University of Rajasthan
Jaipur

SYLLABUS

M.A/M.SC. STATISTICS
(Semester Scheme)

I/II Semester Examination  2018-19
III/IV Semester Examination  2019-20
Scheme of Examination:

Part-I (Course and Internal Assessment)

- The student will require to earn minimum 120 credits out of total 144 credits, in four semesters, for PG degree.
- Each student has to earn minimum 30 credit per semester (i.e. 120 credits in four semester for PG degree).
- Each semester of PG courses shall have 36 credits. There will be three core papers and three elective papers (4 credits each) and one core laboratory and one elective laboratory (6 credits each).
- Core papers (Theory and Practical) are compulsory papers for the students of MA/MSc.(Statistics).
- In theory papers, 15 hrs of contact classes is equal to one credit.
- In practical, 45 hrs of laboratory work is equal to 2 credits.
- Each semester will have continuous assessment (CA). The continuous assessment (CA) consists of two parts, namely (i) Internal Assessment and (ii) Sessional Test(s) in the ratio 30:70. The Internal Assessment component comprises of assessment of student’s performance on the basis of factors like Attendance, Class Room Participation, Quiz, Home Assignment etc.

Part-II (Examination Pattern)

- Each theory paper EoSE shall carry 100 marks.
- The EoSE will be of 3 (Three) hrs duration for each theory paper and 4hrs duration for each practical paper.
- Part A of theory paper shall contain 10 (ten) Short Answer Questions, covering entire syllabus and each question will carry 2 (two) marks i.e. part A will be of total 20 marks.
- Part B of the Question Paper will consist of Four (04) questions with internal choice and weightage of 20 marks each, i.e. total of 80 marks.
- Each laboratory EoSE will be of four hours duration and involve laboratory experiments/exercises, and viva-voce examination with weightage in the ratio of 75:25 (i.e. 15% for record and 10% for viva.)

Abbreviations Used

<table>
<thead>
<tr>
<th>Course Category</th>
<th>CCC: Compulsory Core Course</th>
<th>ECC: Elective Core Course</th>
<th>OEC: Open Elective Course</th>
<th>SC: Supportive Course</th>
<th>SSC: Self Study Core Course</th>
<th>SEM: Seminar</th>
<th>PRJ: Project Work</th>
<th>RP: Research Publication</th>
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Contact Hours

<table>
<thead>
<tr>
<th>L</th>
<th>Lecture</th>
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<tr>
<td>T</td>
<td>Tutorial</td>
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<tr>
<td>P</td>
<td>Practical or Other</td>
</tr>
<tr>
<td>S</td>
<td>Self Study</td>
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Relative Weights

| IA: Internal Assessment (Attendance/Classroom Participation/Quiz/Home Assignment etc.) |
| ST: Sessional Test |
| EoSE: End of Semester Examination |

Course Structure: The details of the courses with code, title, and the credits assigned are as given below.

