMUE) among Fisher Neyman factorization theorem, non uniqueness theorem. Exponential theorem (without proof) Dvori'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.

(Section B)

(24L+12T)

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Reference:


SECTION-B

Reference:

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Multivariate Analysis and Statistical Inference

UNIT-I

(M.Sc. Final)

PAPER-VIII

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.

(24L+12T)

(UNIT-II)

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 Hotelling T² and its applications Wishart matrix its distribution without proofand its properties Null distribution (without proof) of partial Correlation, multiple correlations and sample regression coefficient ant its applications.

(24L+12T)

SECTION-B

(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 Likelihood Ratio Statistic, Similar Regions

(24L+12T)

(UNIT-II)

Generalized Neyman Pearson lemma Elements of statistical decision function, Formulation of the problem, Loss function, Risk functions, Convex set, 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:

11. Wald, A., Sequential Analysis

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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).


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.

References:
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 and 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 defects 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 subgrouping 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 specification specifications (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 Solusions, Monte Carlo Simulation Technique & its Applications, Review of Linear Programming Problems, Revised Simplex Method, Dual Simplex Method, Transport Problem 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 problems with different routings, Theory of Games: Pure & Mixed strategies, Minimax (Maximum) criterion, Solution of Games with Saddle Point, Graphical Solution of 2 x 2 games and linear programming 2 x 2 games without saddle point.

(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, Queuing System, Characteristics of Queuing 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/M/C) models, Mixed Queuing Model (M/D/1), (M/D/C) + FCFS.

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References:

Additional References:

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Optional Papers

Paper-XIII
Economic Statistics & Demography


Unit-II

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

Section-B

(Unit-I)


(24L+12T)

(24L+12T)


REFERENCES:
2. Barlow Techniques of Population Analysis
5. Chenery, H.B. Inner Industrial Economics
Paper XIV
STOCHASTIC PROCESSES
Section-A
(Unit-I)
Introduction: 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
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.

Section-B
(Unit-I)
Markov Process, Poisson Process and its generalization, Yule-Furry process, Birth-Death Process
Definition. Markov Process with Discrete State Space-Kolmogorov Differential Equation, Erlangian
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)
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, Galton-Watson's Branching Process, Properties of Generation Function of BP's, Probability
of ultimate extinction, Distribution of population size. Idea of Martingales.

References:

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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, gamma etc. Estimation of parameters and test in these models (24L+12T)

(Unit-II)

Notions of ageing: IFR, IFRA, NBU, DMRL and NBUE Classes 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)


(Unit-II)


References:
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.

(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.

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 coin (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) squared error less (iii) 0-1 less. Generalization of a common loss functions. Evaluation of the estimate in terms of posterior risk. Bayesian interval estimation Excessive interval. Highest posterior density regions interpretation of the confidence co-efficient for a classical confidence interval.

(Unit-II)
Bayesian testing of hypothesis. Specification of the appropriate form of the prior distribution for a Bayesian test of hypothesis problem. Prior odds, posterior odds, Bayes factor for various types of testing hypothesis problems depending upon whether the null hypothesis and the alternative hypotheses 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.

References:

Additional references:


Section-B


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Additional References:

Paper XVIII
Project work

Important:
1. The project work shall be based on either primary data involving field work or secondary data.
2. The candidate will be required to prepare comprehensive and critical reports on the same.
3. The teacher supervising the project work. Dissertation of a candidate shall be provided on hours per week towards his/her supervision.

In all the theory papers M.A./M.Sc. (Previous & final) Statistics Except paper XVIII the candidate will be required to answer five questions in all taking at least one question from each section.

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