PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR

SALEM – 636 011

DEGREE OF MASTER OF SCIENCE

CHOICE BASED CREDIT SYSTEM

SYLLABUS FOR M.Sc. STATISTICS

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2021 – 2022 ONWARDS

MASTER OF SCIENCE

BRANCH – II STATISTICS
REGULATIONS

1. OBJECTIVES OF THE COURSE

To transform graduates with sufficient strength in statistics so as to be employed in the Industry, Research and Development unit and Academic Institutions. The course is designed to impact professional knowledge and practical skills to the students.

2. CONDITION FOR ADMISSION

A candidate who have passed B.Sc Statistics / B.Sc Mathematics degree of Periyar University or any of the above degree of any other university accepted as per the norms set by the Government of Tamil Nadu as equivalent thereto, subject to such condition as may be prescribed thereto are permitted to appear and qualify for the M.Sc. Statistics degree examination of this university after a course of study of two academic years, under CBCS.

3. DURATION OF THE COURSE

The course for the degree of Master of Science in Statistics shall consist of two academic years divided into four semesters. Each semester consist of 90 working days.

4. COURSE OF STUDY

The course of study shall comprise instruction in the following subjects according to the syllabus and books prescribed from time to time.
## COURSE OF STUDY AND SCHEME OF EXAMINATION

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Paper Code</th>
<th>Subject Title</th>
<th>Hours</th>
<th>University Examinations</th>
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<tr>
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<td>Credits</td>
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<td>Core I</td>
<td></td>
<td>Real Analysis and Linear Algebra</td>
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<td>Core II</td>
<td>Measure Theory</td>
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<td>Distribution Theory</td>
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<td>Core IV</td>
<td>Sampling Theory</td>
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<tr>
<td>Elective – I</td>
<td>Demography</td>
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<td>Practical – (Using R)</td>
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<td>Probability Theory</td>
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<td>Core VI</td>
<td>Statistical Estimation Theory</td>
<td>4</td>
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<td>Core VII</td>
<td>Statistical Quality Control and Reliability</td>
<td>4</td>
<td>6</td>
<td>25</td>
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<tr>
<td>Core Practical I</td>
<td>Practical – I (Calculator based)</td>
<td>4</td>
<td>3</td>
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<td>III SEMESTER</td>
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<td>Core VIII</td>
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<td>Testing Statistical Hypothesis</td>
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<td>Multivariate Analysis</td>
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<td>Core X</td>
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<td>Stochastic Processes</td>
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<td>Elective - II</td>
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<td>Statistical Computing C++</td>
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<td>Practical – III (Calculator based)</td>
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<td>Core Practical IV</td>
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<td>Practical – IV Statistical software</td>
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<td>3</td>
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<tr>
<td>Core Practical IV</td>
<td></td>
<td>Practical – II(Using SPSS)</td>
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<td>IV SEMESTER</td>
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<tr>
<td>Core XI</td>
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<td>Design and Analysis of Experiments</td>
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<td>6</td>
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<tr>
<td>Elective - III</td>
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<td>Advanced Operations Research</td>
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<td>Elective – IV</td>
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<td>Applied Regression Analysis</td>
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<td>Core Practical III</td>
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<td>Practical – III (Calculator based)</td>
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<td>Core Practical IV</td>
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<td>Practical – IV Statistical Software</td>
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<td>Core Practical IV</td>
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<td>Practical – (Using SPSS)</td>
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<td></td>
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<td>Core Project</td>
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<td>Project &amp; Viva-Voce</td>
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<td>Total</td>
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<td></td>
<td>27</td>
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List of Core Subjects to be offered

CORE THEORY SUBJECTS
1. Real Analysis and Linear Algebra
2. Measure Theory
3. Distribution Theory
4. Sampling Theory
5. Probability Theory
6. Statistical Estimation Theory
7. Statistical Quality Control and Reliability
8. Testing Statistical Hypothesis
9. Multivariate Analysis
10. Stochastic Processes
11. Design and Analysis of Experiments
12. Project & VIVA-VOCE

CORE PRACTICALS
1. Practical – I (Calculator based)
2. Statistical Software Practical-II (Using R)
3. Practical – III (Calculator based)
4. Statistical Software Practical-IV (Using SPSS)

ELECTIVE Subjects (Only four)
1. Demography and Actuarial Statistics
2. Advanced Operation Research
4. Statistical Computing C++

Extra Disciplinary Course:
1. Elements of Operations Research
2. Statistical Methods
3. Advanced Business Statistics

**Human Rights.** Common to all courses. Syllabus will be provided by the University.
Examination:

The examination shall be of three hours duration to each theory paper at the end of each semester. The candidate failing in any paper will be permitted to appear in the subsequent semester.