Dy Registrar
<table>
<thead>
<tr>
<th>Semester</th>
<th>Paper</th>
<th>Paper Number</th>
<th>Nomenclature</th>
<th>Max. Marks</th>
<th>Duration of Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Core Theory</td>
<td>MST 101</td>
<td>Statistical Mathematics</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
<td></td>
<td></td>
<td>MST 102</td>
<td>Probability Theory</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
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<td></td>
<td>MST 103</td>
<td>Probability Distributions</td>
<td>100</td>
<td>3 Hours</td>
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<td>Elective Theory</td>
<td>MST A01</td>
<td>Statistical Computing with C</td>
<td>100</td>
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<td>MST A02</td>
<td>Official Statistics</td>
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<td>MST A03</td>
<td>Statistical Quality Control</td>
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<td>Core Lab</td>
<td>MST PC1</td>
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<td>100</td>
<td>4 Hours</td>
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<tr>
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<td>Elective Lab</td>
<td>MST PE1</td>
<td>Practical based on Elective papers</td>
<td>100</td>
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<tr>
<td>II</td>
<td>Core Theory</td>
<td>MST 201</td>
<td>Sampling Distributions</td>
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<td>MST 202</td>
<td>Statistical Inference-I</td>
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<td>MST 203</td>
<td>Design of Experiment-I</td>
<td>100</td>
<td>3 Hours</td>
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<td>Demography</td>
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<td>MST B02</td>
<td>Applied Statistics</td>
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<td></td>
<td>MST B03</td>
<td>Operation Research-I</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
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<td>Core Lab</td>
<td>MST PC2</td>
<td>Practical based on MST 201, MST 202 and MST 203</td>
<td>100</td>
<td>4 Hours</td>
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<tr>
<td></td>
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<td>MST PE2</td>
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<td>4 Hours</td>
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<td>III</td>
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<td>MST 301</td>
<td>Design of Experiment-II</td>
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<td>100</td>
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<td>MST 303</td>
<td>Sample Surveys-I</td>
<td>100</td>
<td>3 Hours</td>
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<td>Elective Theory</td>
<td>MST C01</td>
<td>Econometrics</td>
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<td>3 Hours</td>
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<td>MST C02</td>
<td>Numerical Analysis</td>
<td>100</td>
<td>3 Hours</td>
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<td>Operation Research-II</td>
<td>100</td>
<td>3 Hours</td>
</tr>
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<td>Core Lab</td>
<td>MST PC3</td>
<td>Practical based on MST 301, MST 302 and MST 303</td>
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<td>4 Hours</td>
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<td>MST PE3</td>
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<tr>
<td>Semester</td>
<td>Paper</td>
<td>Paper Number</td>
<td>Nomenclature</td>
<td>Max. Marks</td>
<td>Duration of Exam</td>
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<td>IV</td>
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<td>MST 401</td>
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<td>MST 402</td>
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<td>MST 403</td>
<td>Project Work</td>
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<td>3 Hours</td>
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<td>Elective Theory</td>
<td>MST D01</td>
<td>Measure Theory</td>
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<td>3 Hours</td>
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<tr>
<td></td>
<td></td>
<td>MST D02</td>
<td>Basic Statistics*</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
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<td></td>
<td>MST D03</td>
<td>Stochastic Process</td>
<td>100</td>
<td>3 Hours</td>
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<tr>
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<td>Core Lab</td>
<td>MST PC4</td>
<td>Practical based on Core Papers MST 401, MST 402.</td>
<td>100</td>
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<tr>
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<td>Elective Lab</td>
<td>MST PE4</td>
<td>Statistical Computing with R and SPSS**</td>
<td>100</td>
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*: Only for Non Statistics Students
**: Non-Statistics Students may opt for this elective lab(MST PE4) if they have opted for Elective Theory paper MST D02.

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### Extra Elective Papers

<table>
<thead>
<tr>
<th>Semester</th>
<th>Paper</th>
<th>Paper Number</th>
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<th>Duration of Exam</th>
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<tbody>
<tr>
<td>IV</td>
<td>Extra Electives</td>
<td>MST D04</td>
<td>Reliability Theory</td>
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<td>MST D05</td>
<td>Survival Analysis</td>
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<tr>
<td></td>
<td></td>
<td>MST D06</td>
<td>Statistics for Clinical Trials</td>
<td>100</td>
<td>3 Hours</td>
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</table>

**Instructions to students:**

1. Non Statistics Students may opt for Elective paper MST D04 (Statistical Computing with R and SPSS) if they have opted for elective paper MST D02.
2. Scheme for class room study, Internal Assessment and End of Session Examination (ESoS) for these Extra Elective Papers (MST D04,MST D05,MST D06) will be same as that of other elective papers, mentioned in Table of Semester IV above.

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Dy. Registrar
(Academic)
University of Rajasthan
JAIPUR
## M.A. / M.Sc. STATISTICS
### First Semester

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Code</th>
<th>Course Title</th>
<th>Course Category</th>
<th>Credit</th>
<th>Contact Hours Per week</th>
<th>EoSE Duration (Hrs.)</th>
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<tbody>
<tr>
<td>01</td>
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<td>Statistical Mathematics</td>
<td>CCC</td>
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<td>Probability Theory</td>
<td>CCC</td>
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<tr>
<td>03</td>
<td>MST 103</td>
<td>Probability Distributions</td>
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<td>Thy. 3 0</td>
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<tr>
<td>06</td>
<td>MST A03</td>
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<td>MST PC1</td>
<td>Practical based on Core papers (MST 101 &amp; MST 103)</td>
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<tr>
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<td>Practical based on Elective papers</td>
<td>ECC</td>
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Total Credit: 36

### Second Semester

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<th>EoSE Duration (Hrs.)</th>
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<tbody>
<tr>
<td>01</td>
<td>MST 201</td>
<td>Sampling Distributions</td>
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<td>CCC</td>
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Total Credit: 36

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Dy. Registrar (Academic)  
University of Pratapthn  
JAIPUR
### Third Semester

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<td>3 0</td>
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<td>Operation Research-II</td>
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<td>0 4</td>
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### Fourth Semester

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<tbody>
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<td>Statistical Computing with R and SPSS**</td>
<td>ECC</td>
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|        |              | Total Credit                        |                 | 36     | 24 12                  |                      |

*: Only for Non Statistics Students.

