UNIVERSITY OF RAJASTHAN
JAIPUR

SYLLABUS

M.A. / M.Sc.
STATISTICS
(ANNUAL SCHEME)

M.A./M.Sc. (Previous) Examination 2017
M.A./M.Sc. (Final) Examination 2018
SCHEME OF EXAMINATION
(Annual Scheme)

Each Theory Paper
Dissertation/Thesis/Survey Report/Field
Work, if any

100 Marks
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 (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 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 practicals) 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

<table>
<thead>
<tr>
<th>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>
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<tr>
<td>Paper III</td>
<td>Distribution Theory</td>
<td>100</td>
<td>3 Hours</td>
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<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>30</td>
<td>3 Hours</td>
</tr>
<tr>
<td>Paper VII (b)</td>
<td>Practical based of paper III and VI (a)</td>
<td>50</td>
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<td>Paper VII</td>
<td>Practical based of Paper IV and V</td>
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<td>4 Hours</td>
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Total: 700
## M.A./M.Sc. Statistics

### Final

#### Compulsory Papers

<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Marks</th>
<th>Hours</th>
</tr>
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<tbody>
<tr>
<td>VIII</td>
<td>Multivariate Analysis and Statistical Inference</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>IX</td>
<td>Advanced Design of experiments and Sample Theory</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>X</td>
<td>S.Q.C. and O.R</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>XI</td>
<td>Practical based on Paper IX</td>
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<td>4</td>
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<tr>
<td>XII</td>
<td>Paper VIII &amp; X</td>
<td>100</td>
<td>4</td>
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</table>

#### Optional Papers

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

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

[Signature]

Registrar (Acad.)
University of Rajasthan
Jaipur
Syllabus
M.Sc. (Previous)
PAPER I
(MATHMATICAl ANALYSIS)
SECTION-A
(Unit-1)
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)
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)

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)

(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. Caratheory 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:

Dy. Registrar (Acad.)
University of Rajasthan
JAIPUR
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.

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

References:

Dy. Registrar (Acad)
University of Rajasthan
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 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)

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:

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, Sufficient estimator, Fisher Neyman factorization theorem, Non uniqueness theorem, Exponential theorem (without proof), Davi’s theorems (without proof), Rao- Blackwell efficient estimator, Completeness and Lehmann- Schell 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).

(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 IIst 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)

(Unit-II)
Non-Parametric tests, Sign Tests, Signed Rank test, Kolmogorov- Smirnov one sample test, General two sample Problem, Wallis-Wruss 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.

Reference:
2. Goon and others: Outline of Statistical theory, Vol.I.
Paper VI (a)
Computer Programming (Theory)

SECTION-A


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.

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)


(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 its 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)


References:
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 Lahiri’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)

(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-Menechish theorem, simple methods of construction of BIB designs. Constructions of symmetrical fractional factorial designs.

(24L+12T)

References:
Paper X
Statistical Quality Control & Operation Research

Section-A
(Unit-I)

(Unit-II)

Section-B
(Unit-I)

(Unit-II)
Inventory Control System: Inventory Models, Costs, Advantages, EOQ Models, 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/M/1) models. Mixed Queueing Model (M/D/1), (M/D/1)/(M/D/1) (LICFS).

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-Slursky 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

Meaning and basis of demand. Demand equation, demand curve, relation between demand curve
and demand function. Estimation of demand function by leontieff'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 income 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
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.

(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. Barlow: Techniques of Population Analysis
5. Chenery, H. B. Inner Industrial Economics
London
Paper XIV
STOCHASTIC PROCESSES
(UNIT-I)

(UNIT-II)

(UNIT-I)

(UNIT-II)

References:
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

(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

Section-B
(Unit-I)
Concepts of time, Order and random censoring, likelihood in this case, life distribution Exponential, Gamma, Weibull Lognormal, Pareto. Linear Failure rate. Parametric inference: Point estimation, Confidence intervals of 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)

References:
Paper XVI
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 coefficient. 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) squared error less(iii) 0-1 less. Generalization of a common loss function. Evaluation of estimate in terms of posterior risk, Bayesian interval estimation Exedible interval. Highest posterior density regions interpretation of the confidence coefficient for a classical confidence interval. (24L+12T)

(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:

Additional references:
Paper-XVII
Econometrics & Investment System

Section-A
(Unit-I)

(Unit-II)

Section-B
(Unit-I)

(Unit-II)

REFERENCES:

Additional References:
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.

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