Practical examinations should be conducted at the end of even semester:

At the end of fourth semester, viva-voce will be conducted on the basis of Project/Dissertation submitted by the student. The viva-voce should be conducted jointly by the guide and the external examiner.

Theory Papers:

Total marks for each course (core / elective) is 100. 25 marks for Internal and 75 marks for University Examination. The components of Internal Assessment are:

1. Test = 10 Marks
2. Attendance = 5 Marks
3. Seminar = 5 Marks
4. Assignment = 5 Marks
Total = 25 Marks

Practical:

Total marks for each practical course is 100. 40 marks for internal and 60 marks for Written Examination. The components of Internal Assessment are:

1. Record work = 25 Marks
2. Test = 10 Marks
3. Attendance = 5 Marks
Total = 40 Marks

Project work:

The Marks for the Project work is 100 and the components are:

Internal Assessment: : 40 Marks
(For two reviews 20+20 = 40)

Evaluation:

Evaluation of Project report by External Examiner and Guide : 40 Marks
Viva-Voce conducted by External Examiner & Guide : 20 Marks
Total : 100 Marks
QUESTION PAPER PATTERN

(a) For Theory

- Total marks for each theory course (University examination) is 75.
- The Question paper is divided into three parts.
- PART-A consists of 15 questions, three from each unit with multiple choice. Each question carries 1 mark. All questions should be answered. Total marks for PART-A is 15.
- PART-B consists of 5 questions, one from each unit. Each question carries 5 marks. Any two questions should be answered. Total marks for PART-B is 10.
- PART-C consists of 5 questions, either (or) type one from each unit. Each question carries 10 marks. All the questions should be answered. Total marks for PART-C is 50.

(b) For Practical

- Total marks for each practical (university examination) is 60.
- The candidate should attend 3 questions out of 5 questions each carrying 20 marks.

Classification of Results:

(i) Passing Minimum:

A candidate shall be declare to have passed the examination if the candidate secures not less than 50% of the marks in the Semester Examination and in IA in each course (or) practical. The candidate should get a minimum of 50% marks in semester examination (SE) as well as a minimum of 50% marks in Internal Assessment (IA), i.e., a minimum of 38 marks out of 75 in SE and minimum of 12 marks out of 25 in IA in the theory courses.

For practical courses, the distribution of marks will be 40 for IA & 60 for practical examination. The candidate should get a minimum of 20 marks out of 40 in IA and a minimum of 30 out of 60 in practical examination. The submission of record note book is a must in the practical examinations.

For the project work and viva-voce a candidate should secure 50% of the marks for pass. The candidate should compulsorily attend viva-voce examination to secure pass in the paper (Project).

Candidates who do not obtain the required minimum marks for a pass in a course or practical or project report shall be required to appear and pass the same at a subsequent appearance.
(ii) Minimum Credits to be earned: 90 credits
For Human Rights: 2 credits
Total: 92 credits

(iii) Marks and Grades:

The following table gives the marks, grade points, letter grades and classification to indicate the performance of the candidate.

Conversion of Marks to Grade Points and Letter Grade (Performance in a paper / course)

<table>
<thead>
<tr>
<th>RANGE OF MARKS</th>
<th>GRADE POINTS</th>
<th>LETTER GRADE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>90-100</td>
<td>9.0-10.0</td>
<td>O</td>
<td>Outstanding</td>
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<tr>
<td>80-89</td>
<td>8.0-8.9</td>
<td>D+</td>
<td>Excellent</td>
</tr>
<tr>
<td>75-79</td>
<td>7.5-7.9</td>
<td>D</td>
<td>Distinction</td>
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<tr>
<td>70-74</td>
<td>7.0-7.4</td>
<td>A+</td>
<td>Very Good</td>
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<td>60-69</td>
<td>6.0-6.9</td>
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<td>Good</td>
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<tr>
<td>50-59</td>
<td>5.0-5.9</td>
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<tr>
<td>00-49</td>
<td>0.0-4.9</td>
<td>U</td>
<td>Re-appear</td>
</tr>
<tr>
<td>ABSENT</td>
<td>0.0</td>
<td>AAA</td>
<td>ABSENT</td>
</tr>
</tbody>
</table>