**: Non-Statistics Students may opt for this elective lab (MST PE4) if they have opted for Elective Theory paper MST D02.
### Additional Electives for Fourth Semester*

<table>
<thead>
<tr>
<th>Semester</th>
<th>Paper</th>
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<tr>
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<td>MST D06</td>
<td>Statistics for Clinical Trials</td>
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<td>3 Hours</td>
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Semester I
MST 101: Statistical Mathematics

Linear Algebra: Inverse and rank of a matrix, solution of linear equations, orthogonal matrix, orthogonal reduction of a real symmetric matrix to a diagonal form, generalized inverse and its simple properties, idempotent and nilpotent matrices, solutions of matrix equations.

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

Real Analysis: Real valued functions, limit, continuous function, differentiability of a function; Rolle’s theorem, Lagrange’s mean value theorem, Cauchy’s mean value theorem, maxima-minima of functions, maxima-minima of a function of two independent variables, Lagrange’s method of undetermined multipliers.

Differentiation under the sign of Integration, Multiple integrals, Transformation of Multiple Integrals, Dirichlet’s theorem, Liouville’s Extension of Dirichlet’s theorem. Beta and Gamma integrals.

References:
MST 102: Probability Theory


Concept of random variables, cumulative distribution function and probability functions, joint, marginal and conditional distributions. Functions of random variables and their distributions using Jacobian of transformation for one and two variables.

Mathematical expectation, conditional expectation, moments, moment generating functions, cumulative generating functions and their applications, Characteristic function, Inversion uniqueness and continuity theorems. Chebyshev, Markov and Johnson. Probability inequalities and their applications.

Convergence in probability, Convergence in distribution. Weak law of large numbers. Central limit theorem for a sequence of independent random variables under Lindeberg’s condition, central limit theorem for independent and identically distributed random variables with finite variance.

Sequence of events and random variables: Borel 0-1 law, Kolmogorov’s 0-1 law. Law of large numbers and central limit theorems for independent variables. Kintchin’s weak law of large numbers, Tchebycheff’s and Kolmogorov’s inequalities and strong law of large numbers. Martingales.

Reference:
MST-103: Probability Distributions

Measures of location, dispersion, Skewness and Kurtosis, Moments, Sheppard's correction, moment and cumulant generating functions, probability generating function.

Bernoulli, Binomial (compound and truncated also), Poisson (compound and truncated also), negative binomial, geometric, Hyper-geometric and multinomial distributions.

Rectangular, Normal (truncated also), Exponential, Lognormal and Triangular distributions.

Gamma, Beta, Cauchy (truncated also), Laplace distributions, Pearson's distributions (Type I, IV and VI).

References:

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Statistical

MST A01: Computing with C

Basics of C: Components of C language, structure of a C program, Data type, basic Data types, Enumerated data types, Derived data types, Variables. Variable declaration, Operators. Type modifiers and expressions. Basic input/output. Control statements: conditional statements, loops, goto and label declarations, break, continue, exit(). Arrays.

Storage classes: Automatic variables, External variables, Static variables, Scope and lifetime of declarations. Functions: classification of functions, functions definition and declaration, assessing a function, return statement, parameter passing in functions.

Pointers (concept only). Structure: Definition and declaration; structure (initialization) comparison of structure variable; Array of structures: array within structures, structures within structures, passing structures to functions; Unions accessing a union member, union of structure, initialization of a union variable, uses of union. Introduction to linked list, linear linked list, insertion of a node in list, removal of a node from list.

Files in C: Defining and opening a file, input–output operation on a file, creating a file, reading a file. Statistics Methods and Techniques in R. Introduction to SPSS, Data Entry, Data Analysis and Statistical Tests.

References:

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MST A02: Official Statistics


Population Census: Need, Data Collected, Periodicity, Methods of data collection, dissemination, Agencies involved. Socio-Economic Indicators, Gender Awareness/ Statistics, Important Surveys and Censuses.

