University of Rajasthan
Jaipur

SYLLABUS

M.A./M.Sc. Statistics
(ANNUAL SCHEME)
2015-2017
**SCHEME OF EXAMINATION**

(Annual Scheme)

<table>
<thead>
<tr>
<th>Each Theory Paper</th>
<th>3 Hrs. duration</th>
<th>100 Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissertation/Thesis/Survey Report/Field Work, if any</td>
<td>100 Marks</td>
<td></td>
</tr>
</tbody>
</table>

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 (where 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 Papers/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 ass 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

<table>
<thead>
<tr>
<th>Previous Paper Number</th>
<th>Nomenclature</th>
<th>Max. Marks</th>
<th>Duration of Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper I</td>
<td>Mathematical Analysis</td>
<td>100</td>
<td>3 Hours</td>
</tr>
<tr>
<td>Paper II</td>
<td>Probability and Measure Theory</td>
<td>100</td>
<td>3 Hours</td>
</tr>
<tr>
<td>Paper III</td>
<td>Distribution Theory</td>
<td>100</td>
<td>3 Hours</td>
</tr>
<tr>
<td>Paper IV</td>
<td>Sample Surveys &amp; Design Of Experiment</td>
<td>100</td>
<td>3 Hours</td>
</tr>
<tr>
<td>Paper V</td>
<td>Statistical Inference</td>
<td>100</td>
<td>3 Hours</td>
</tr>
<tr>
<td>Paper VI (a)</td>
<td>Computer Programming (Theory)</td>
<td>50</td>
<td>3 Hours</td>
</tr>
<tr>
<td>Paper VI (b)</td>
<td>Practical based of paper III and VI (a)</td>
<td>50</td>
<td>4 Hours</td>
</tr>
<tr>
<td>Paper VII</td>
<td>Practical based of Paper IV and V</td>
<td>100</td>
<td>4 Hours</td>
</tr>
</tbody>
</table>

**Total**: 700
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 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 1 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 Paper XIV the candidates will be required to answer five question in all taking at least two questions from each section.
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.

(24L+12T)

(Unit-II)

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)

(24L+12T)

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 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, Cartheodory 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:
Paper III

Distribution Theory

SECTION A
(UNIT-I)


(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: intrà-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:

Sample Surveys & Design of Experiment

SECTION-A

(UNIT-I)

(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)

SECTION-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 Trials, 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:


(6)
Paper-V
Statistical Inference

SECTION A
(UNIT-I)
Point estimation, Criteria of good estimator, unbiased estimators uniformly minimum variance
unbiased estimator (UMVUE) Carmer Rao Inequality. Consistent estimator, Sufficent 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 I\textsuperscript{st} and II\textsuperscript{nd}
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.

(SECTION B)
(UNIT-I)
Definition of S.P.R.T. Fundamental relation among \( \alpha, \beta, A \) 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. Waldowitz 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:
2. Goon and others: Outline of Statistical theory, Vol.I.
5. Mood, Graybill and Boes: Introduction to the theory of Statistics 3\textsuperscript{rd} ed.


SECTION-B


Reference:

4. Gottfried B.S., Theory and Problems of programming with TMH.
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)
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
(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

(Unit-II)
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:

\[\text{(24L+12T)}\]
Paper-IX
Advanced Sample Survey & Design of Experiments

Section-A
(Unit-I)

(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).

Section-B
(Unit-I)

(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-Meeueish 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 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 defects n, np, c, t 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)

(24L+12T)

Section-B
(Unit-I)

(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/Ek, 1) models. Mixed Queueing Model (M/D/1), (M/D/1) ($\infty$/FCFS).

(24L+12T)

References:

Additional References:
Paper XI
Practicals based on Paper IX

Paper XII
Practicals based on Paper VIII & Paper X
Optional Papers

Paper-XIII
Economic Statistics & Demography

Time series: Concept, its components and methods of their determination, Variate difference method, Yule-Slusky 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

(24L+12T)

Unit-II


Section-B

(UNIT-I)


(24L+12T)

(UNIT-II)

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:

2. Barclay: Techniques of Population Analysis
5. Chennery, H.B. Inner Industrial Economics
8. GGanguly and others: Studies in Consumer’s Behaviour.
Paper XIV
STOCHASTIC PROCESSES

Section-A
(Unit-I)

(Unit-II)

Section-B
(Unit-I)

(Unit-II)

References:
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)

(24L+12T)

(Unit-II)

(24L+12T)

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 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) 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. Exceedable 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 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 prediction problem.

References:

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2. The teacher supervising the Project work/Dissertation of a candidate shall be provided on hour per week towards his/her supervision.

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