C_i = Credits earned for course i in any semester.
G_i = Grade point obtained for course i in any semester
n = Refers to the semester in which such courses were credited.

a) Semester:

GRADE POINT AVERAGE (GPA) =

\[
\text{GPA} = \frac{\text{Sum of the multiplication of grade points by the credits of the courses}}{\text{Sum of the credits of the courses in a semester}}
\]

b) The Entire Programme:

CUMULATIVE GRADE POINT AVERAGE (CGPA) =

\[
\text{CGPA} = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}
\]
<table>
<thead>
<tr>
<th>CGPA</th>
<th>GRADE</th>
<th>CLASSIFICATION OF FINAL RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 - 10.0</td>
<td>O+</td>
<td>First class with Exemplary*</td>
</tr>
<tr>
<td>9 and above but below 9.5</td>
<td>O</td>
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</tr>
<tr>
<td>8.5 and above but below 9.0</td>
<td>D++</td>
<td>First class with Distinction*</td>
</tr>
<tr>
<td>8.0 and above but below 8.5</td>
<td>D+</td>
<td></td>
</tr>
<tr>
<td>7.5 and above but below 8.0</td>
<td>D</td>
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</tr>
<tr>
<td>7.0 and above but below 7.5</td>
<td>A++</td>
<td>First Class</td>
</tr>
<tr>
<td>6.5 and above but below 7.0</td>
<td>A+</td>
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<td>6.0 and above but below 6.5</td>
<td>A</td>
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<tr>
<td>5.5 and above but below 6.0</td>
<td>B+</td>
<td>Second class</td>
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<td>5.0 and above but below 5.5</td>
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<tr>
<td>0.0 and above but below 5.0</td>
<td>U</td>
<td>Re-appear</td>
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</table>

* The candidates who have passed in the first appearance and within the prescribed semester of the PG Programme (Core, Elective, Non-major Electives and Extra-Disciplinary courses alone) are eligible.

**Dissertation:**

The topic of the dissertation shall be assigned to the candidate before the end of second semester. The student should prepare the plan of work for the dissertation at the end of second semester. In case the student wants to avail the facility from other organisations / university / laboratory, they will undertake the work with the permission of the guide and acknowledge the alien facilities utilized by them. The students should prepare three copies of dissertation and submit the same for the evaluation by Examiners.

**Format to be followed:**

The format / certificate for dissertation to be submitted by the students are given below.

**Format of the preparation of project work**

(a) Title page
(b) Bonafide Certificate
(c) Acknowledgement
(d) Table of Contents
## CONTENTS

<table>
<thead>
<tr>
<th>Chapter No.</th>
<th>Title</th>
<th>Page No.</th>
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<tbody>
<tr>
<td>1.</td>
<td>Introduction</td>
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<td>2.</td>
<td>Review of Literature</td>
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<td>3.</td>
<td>Methodology</td>
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<td>5.</td>
<td>Summary of Conclusions</td>
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<td>7.</td>
<td>Tables</td>
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</table>
Format of the Title Page:

TITLE OF THE DISSERTATION

Dissertation submitted to the Periyar University

in partial fulfillment of the requirement for the Degree of

Master of Science

in

STATISTICS

By

NAME OF THE STUDENTS

REG. NO

(College

COLLEGE NAME

(AFFILIATED TO PERIYAR UNIVERSITY)

Place with Pin Code

MONTH & YEAR
UNIT I


UNIT II

Real valued functions - Limits and continuity and uniform continuity – Differentiability – Maxima and Minima of functions – mean value theorem, Taylor’s theorem – functions of several variables.

UNIT III


UNIT IV

Vector Space - sub-space, basis of vector space –Gram-Schmidt orthogonalization. Linear transformation (LT) and its properties – matrix of linear transformation –matrix of inverse transformation – change of basis, orthogonal transformation, dual space.