4. Reports od MOSPI, CSO etc.

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MST A03: Statistical Quality Controls


General Theory of Control Charts, Causes of Variation in Quality, Control Limits, Sub-Grouping. Control-Charts: Concept and construction of control charts for variables and attributes and their OC Curve. Modified control limits. A.R.L. of control charts; control by gauging; moving average and exponentially weighted moving average charts; Cu-Sum charts using V-masks and decision intervals; Economic design of X-bar chart


Idea of Standard sampling tables: Dodge and Romig tables. Sampling Inspection Plans for Variables (single, double, multiple and sequential) One sided specification standard (Known and Unknown Cases), two sided specifications (for known standards).

REFERENCES
MST-PC1 (Practical Paper Based on MST 101, MST 103)

List of Practical

(MST 101)
1. Determinants - by row and column operations, by partitioning.
2. Inverses of a matrix - by row and column operations, by partitioning
3. Rank of a matrix
4. Solutions of matrix equations
5. Characteristic roots and vectors of a matrix.

(MST 103)
1. Coefficient of variation.
2. Calculation of central moments, coefficient of variation, $\beta_1, \beta_2$ and $\gamma_1, \gamma_2$ coefficients, Sheppard’s correction to moments.
3. Plot binomial curve for different values of n and p
4. Fitting of binomial distributions, Poisson distribution, Negative Binomial distribution and Normal distribution

MST-P1 (Practical Paper Based on Elective Papers)

MST A01: Statistical Computing with C
1. Practical based on Conditional Statements
2. Practical based on Loops Statements
3. Practical based on Structures and Unions.

MST A03: Statistical Quality Control
1. Control charts for variables
   (i) $\bar{X}$ & R charts with known parameters.
   (ii) $\bar{X}$ & R charts with unknown parameters.
   (iii)$\bar{X}$ & $s$ charts with known parameters.
   (iv)$\bar{X}$ & $s$ charts with unknown parameters.
2 Control Charts for Attributes
   i. C - charts with known & unknown parameters.
   ii. p - charts with known & unknown parameters.
   iii. np - charts with known & unknown parameters.
   iv. 100 np - charts with known & unknown parameters.
3. Control charts for varying sample size.
4. Draw O.C. ASN and AOC curves of:
   (i) Single sampling Plan
   (ii) Double sampling Plan
5. Find producer’s risk and consumer’s risk
Semester II

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MST 201: Sampling Distributions

Sampling Distributions: Basic concepts, standard error, Chi-Square, t and F distributions (central and non-central) and their applications. Fisher’s Z-distribution and its applications.

Standard errors of functions of moments. Order statistics: their distributions and properties; joint and marginal distributions of order statistics, sampling distributions of range and median of univariate population.

Bivariate Normal Distribution: Joint, marginal and conditional distributions and their properties.

Correlation, linear regression, intra-class correlation and correlation ratio. Null and non-null distribution of sample correlation coefficient. Power series distribution.

References:


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MST 202: Statistical Inference-I


Methods of Estimation: Maximum likelihood method, moments, minimum Chi-square and modified minimum Chi-square methods. Properties of maximum likelihood estimator (with proof). Confidence intervals: Determination of confidence intervals based on large samples & small samples. Statistical Hypothesis: Simple and composite, critical region, types of errors, level of significance, power of a test, most powerful test and Neyman-Pearson lemma.


Reference:

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MST 203: Design of Experiment-I


One way and two-way classifications, fixed, random and mixed effects models. Analysis of variance (two-way classification only).

Principles of design of experiments, uniformity trials, randomized experiments, completely randomized design, randomized block design, Latin square design. Factorial Experiment $2^n$ and $3^2$, total and partial confounding. Construction of confounded factorial experiments belonging to $2^n$ series.

Analysis of non orthogonal data, analysis of missing plot and mixed plot data. Split plot and strip plot designs. Balanced incomplete block design (intra-block analysis).

References:


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MST B01: Demography

Sources of demographic data, census, registration, ad-hoc surveys, Hospital records, Vital Rates and Ratios. Demographic profiles of the Indian Census.


Internal migration and its measurement, migration models, concept of international migration. Net migration. International and post censal estimates. Projection method Including logistic curve fitting. Decennial population census in India.

8. Reports od MOSPI, CSO etc.

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MST B02: Applied Statistics

Index Numbers: Price relatives and quantity or volume relatives, Link and chain relatives composition of index numbers; Laspeyre's, Paasches', Marshal Edgeworth and Fisher index numbers; chain base index number, tests for index number. Construction of index numbers of wholesale and consumer prices.

Income distribution-Pareto and Engel curves, Concentration curve, Methods of estimating national income, Inter-Sectoral flows, Inter-industry table. Demand Analysis- Price Elasticity of Demand and Supply. Partial Elasticity of Demand. Elasticity Estimation- Leontief's, Pigou Methods.

Time Series Analysis: Economic time series, different components, illustration, additive and multiplicative models, determination of trend, seasonal and cyclical fluctuations. Time-series as discrete parameter stochastic process, auto covariance and Auto-correlation functions and their properties. Exploratory time Series analysis, tests for trend and seasonality, exponential and moving average smoothing. Holt and Winters smoothing, forecasting based on smoothing.

Detailed study of the stationary processes:(1) Moving Average (MA),(2)auto regressive(AR), (3)ARMA and(4)AR integrated MA (ARIMA) models. Box-Jenkins models, choice of AR and MA periods. Discussion (without proof) of estimation of mean, auto covariance and Auto-correlation functions under large sample theory, estimation of ARIMA model parameters. Spectral analysis of weakly stationary process, periodogram and correlogram analyses, computations based on Fourier transform.

MST B03: Operation Research-I


Sequencing Problem: Assumptions, Solution of n jobs 2 machines system, Johnson Algorithm, Processing of n jobs and 3 Machines.

Inventory Control System: Inventory models, costs, advantages, EOQ models without shortages, reorder level and optimum buffer stock, EOQ models with shortages and quantity discounts. ABC analysis. Multi-item inventory subject to constraints. Models with random demand, the static risk model. P and Q-systems with constant and random lead times.

Queuing System: Characteristics of queuing system, Poisson process, pure birth and pure death process. Steady state solution of (M/M/1) and (M/M/C) models. (M/G/1) model—Pollaczek Khintchine formula.

References:

2. Kanti Swaroop et. al Operation Research, Sultan Chand & Sons

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MST-PC2 (Practical Paper Based on MST 201, MST 202, & MST 202)

MST 201 (Sampling Distributions)
1. Correlation and regression coefficients for Bivariate frequency distributions.
2. Large sample tests (i) For population mean (ii) equality of two population means (iii) For population variance (iv) equality of two population variances.
3. Small sample tests viz. t, F, $x^2$ and Z tests.

MST 202 (Statistical Inference-I)
1. Test of significance of sample correlation coefficient.
2. Sign, median and run tests for small and large samples.
3. Sequential probability ratio test and calculation of constants and graphical representation for testing simple null against simple alternative for (i) Binomial (ii) Poisson (iii) Normal (iv) Exponential distributions.

MST-203 (Design of Experiment I)
1. One-way classified data
2. Two way classification with single and equal observations
3. Two way classification with unequal observations
4. Analysis of CRD, RBD, LSD with and without missing observations.
5. Analysis of BIBD.
6. Yates method for analysis
7. $2^n$ factorial experiments - n=3
8. $2^n$ factorial experiments for n = 4
9. Total confounding in $2^n$, n = 3, 4
10. Partial confounding in $2^n$, n = 3, 4
11. $3^2$ factorial experiments
12. Analysis of a confounded factorial experiment.
13. Analysis of covariance in one way classified data
14. Analysis of covariance in two way classified data
MST PE2: Practical Based on Elective Papers

List of Practical:

1. MST B01 (Demography)
   1. Computation of various Death rates.
   2. Computation of various Birth rates, NRR, GRR.
   3. Construction of Life tables- Abridged, Lotka Life Tables
   4. Construction of Makehams and Gompertz curves.
   5. Logistic curve fitting for projection.

2. MST B02 (Applied Statistics)
   1. Practical based on Index Number
   2. Practical based on Income Distribution & Demand Analysis
   3. Practical based on Time Series Analysis

3. MST B03 (Operation Research)
   1. Problems based on Monte Carlo Simulation
   2. Duality problems
   3. Transportation Problems
   4. Assignment Problems
   5. Replacement Problems and Sequencing Problems
   6. Simulation Problems based on Inventory Control and Queuing Problems

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Semester III
MST 301: Design of Experiment-II

Linear Models: Theory of linear estimation, Gauss-Markov Theorem, estimable functions, error and estimation space, normal equations and least square estimators, estimation of Error variance, estimation with correlated observations, properties of least square estimators, generalized inverse of a matrix and solution of normal equations, variances and covariances of least square estimators. Testing of hypothesis: involving several linear functions, test of sub-hypothesis and test involving equality of the parameters.