UNIT V

Books for Study and Reference:


QP Pattern: Unit wise internal choice with maximum 75 marks

Part A: 15 × 1 = 15, Part B: 2 × 5 = 10 & Part C: 5 × 10 = 50
CORE II - MEASURE THEORY

Unit I

Algebra of sets-Countable sets – field –monotonic field-monotonic class-field generated by a class of subsets-Borel sets- Borel field.

Unit II


Unit III

Lebesque measure and its properties.Lebesque-Stieltjes measure-examples. Measurable functions- Borel measurable functions –Approximation theorem

Unit IV


Unit V

Product measure – product measure functions-properties – Product measure theorem – Fubini’s theorem (concept) and its applications in probability. Radon- Nikodym theorem (concept) and its applications.

Books for Study and Reference:

(2011)

QP Pattern: Unit wise internal choice with maximum 75 marks

Part A: $15 \times 1 = 15$, Part B: $2 \times 5 = 10$ & Part C: $5 \times 10 = 50$
CORE III - DISTRIBUTION THEORY

Unit I

Quick review of the following distributions – Discrete Distribution: Binomial, Poisson, Geometric, Hyper geometric, Multinomial, Negative binomial, Gamma and Beta distributions. Continuous Distribution: Normal, Bernoulli, Exponential, Lognormal and Cauchy (Derivation, application and Properties). Concept of truncated distribution and compound distribution (Binomial & Poisson).

Unit II

Bivariate and multivariate distributions; Concepts of joint, marginal and conditional distributions. Detailed study of Bivariate Binomial and Bivariate normal distribution. Functions of random variables and their distribution: sum and difference, products and quotients of random variables.

Unit III

Multivariate normal distribution and its properties: Marginal and conditional distribution; characteristic function and its uses. Distribution of linear functions of normal variables.

Unit IV

Sampling distribution of statistics from normal samples leading to Normal, t, chi-square, and F (non-central) - properties of these distribution. Distribution of quadratic form.

Unit V

Order statistics and their distribution; single & two order statistics. \( r \)th order statistics Distribution of median, range. Asymptotic distribution of extreme order statistics.

Books for Study and Reference:


QP Pattern: Unit wise internal choice with maximum 75 marks

Part A: $15 \times 1 = 15$, Part B: $2 \times 5 = 10$ & Part C: $5 \times 10 = 50$
UNIT I

Ratio Estimator: Approximate variance – Confidence limits – Comparison of the Ratio estimator with mean per unit – Conditions under which Ratio estimator is a BLUE – Bias term – Separate and combined ratio estimators – Unbiased Ratio Type estimator (Hartley and Ross).


UNIT II


UNIT III

Cluster Sampling: Equal cluster sampling – Estimators of mean and variance, optimum cluster size, Unequal cluster sampling – Estimators of mean and variance, varying probability cluster sampling –

UNIT IV

Two stage sampling – variance of the estimated mean. Multiphase sampling: Double sampling for stratification – Optimum allocation – Estimated variance in Double sampling for stratification.

UNIT V

Sources of errors in Surveys – A mathematical model of the effects of call-backs – a mathematical model of the errors of measurement – Interpenetrating subsampling method.

Books for Study and Reference:


QP Pattern: Unit wise internal choice with maximum 75 marks

Part A: 15 \times 1 = 15, Part B: 2 \times 5 = 10 & Part C: 5 \times 10 = 50
Elective I - DEMOGRAPHY AND ACTUARIAL STATISTICS

Unit I

Demographic data – sources, coverage and content errors in demographic data. Use of balancing equations and Chandrasekaran Deming formula. Vital Registration system – Adjustment of age data - use of Whipple, Myer and UN Indices – Smoothing of age data.

Unit II


Unit III


Unit IV

Life table function at non-integer age (fractional ages). Analytical laws of mortality – Gompertz’s law and Makeham’s law. Select and ultimate and aggregate mortality tables.

Unit V

Multiple life function – joint life and lost survivor status – Insurance and annuity benefits through multiple function.

Books for Study and Reference:

6. Dixit et all (2008)  
   Mathematical basis of life assurance, IC 81, Insurance Institute of India, Bombay.

7. Benjamin, B. (1975)  
   Demographic Analysis, George Allen and Unwin, London.


   Urban Research Methods. Literary Licensing, LLC, WhiteFish, USA.


    Introduction to Demographic Analysis, Harvard University Press, Harvard.