Constructions of orthogonal Latin squares - (i) for prime power numbers and (ii) by Mann-Mccneish theorem. Simple methods of construction of BIB, BID designs. Constructions of symmetrical fractional experiments.

References:
MST 302: Statistical Inference-II

Location Invariance, scale invariance. Pitmann’s estimators for location and scale parameters. Proof of the properties of M.L.E, Huzur Bazaar theorem, consistent asymptotic normal (CAN) estimator, invariance property. Resampling, Bookstrap and Jacknife.


Reference:
MST 303: Sample Surveys-1

Planning, execution and analyses of sample surveys with illustrative examples. Errors in survey, sources of non-sampling errors. Determination of sample size.

Basic finite population sampling techniques: Simple random sampling with and without replacement. Stratified sampling. Sample allocation problems in stratified sampling and related results on estimator of mean/total.

Systematic sampling, cluster sampling, two-stage sampling with equal and unequal number of second stage units, Multistage sampling. Estimation of their Population Mean, Total and Standard Errors.

Use of Auxiliary Information: Ratio, product and regression methods of estimation, their comparisons among them, and with sample mean under SRSWOR. Concept of double sampling and its uses in ratio, product and regression methods of estimation.

References:
MST C01: Econometrics

Nature of econometrics, the general linear model (GLM) and its extensions, ordinary least squares (OLS) estimation and prediction, generalized least squares (GLS) estimation and prediction, heteroscedastic disturbances, pure and mixed estimation.

Autocorrelation, its consequences and tests. Theil BLUS procedure, estimation and prediction, multi-collinearity problem, its implications and tools for handling the problem, ridge regression.

Linear regression and stochastic regression, instrumental variable estimation, errors in variables, auto regressive linear regression, lagged variables, distributed Lag models, estimation of lags by OLS method, Koyck's geometric lag model. Simultaneous linear equations model and its generalization, identification problem, restrictions on structural parameters, rank and order conditions.

Estimation in simultaneous equations model, recursive systems, 2SLS estimators, limited information estimators, k-class estimators, 3SLS estimator, full information. Maximum likelihood method, prediction and simultaneous confidence intervals.

References:
MST C02 Numerical Analysis

Interpolation formulae (with remainder term) due to Lagrange’s, Newton-Gregory, Newton’s divided difference formulae. Central difference formulae: Gauss, Sterling & Bessel. Concept of Error terms in interpolation formulae.


References:

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MST C03: Operation Research-II

Dynamic Programming: Definition, Algorithm, Formulation of Dynamic Programming, Bellman’s principle of optimality, Computational methods and application of dynamic programming to LPP.

PERT & CPM: Definitions, Basic Steps of PERT/CPM, Terminologies, Rules, Uses, Disadvantages, Time Estimate and Network Analysis, Resources Allocation.

Game Theory: Basics, Decision-making in the face of competition, Characteristics of Games, Two person Zero Sum Games, Saddle Point, Mixed Strategy, dominance criteria, Minimax-Maxmin Criterion, Solution of m x n games, Solution by LPP.

Decision Analysis: Types, Components, Laplace Criteria, Hurwitz Criteria, Decision under Risk. Replacement Models for items that fail or deteriorate.

References:
   Mckinsey,J.C.C.(1952): Introduction to the theory of games, Mcgraw Hill

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MST-PC3 (Practical Based on Paper MST 301, MST 302, MST 303)

List of Practical:

1. MST 301: Design of Experiment -II
   1. Testing of Hypotheses regarding equality of some treatment effects in one and two way classifications.
   2. Analysis of Incomplete block designs without specific form of C matrix.
   3. Group divisible designs.
   4. Linked Block designs.
   5. Simple lattice designs with 2 or more replications.

2. MST 302: Statistical Inference -II
   1. Power curve for testing one sided Null Hypothesis hypothesis against one sided and two sided alternative for Binomial distribution, Poisson distribution, Normal distribution & Exponential distribution
   2. Construction of Randomized test of a desired size for testing simple null against simple alternative hypothesis for (i)Bernoulli’s trial (ii) Poisson distribution.
   3. Test of hypothesis using generalized likelihood ratio test for testing equality of (i) two means (ii) two variances in normal distribution(s).

3. MST-303 (Sample Surveys –I)
   1. Drawing of random samples from finite populations.
   2. Drawing of random samples from Binomial and Normal populations.
   4. Estimation of mean & variance in stratified sampling under proportional and optimum allocations.
   5. Gain in precision due to stratification.
   6. Estimation of mean& variance in systematic sampling and comparison with S.R.S.
   7. Estimation of mean & variance in cluster sampling and comparison with S.R.S.
   8. Estimation of mean & variance by (i) ratio and (ii) regression methods of estimation.
MST-PE3 (Practical Based on Elective Papers MST C01, MST C02, MST C03)

List of Practical:

MST C01: Econometrics

1. OLS estimation and prediction in GLM.
2. Use of dummy variables (dummy variable trap) and seasonal adjustment.
3. GLS estimation and prediction.
5. Tests for autocorrelation. BLUS procedure.
7. Instrumental variable estimation.
8. Estimation with lagged dependent variables.
9. Identification problems - checking rank and order conditions.
10. Estimation in recursive systems.
11. 2SLS and 3SLS estimation.

MST C02: Numerical Analysis (with software)

1. Interpolation formulae: Lagrange's, Newton-Gregory, Newton's divided difference formulae.
2. Central difference formulae: Gauss, Sterling & Bessel with error terms.
6. Solution of Simultaneous Linear equation
8. Inverse interpolation.

MST C03: Operation Research – II

1. Practical based on Dynamic Programming
2. PERT CPM
3. Game Theory
4. Decision Analysis
5. Replacement Problems.
MST 401: Multivariate Analysis


Maximum likelihood estimator of the mean vector and covariance, their independence and related distributions. Partial and multiple correlation coefficients.

Classification and discrimination procedure for discrimination between two multivariate normal populations, sample discriminate function, test associated with discriminate functions probabilities of misclassification and their estimation.


References:

MST 402: Sample Survey-II

Rational behind the use of unequal probability sampling: Probability proportional to size with and without replacement method (including cumulative total method and Lahiri's method), related estimators of finite population mean (Hansen-Hourwitz, 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 variance of HTE and its unbiased estimator due to Horvitz-Thompson and Yates & Grundy.

P.P.S. Schemes of sampling due to Midzuno-Sen, Brewer, Durbin and JNK Rao (sample size of 2 only), Rao-Hartley and Cochran sampling scheme and their estimation procedure. Theory of multi-stage sampling with varying probabilities (with or without replacement) due to Durbin, Narain and Sukhatme sampling schemes.

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). Inter penetrating sub sampling.


References:
MST 403: Project Work

Guidelines for Project Report

Project Duration: 1st December to 15th May. (Students may start preliminary work related to their project after third semester.)

Project Guide: Teachers from the Department of Statistics. Each project group will be guided by concerned teacher (guide) for one hour per week throughout the semester.

Fieldwork: Students will be given 4 to 6 weeks during last semester for their industrial work/data collection/survey or any other fieldwork involved in the project.

Project Topic: Students in consultation with the guide will decide Project Topic/Area. Topic may be decided after completion of third semester. Project work may be carried out in a group of students depending upon the depth of fieldwork/problem involved.

Project report: Project report should be submitted as per university norms.

Project Evaluation: Project valuation will be done according to university norms.

(i) Project Report (70 marks)
(ii) Presentation by student or group of students. (30 marks)

Project report will be evaluated from the panel of examiners submitted by B.O.S. convener.

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MST D01: Measure Theory

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. Lebesgue and Lebsegue Stieltjes measure (one dimension only) Probability measure, distribution function and its correspondence with Lebesgue Stieltjes.

Measurable sets and measurable space. Simple, elementary and measurable functions. Sequence of measurable functions. Integrability of measurable function, properties of integrals.

Lebesgue monotone convergence theorems, Fatous lemma, dominance convergence theorem, Absolute continuity, Random Nikodym theorem (statement only) and applications, product measure (idea only), Fubinies theorem.