QP Pattern: Unit wise internal choice with maximum 75 marks

Part A: $15 \times 1 = 15$, Part B: $2 \times 5 = 10$ & Part C: $5 \times 10 = 50$
CORE V - PROBABILITY THEORY

Unit I

Probability measure – properties – Discrete probability space and general probability space, conditional probability space. Functions and inverse functions – Random variables – Induced probability space by random variables.

Unit II


Unit III


Unit IV

Characteristic Function of random variables – properties – Inversion theorem – Simple examples – Uniqueness theorem, Levy continuity theorem (statement only).Law of Large numbers – WLLN for independent and i.i.d case – SLLN for independent and i.i.d case.

Unit V

Books for Study and Reference:


QP Pattern: Unit wise internal choice with maximum 75 marks

Part A: $15 \times 1 = 15$, Part B: $2 \times 5 = 10$ & Part C: $5 \times 10 = 50$
CORE VI - STATISTICAL ESTIMATION THEORY

Unit I


Unit II


Unit III


Unit IV


Unit V


Books for Study and Reference:


QP Pattern: Unit wise internal choice with maximum 75 marks

Part A: 15 × 1 = 15, Part B: 2 × 5 = 10 & Part C: 5 × 10 = 50
PRACTICAL – I (CALCULATOR BASED)

(Based on Core courses: Sampling theory, Statistical Estimation Theory & Demography)

The Maximum mark is 100 with 40 marks for Internal and 60 Marks for the University examination. The candidate should attend 3 questions out of 5 questions each carrying 20 marks. The Core Practical-I examination should be conducted at the end of II Semester.

Unit I

(a) Estimation of population mean, total and SE in stratified Random Sampling
(b) Estimation of population mean, total and SE in Systematic sampling.
(c) Ratio estimation and Regression estimation for population mean, total and its variance (SRS).
(d) Estimation of mean, total and variance in Cluster sampling and two stage cluster sampling with equal size clusters.

Unit II

(a) PPS sampling with replacement.
(b) Double sampling for stratification.
(c) Double sampling for Ratio estimation & Regression estimation.

Unit III

(a) UMVUE in one parameter exponential family of distribution.
(b) Maximum likelihood estimation & Methods of Moments.
(c) Interval estimation based on i) Normal ii) t iii) $\chi^2$ iv) F distributions

Unit IV

Fitting of Population Growth Models
(a) Gompertz’s Law.
(b) Makeham’s Law.
(c) Logistic Law - Method of partial sums & Method of three selected points.

Unit V

(a) Computation of Mobility measures.
(b) Probability of living and dying rate of mortality.
(c) Estimation and other measures from mortality table.
(d) Construction of Abridged life tables
   i) Reed and Merrell ii) JIA Method iii) Greville’s methods
PRACTICAL II - STATISTICAL SOFTWARE PRACTICAL – I (Using R)

The Maximum mark is 100 with 40 marks for Internal and 60 Marks for the University examination. The candidate should attend 3 questions out of 5 questions each carrying 20 marks. The Core Practical-II examination should be conducted at the end of II Semester.

Problems Relating to:

1. Using R command – Operations on vectors, logical vector, index vector and matrices
2. Graphical procedures – Bar charts, Box plots, Histograms using single & multiple groups.
3. Creating and Manipulation of data frames, using various user defined functions.
4. Calculations of probability functions and generation of random samples for various discrete and continuous distributions.
5. Writing R Functions for Descriptive statistics, Correlations and Regression coefficient
6. Statistical Inference : Confidence interval for Proportion, Mean, Median
7. Analysis of variance - One way and Two way ANOVA
CORE VI - STATISTICAL QUALITY CONTROL AND RELIABILITY

Unit I


Unit II

Acceptance sampling – lot formation – sampling inspection by attributes – single, double and multiple sampling plans – operations and its uses – OC, ASN, ATI and AOQ forms, AOQ, LTPD procedures risk and consumers risk and OC curve – Use of Dodge-Roming and other tables of plans.

Unit III

Sampling inspection by variable – merits and demerits of Variable sampling plan- known and unknown sigma variable sampling plan – derivation of OC curve and the parameters of the plan.

Unit IV


Unit V

Concept of reliability, components and systems – life distributions reliability function, Hazard function, Hazard rate, failure rate, common life distributions – exponential, Weibull and Gamma distributions – Estimation of parameters, complete samples in exponential and Weibull distribution only. Coherent systems, reliability of Coherent system.

Books for Study and Reference:


QP Pattern: Unit wise internal choice with maximum 75 marks

Part A: $15 \times 1 = 15$, Part B: $2 \times 5 = 10$ & Part C: $5 \times 10 = 50$
CORE VIII - TESTING STATISTICAL HYPOTHESES

Unit I

Test of Hypotheses. Concepts of testing hypotheses. Non-Randomized and randomized test-
Critical region, Test function, Two types of errors, Level of significance, Size of the test, Power
function. MP test - Neyman - Pearson fundamental Lemma.

Unit II

UMP test, MLR property, UMP tests for one sided test in one parameter exponential and
MLR family of distributions. Non existence of UMP test for simple hypotheses against two sided
alternatives in one parameter exponential family.

Unit III

Invariant tests – Maximal invariant statistics - Generalized Neyman - Pearson fundamental
Lemma (statement only). UMP test for two sided alternatives in one parameter exponential
family. Unbiased test, UMP unbiased test, Similar test, Neyman Structure test, Likelihood Ratio
test (Concepts & properties).

UNIT IV

Sequential Probability Ratio Test- Optimum properties of the SPRT- The Fundamental
Identity of Sequential analysis, OC and ASN function of sequential plans. Simple examples –
Application to standard statistical distributions.

UNIT V

Non-parametric test; Empirical distribution, Kolmogorov – Smirnov goodness of fit for
one sample and two sample problems, Sign test, Run test, Wilcoxon Signed- Rank test, Median
test, Mann- Whitney U test. Wald – Wolfowtz runs test, Kruskal – Wallis Test and Friedman’s
Test.
**Books for Study and Reference:**


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CORE IX - MULTIVARIATE ANALYSIS

Unit I


Unit II

Inference problems concerning the mean vector when the covariance matrix is known (one and two sample problems); likelihood ratio criterion and its application; Mahalanobis D-square and its application. Inference concerning the mean vector (s) when the covariance matrix is unknown (one and two sample problem); Generalized T-square statistics, its distribution and its application; The relationship between T-square and D-square.

Unit III

Wishart distribution (WD) (no derivation) and its properties; characteristic function of WD and its uses; test for covariance matrix. Sphericity’ test; test for the equality of covariance matrices; testing the independence of sets of variates. Multivariate analysis of variance (one way and two way classification concepts only).

Unit IV

Canonical correlation and variates; Estimation and interpretation. Classification problems, standard of good classifications; procedure of classification with two or more populations with known and unknown distributions. Classification procedures when the parent distribution are normal; Estimation of misclassification probabilities; Fisher’s discriminant function and its uses.

Unit V

### Books for Study and Reference:


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CORE X - STOCHASTIC PROCESSES

Unit I

Introduction to stochastic process (SP) – classification of SP according to state space and time domain. Countable state markov chain (MC). Chapman-Kolmogorov equations. Calculation of ‘n’ step transition probability.

Unit II


Unit III

Markov process – continuous time and continuous state space - time homogenous markov process – Kolmogorov’s equation. Wiener process as a limit of random walk, first passage time. Diffusion process with Wiener process.

Unit IV


Unit V

Branching processes - properties of generating functions of Branching processes - Probability of ultimate extinction - Martingales in discrete time – Super martingales and sub martingales, Martingale convergence theorem and its applications.
### Books for Study and Reference:


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UNIT I


UNIT II


UNIT III


UNIT IV


UNIT V

Books for Study and Reference:


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DESIGN AND ANALYSIS OF EXPERIMENTS

Unit I

Linear models - Estimability of linear parametric functions-Generalized Gauss-Markov theorem on linear estimation (BLUE) –Fixed, mixed and random effect models- ANOVA for one-way and two-way classified data – ANOCOVA for one-way and two-way classification with one concomitant variable.

Unit II

Introduction to designed experiments – Efficiency of CRD, RBD& LSD– Missing plot techniques for RBD and LSD with one (or) two missing observations – Need and scope of Split-plot design – SPD as main effect confounded design.

Unit III

General factorial experiments-analysis of symmetrical $2^n$ $(n\leq4),3^n$ $(n\leq2)$,and asymmetrical $(p \times q)$ factorial – construction and analysis of confounded (complete and partial)

Unit IV

General block designs- concepts of connectedness, balancedness and orthogonality – BIBD and its parametric relations – Information (C) matrix and criteria for connectedness of block designs - Intra and Inter block analysis of BIBD – Youden square design and its intra block analysis.

Unit V

PBIBD with ‘m’ associate classes – classifications and parametric relations of PBIBD (2) – Intra block analysis of PBIBD(2) – Need and scope of response surface experiments-applications of experimental designs to quality management technique.

Books for Study and Reference:


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<th>Author(s)</th>
<th>Title</th>
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ADVANCED OPERATION RESEARCH

Unit I

Linear Programming Problems – Graphical method, Simplex method – Big – M method – Two Phase method – Dual Simplex method

Unit II

Integer programming problem – All integer programming – Mixed integer programming – Gomory’s cutting plane method – Branch and Bound method.

Unit III


Unit IV


Unit V

Queuing models – Specification and effectiveness measures. Steady – state solutions of M/M/1 and M/M/c models with associated distributions of queue – length and waiting time. Steady – state solution of M/Ek/1 and Ek/M/1 queues- M/G/1 queue and Pollazcek Khinchine result.

Books for Study and Reference:


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Unit – I


Unit – II


Unit – III


Unit – IV

Polynomial regression. Polynomial model in one variable. Piecewise Polynomial fitting (Splines) - Non parametric regression. Kernel regression – Locally Weighted regression. Polynomial model in two or more variables.

Non-linear regression-nonlinear least square-transformation to linear model-parameter estimation.

Unit – V

Generalized Linear Models (GLM).Logistic regression-Estimation of parameters in logistic regression models-Interpretation of parameters in logistic regression models.Poisson regression-GLM-link function and linear prediction- parameter estimation in GLM.

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PRACTICAL – III (Calculator Based)

(Based on papers: Multivariate Analysis, Testing of Hypothesis, Design of Experiments and Statistical Quality Control & Operation Research)

The Maximum mark is 100 with 40 marks for Internal and 60 Marks for the University examination. The candidate should attend 3 questions out of 5 questions each carrying 20 marks. The Core Practical-III examination should be conducted at the end of IV Semester.

Unit I

(a) Finding partial, multiple correlation & Regression coefficients from Σ matrix.
(b) Testing for partial, multiple correlation and regression coefficients.
(c) Testing \( H_0: \mu = \mu_o \) When \( \Sigma \) is known & When \( \Sigma \) is unknown.
(d) Testing \( H_0: \mu^{(1)} = \mu^{(2)} \) When \( \Sigma \) is known & When \( \Sigma \) is unknown.
(e) MLE’s for \( \mu \) and \( \Sigma \) in a p –variate normal distribution.
(f) Test for dispersion matrix of p- variate Normal distribution (All Asymptotic tests)
   i) \( H_0: \Sigma = \Sigma_0 \)
   ii) \( H_0: \Sigma_1 = \Sigma_2 \)
   iii) \( H_0: \mu = \mu_o \) and \( \Sigma = \Sigma_0 \)

(g) First principal component and its variance – Extraction method

Unit II

(a) Most powerful test – Binomial, Normal, Exponential.
(b) UMP Test : One –sided - Normal, Exponential and two – sided Bernoulli
(c) UMPU Test : Binomial, Normal, Exponential
(d) Sequential Probability Ratio Test (SPRT)
   i) Bernoulli ii) Normal iii) Exponential


Unit III

(a) Statistical Analysis of RBD with two observations missing.
(b) Statistical Analysis of LSD with two observations missing.
(c) Statistical analysis of \( 2^3 \) and \( 3^2 \) factorial experiments
(d) Statistical analysis of BIBD (intra block analysis only)

UNIT IV

(a) Construction of moving average control chart.
(b) Construction of EWMA control chart.
(c) Acceptance sampling plan for variables – construction of one sided - procedure schemes, known and unknown sigma plans – O.C.curves.

Unit V

(a) Integer Programming Problem :
   i) Gomory’s Cutting Plan Method for Pure IPP.
   ii) Gomory’s Cutting Plan Method for Mixed IPP.
(b) Quadratic Programming problem
   i. Wolfe’s modified Simplex Method
   ii. Beale’s Method
STATISTICAL SOFTWARE PRACTICAL –II (Using SPSS)

The Maximum mark is 100 with 40 marks for Internal and 60 Marks for the University examination. The candidate should attend 3 questions out of 5 questions each carrying 20 marks. The Core Practical-I examination should be conducted at the end of II Semester.

Problems relating to:

1. Functions of Statistics (Classification, Diagrams and Graphical representation of Data)
2. Descriptive Statistics
3. Calculation of Probabilities under various distributions
4. Correlation & Regression – Partial and Multiple Correlations, Multiple Regression
5. Curve Fitting, Time series and Forecasting
6. Confidence Intervals for mean, variance, proportions
7. Inferential Statistics for Single through multiple samples. (Chi – Square, t, F and Z test)
8. Non – Parametric tests.
9. Experimental Design: One way ANOVA , Two way ANOVA – Factorial designs – Multiple comparison tests
10. Multivariate : Principal component and discriminant analysis – Factor Analysis
PROJECT WORK

Project/Dissertation work shall be carried out under the supervisor of a Faculty member on the recommendation of the Head of the Department. **Three copies** of the Project report should be submitted at least two weeks before the last working day of the fourth semester. The Marks for the Project work is 100 and the components are:

- **Internal Assessment:** : 40 Marks
  (For two reviews 20+20 = 40)

- **Evaluation of Project report by External Examiner and Supervisor** : 40 Marks

- **Viva-Voce by External Examiner and Supervisor** : 20 Marks

The Evaluation of the Project will be based on Project Report and a VIVA-VOCE examination to be conducted by the Supervisor and an External Examiner.
ECONOMETRICS

Unit I


Unit II

General Linear Model (GLM) and its extension. Ordinary Least square (OLS) estimation and prediction .Generalized Least square (GLS) estimation and prediction and their properties – problem of hetroscedasticity and multicollinearity pure and mixed estimation. Grouping of observations and equations.

Unit III

Single equation linear model – dynamic case; Autocorrelation and its consequences

Testing for Autocorrelation; Theil’s BLUS procedure .Estimation and Prediction Estimation of parameters of a linear model with auto correlated disturbances and distributed lag models – Errors in variable models.

Unit IV

Simultaneous linear equation model – Examples. Identification problem .Estimation

Using LIM, Instrumental Variables. 2 – SLS methods.

Unit V

K class estimators; Full information Maximum Likelihood methods .3-SLS estimators-Simultaneous LSE and integrated LST methods .Monte Carlo studies and simulation – Concepts of structural change – Tests of structural change.

Books for Study and Reference:

   Econometrics models (3rd edition), McGraw Hill, Tokyo.

   Econometric models :- Techniques and Applications, Prentice Hall of India.
   **An introduction to Econometrics**, McMillan & Co.

4. Gold Berger. (1964)  
   **Econometric theory**, Wiley.

   **Mathematical Economics**, McMillan & Co.

   **Econometrics**, McGraw Hill.

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Elements of Operations Research

Unit I


Linear programming problem. Formulation of LPP.

Unit II

Graphical method of solving LPP.Simplex method –Big M method.Concept of duality in LPP.Formulation of dual problems only.

Unit III


Unit IV

Sequencing: problem of sequencing- basic terms used in sequencing- processing ‘n’ jobs through two machines- processing ‘n’ jobs through ‘k’ machines- processing two jobs through ‘k’ machines.

Unit V

Game Theory: Definition-types of games- The Maximin - Minimax principle. Games without saddle points (mixed strategies)-graphical method of 2 x n and m x 2 games - Dominance property.

Books for Study and Reference:


QP Pattern: Unit wise internal choice with maximum 75 marks

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Statistical Methods

Unit I


Unit II

Measures of central tendency: concept and uses. Mean, Median, Mode, Geometric Mean and Harmonic mean.

Measures of variation: concept and uses. Range, Quartile deviation, standard deviation and coefficient of variation. Measures of Skewness.

Unit III


Unit IV

Simple linear correlation: meaning and its uses. Scatter diagram-Karl pearson (product moment) correlation-rank correlation.


Unit V


Books for Study and Reference:


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Part A: 15 × 1 = 15, Part B: 2 × 5 = 10 & Part C: 5 × 10 = 50