Reference:
MST D02: Basic Statistics

Concept of statistical Population and Data. Types of Data. Data Collection, Classification, Organizations, Representation: Diagrammatic & Graphical; Graphical presentation of data- Histogram, frequency polygon, frequency curve and ogives. Measures of central tendency, dispersion, skewness and kurtosis and its computation from data. Correlation analysis- Assumption, Types-Scatter diagram, Karl-Pearson and Spearman's correlation. Regression analysis-Fitting of regression lines, regression coefficients and their properties and its computation from data.


Hypothesis and its Types. Test of Significance- t-test, z-test, Chi-Square Test and their applications. Analysis of Variance-Need, Assumptions, Applications. One way and Two ways ANOVA. Large Sample Tests-Single Mean and Two means. Basic Concept of Design of Experiments and types with layouts.

References:
2. Gupta, S.P.: Statistical Methods, Sultan Chand and Sons.
MST D03: Stochastic Processes


Branching Process: Galton-Watson’s branching process, properties of generating function of branching process. Probability of extinction, distribution of total number of Progeny.

Random walk, gambler’s ruin’s problem.

References:

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MST-411 (Practical Paper Based on MST 401 & MST 402)

MST 401 Multivariate Analysis

1. Linear combination of correlated normal variates and evaluation of
   Probabilities.
2. Estimation of mean vector and covariance matrix.
3. Estimation and testing of partial and multiple correlation coefficients.
4. Discriminate function.

MST 402 (Sample Surveys-II)

1. PPSWR Sampling: Cumulative total method, Lahri's method of sample
   selection/section, estimation of total and its variance.
2. Horvitz and Thompson's procedure of estimating mean (total) and variance of the
   population.
3. Yates and Grundy estimator of variance.
4. Midzuno's sampling schemes.
6. Two-stage sampling method where f.s.u. being selected with pps with replacement
   and s.s.u. with equal prob. without replacement. Estimation of optimum number of
   s.u. and s.s.u.

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**MST-PE4 (Statistical Computing with R and SPSS)**

**Introduction to R:** The R package Starting and quitting R. Basic features of R. Calculating with R Vectors. Logical operations in R, Relational operators, Data input and output, Lists Vector arithmetics. Character vectors. Data Import.

Matrices and Arrays, Triangular matrices, Matrix arithmetic, Matrix multiplication and Inverse. Flow control- The if() statement, for() loop, while() loop. Repeated loops, break and next Statements.


Generation of pseudorandom numbers, Simulation of other random variables-1 Bernoulli, Binomial, Poisson, Exponential, Normal random variables. Monte Carlo Simulation.


**References:**
7. Verma, J.P. : Data Analysis in Management with SPSS Software, Springer

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Extra Elective Papers for Semester-IV
MST D04: Reliability Analysis

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 tests in these models.

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. Univariate shock models and life distributions arising out of them; bivariate shock models; common bivariate exponential distributions and their properties.

Reliability estimation based on failure times in variously censored life tests and in tests with replacement of failed items stress-strength reliability and its estimation. Maintenance and replacement policies, availability of repairable systems, modeling of a repairable system by a non-homogeneous Poisson process.

Reliability growth models, probability plotting techniques, Hollander-Proshchan and Deshpande tests for exponentiality; tests for HPP vs. NHPP with repairable systems. Basic ideas of accelerated life testing.

REFERENCES

MST D05: Survival Analysis


Parametric inference (Point estimation, Confidence intervals Scores, LR, MLE tests (Rao-Willks-Wald ) for these distribution life tables failure rate, mean residual life and their elementary properties. Ageing classes-and their properties, Bathtub failure rate.

Estimation of survival function- Actuarial estimator, Kaplan-Meier estimator, estimation under the assumption of IFR/DFR. Tests of exponentially against non-parametric classes, total time on test, Deshpande test. Two sample problem-Gehan test, log rank test Mantel–Haenszel test, Tarone-Ware tests.

Cox’s proportional hazards model with one and several covariates. Rank test for the regression coefficients. Competing risks model, parametric and non-parametric inference for this model. Assumptions, extended Cox model, MLE of Cox PH model, hazard ratio, survival curves.

References:


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MST D06: Statistics for Clinical Trials

Introduction to clinical trials: the need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, Phase I-IV trials, multi-center trials. Data management: data definitions, case report forms, database design, data collection systems for good clinical practice.

Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, review of factorial designs, objectives and endpoints of clinical trials.

Design of Phase I trials, design of single-stage and multi-stage Phase II trials, design and monitoring of Phase III trials with sequential stopping, design of bioequivalence trials.


REFERENCES: