THIRUVALLUVAR UNIVERSITY
MASTER OF SCIENCE

M.Sc. DEGREE COURSE in STATISTICS
(with effect from 2020 – 2021)

The Course of Study and the Scheme of Examination

Sl. No.	Study Components / Course Title		ins. hrs / week	Credit	Title of the Paper	Maximum Marks		
						CIA	Uni. Exam	Total
SEMESTER I								
1	Core	Paper-1	5	4	Mathematical Analysis	25	75	100
2		Paper-2	5	4	Measure and Probability Theory	25	75	100
3		Paper-3	5	4	Distribution Theory	25	75	100
4		Paper-4	5	4	Programming in R	25	75	100
		Practical-1	2	-	Statistical Practical – I	-	-	-
		Practical-2	2	-	Statistical Software Practical – I (Using R)	-	-	-
Internal Elective for same major students (Choose any one)								
5	**Core Elective**	**Paper-1**	3	3	A. Official Statistics B. Advanced Operations Research	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
6	**Open Elective**	**Paper-1**	3	3	A. Basic Statistics B. Operations Research	25	75	100
			30	**22**		**150**	**450**	**600**
SEMESTER II						CIA	Uni. Exam	Total
7	Core	Paper-5	6	4	Sampling Theory	25	75	100
8		Paper-6	6	4	Estimation Theory	25	75	100
9		Practical-1	4	3	Statistical Practical – I	40	60	100
10		Practical-2	4	3	Statistical Software Practical – I (Using R)	40	60	100
Internal Elective for same major students (Choose any one)								
11	**Core Elective**	**Paper-2**	4	3	A. Linear Regression Analysis B. Actuarial Statistics	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
12	**Open Elective**	**Paper-2**	4	3	A. Probability and Statistics B. Indian Official Statistics	25	75	100
13	***Field Study**		-	2		100	-	100
14	**Compulsory Paper**		2	2	**Human Rights**	25	75	100
			30	**24**		**305**	**495**	**800**

Note:

➢ Evaluation of Core Practical : CIA : 25 Marks + Practical Record 15 Marks = 40 Marks

➢ $^{\$\$}$ Evaluation of Project (50) + Project Viva-voce (25)

➢ ** A student has to complete at least 2 credits course through MOOC under SWAYAM portal in the subject category of Mathematical Sciences before end of THIRD semester. Website maintained by UGC : https://swayam.gov.in/

➢ Students can find e-books and e-materials through the website e-Pgpathsala maintained by UGC: http://epgp.inflibnet.ac.in/

* Field Study

There will be field study which is compulsory in the first semester of all PG courses with 2 credits. This field study should be related to the subject concerned with social impact. Field and Topic should be registered by the students in the first semester of their study along with the name of a mentor before the end of the month of August. The report with problem identification and proposed solution should be written in not less than 25 pages in a standard format and it should be submitted at the end of second semester. The period for undergoing the field study is 30 hours beyond the instructional hours of the respective programme. Students shall consult their mentors within campus and experts outside the campus for selecting the field and topic of the field study. The following members may be nominated for confirming the topic and evaluating the field study report.

(i). Head of the respective department

(ii). Mentor

(iii). One faculty from other department

THIRUVALLUVAR UNIVERSITY
VELLORE - 632 115

M.Sc. STATISTICS
SYLLABUS

(with effect from 2020 - 2021)

List of Core / Elective / Open Elective Subjects

Core Subjects
1. Mathematical Analysis
2. Measure and Probability Theory
3. Distribution Theory
4. Programming in R
5. Sampling Theory
6. Estimation Theory
7. Statistical Practical-I
8. Statistical Software Practical-I (Using R)
9. Testing Statistical Hypotheses
10. Design and Analysis of Experiments
11. Multivariate Analysis
12. Statistical Quality Control
13. Stochastic Processes
14. Statistical Practical-II
15. Statistical Software Practical-II (Using SPSS)
16. Project with Viva-voce

Core Elective Subjects (for students of Statistics)
1. A. Official Statistics
   B. Advanced Operations Research
2. A. Linear Regression Analysis
   B. Actuarial Statistics
3. A. Statistical Methods of Epidemiology
   B. Data Mining
4. A. Econometrics
   B. Biostatistics and Survival Analysis

Open Elective Subjects (for students of other departments)

1. A. Basic Statistics
   B. Operations Research
2. A. Probability and Statistics
   B. Indian Official Statistics
3. A. Business Statistics
   B. Research Methodology
4. A. Descriptive Statistics
   B. Statistical Methods for Researchers

CORE SUBJECTS

Name of the course/subject: M.Sc. Statistics   **Semester: I**
Name of the Paper: Mathematical Analysis **Credits: 4** **Hours of teaching: 5**
Paper type: Core
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Course Objective(s)

  To enable students to gain knowledge in real analysis and matrix theory towards better understanding of mathematical statistics.

Unit-1: Metric Space – open, closed sets – Intervals (rectangles), Real valued Continuous functions-Discontinuities - compact sets, Bolzano – Weirstrass theorem, Heine – Borel theorem.

Unit-2: Derivatives - maxima and minima - Riemann integral & Riemann – Stieltjes integral with respect an increasing integrator – properties of R. S. integral. Functions of several variables, constrained and unconstrained maxima – minima of functions, partial and total derivatives

Unit-3: Basic properties of matrices (orthogonal, idempotent, kronecker product, projection operators etc); Linear dependence, independence and rank of a matrix; characteristic roots and polynomial, multiplicity of characteristic roots; Cayley Hamilton theorem; inverse of a matrix and determinants;

Unit-4: Reduction of matrices, Echelon form, Hermite canonical form, diagonal reduction, rank factorization, triangular reduction Jordan form; Symmetric matrices and its properties; Decomposition - singular value decomposition, spectral decomposition, Cholesky decomposition.

Unit-5: Matrix differentiation; generalized inverse and its properties, Moore-Penrose inverse; Application of g-inverse; Quadratic forms, classification, definiteness, index and signature, extremum; transformation and reduction of quadratic form; applications of quadratic forms.

Text Books:

  Unit-1 and 2 : Rangachari,M.S.(1996): Real Analysis, Part 1, NewCentury Book House.
  Unit-3, 4 and 5: Rao, C.R. & Bhimasankaran, P.(1992) : Linear algebra, Tata McGraw Hill Pub. Co. Ltd.

Reference Books:

1. Apostol, T.M. (1985) : Mathematical Analysis, Narosa Publishing House Ltd., New Delhi
2. Royden, H.L.(1995) : Real analysis, 3ed., Prentice Hall of India.
3. Ash, R.B. (1972): Real analysis and probability, Academic press.
4. Biswas, S. (1984): Topics in Algebra of Matrices, Academic Publications.
5. Graybill, F.A. (1983): Matrices with application in Statistics, 2nd ed. Duxbury Press.
6. Searle, S.R. (1982): Matrix Algebra useful for Statistics, John Wiley and Sons, Inc.

Course outcomes

1. After studying unit-1, the student will be able to understand concepts of metric spaces, properties related to functions and discontinuities
2. After studying unit-2, the student will be able to understand concepts of Riemann integral and its properties, method of optimizing functions and concepts of derivatives.
3. After studying unit-3, the student will be able to understand various properties of matrices.
4. After studying unit-4, the student will be able to understand the methods of reducing and decomposing matrices.
5. After studying unit-5, the student will be able to understand matrix inversion, quadratic forms and its applications.

Name of the course/subject: M.Sc. Statistics   Semester: I
Name of the Paper: Measure and Probability Theory   Credits: 4   Hours of teaching: 5
Paper type: Core
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Course Objective(s)

To enable students to gain knowledge in fundamental concepts and results related to measure theory and probability theory.

Unit-1: Measure Theory - Limits of sequence of sets, classes of sets – Field, Sigma Field and Monotone class, Measure and Measure Space – Measurable function

Unit-2: Lebesgue – Stieltjes measure, Measure integral and its properties, Dominated convergence theorem – Radon–Nikodymn theorem, almost everywhere convergence, convergence in measure and convergence in mean.

Unit-3: Events, sample space, different approaches to probability, random variables and random vector, Distribution functions of random variables and random vector, Expectation and moments, basic, Markov, Chebyshev's, Holder's, Minkowski's and Jensen's inequalities.

Unit-4: Independence of sequence of events and random variables, conditional probability, conditional expectation, Characteristic functions and their properties, inversion formula, convergence of random variables, convergence in probability, almost surely, in the r-th mean and in distribution, their relationships, convergence of moments, Helly-Bray theorem, continuity theorem and convolution of distributions.

Unit-5: Central limit theorem, statement of CLT, Lindeberg, Levy and Liapounov forms with proof and Lindeberg Feller's form examples. Khintchine's weak law of large numbers, Kolmogorov inequality, strong law of large numbers.

Text Books:

Unit-1 and 2: Parthasarthy, K.R. (1977): Introduction to probability and measure, MacMillan
Unit-3, 4, and 5: Bhat, B.R. (1985) : Modern probability theory, 2nd ed. Wiley Eastern.

Reference Books:

1. Chow, Y.S. and Teicher, H. (1979): Probability theory, Springer verlag.
2. Munroe, M.E. (1971): Measure and integration, 2nd ed. Addision Wesley.
3. Halmos, P.R. (1974): Measure theory, East-West.

Course outcomes

1. After studying unit-1, the student will be able to understand concepts of class, field and measurable space.
2. After studying unit-2, the student will be able to understand concepts of measure integrals and convergence.
3. After studying unit-3, the student will be able to understand various approaches for finding probability, concept of random variables and moments, results related to various inequalities.
4. After studying unit-4, the student will be able to understand the concept of independence, characteristic function and convergence of random variables.
5. After studying unit-5, the student will be able to understand various limit theorems and laws of large numbers.

Name of the course/subject: M.Sc. Statistics   **Semester: I**
Name of the Paper: Distribution Theory   **Credits: 4   Hours of teaching: 5**
Paper type: Core

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Course Objective(s)

To enable students to gain knowledge about various probability distributions (discrete and continuous case) and their properties and characterizations.

Unit-1 : Brief review of distribution theory, functions of random variables and their distributions using Jacobian of transformation, Laplace and Cauchy distribution, lognormal distribution, gamma, logarithmic series.

Unit-2: Bivariate distributions: Normal, exponential, Poisson; Compound, truncated and mixture of distributions, concepts of convolution.

Unit-3: Sampling distributions, non-central chi-square distribution, t and F distributions and their properties, distributions of quadratic forms under normality.

Unit-4: Order statistics their distributions and properties, Joint and marginal distributions of order statistics, extreme value and their asymptotic distributions, approximating distributions of sample moment, delta method.

Unit-5: Kolmogorov Smirnov distributions, life distributions, exponential, Weibull and extreme value distributions, Mills ratio, distributions classified by hazard rate.

Text Books:

Unit-1 and 2 : Rohatgi, V.K. and Md. Saleh, A.K. (2002): An introduction to probability & Statistics, John Wiley and Sons.
Unit-3: Mood, A.M. &Graybill, F.A. and Boes, D.C. : Introduction to the theory of statistics, McGraw Hill.
Unit 4 and 5: Robert V. Hogg, Joeseph McKean, Allen T Craig (2012): Introduction to mathematical Statistics, Pearson.

Reference Books:

1. Rao, C.R. (1973): Linear statistical inference and its applications, 2ed, Wiley Eastern.
2. Johnson, S. & Kotz,(1972): Distributions in Statistics, Vol. I, II & III, Houghton
3. Miffin. Dudewicz, E.J., Mishra, S.N. (1988) : Modern mathematical Statistics, John Wiley.

Course outcomes:

1. After studying unit-1, the student will be able to understand concepts and applications of univariate distributions.
2. After studying unit-2, the student will be able to understand concepts of and applications of bivariate, truncated and convoluted distributions.
3. After studying unit-3, the student will be able to understand various sampling distributions and their properties.
4. After studying unit-4, the student will be able to understand the concept of order statistics and their distributions.
5. After studying unit-5, the student will be able to understand life distributions and its applications.

Name of the course/subject: M.Sc.Statistics   **Semester: I**
Name of the Paper: Programming in R   **Credits: 4   Hours of teaching: 5**
Paper type: Core
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Course Objective(s)

To enable students to gain working knowledge on basic and advanced statistical functions available in R programming language

Unit-1:
R data types, Operations on matrices, dataframes, lists, setwd, read.table, read.csv, write.csv, creation of new variables, categorization, cut, factor; round, apply, creation of patterned variables-saving output to a file.

Unit-2:
Graphics in R- the plot command, histogram, barplot, boxplot- points, lines, segments, arrows, paste-inserting mathematical symbols in a plot, pie diagram, customization of plot-setting graphical parameters-text and mtext, the pairs command, colours and palettes, saving to a file.

Unit 3:

Basic Statistics- obtaining descriptive statistics, measures of correlation and association, generating samples from standard discrete and continuous distributions, one and two sample t-tests, F-test for equality of variances, chi-squared test of independence, fitting of distributions, qq plot.

Unit 4:

Matrix operations- addition, subtraction, multiplication, determinant, inverse, solving linear equations, computing eigenvalues, matrix decomposition- lu, qr and svd, finding g inverse, finding a basis, orthonormalization, finding rank.

Unit 5:

Linear model–fitting of linear model, goodness of fit measures, predicted values and residuals; residual plots, checking assumptions of the model, ANOVA table.

Text Books (for Units 1 to 5)

1. Purohit, S. G., Gore, S. D., and Deshmukh, S. R. (2009). Statistics Using R, Narosa Publishing House, NewDelhi.

Reference Books

1. Everitt, B. S., and Hothorn, T. (2010): A Handbook of Statistical Analyses Using R, Second Edition, Chapman and Hall/CRC Press.
2. Crawley, M.J. (2013): The R Book, John Wiley and Sons, Limited

E-Resources

www.r-project.org

Course outcomes

1. After studying unit-1, the student will be able to perform operations on matrices, lists and data frames.
2. After studying unit-2, the student will be able to plot diagrams and graphs in R.
3. After studying unit-3, the student will be able to perform statistical analysis in R.
4. After studying unit-4, the student will be able to perform matrix operations and manipulations in R.
5. After studying unit-5, the student will be able to fit linear models in R.

Name of the course/subject: M.Sc. Statistics   Semester: II
Name of the Paper: Sampling Theory   Credits: 4   Hours of teaching: 6
Paper   type: Core
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Course Objective(s)

To enable students to understand various sampling schemes, their properties and applications

Unit-1

Population and Sample – Census and sample survey– sampling–sampling design–sampling and non-sampling errors–non-response and its effects–sample surveys– principal steps in sample survey-limitations of sampling – sampling schemes

Unit-2

Simple Random Sampling (with and without replacement): Notations and terminology - Estimates of population total, mean and their variances and standard errors – Pooling of estimates -Determination of sample size. Simple random sampling for attributes.

Unit-3

Stratified random sampling: Estimates of population total, mean and their variances-Related properties –Allocation of sample sizes – Neyman's proportional and optimum allocations-Comparison of stratified sampling with simple random sampling-Estimation of proportion under stratified random sampling.

Unit-4

Systematic sampling: Estimates of population total, mean, and their variances and standard errors – systematic sampling with linear trend–comparison of systematic sampling with stratified and simple random sampling– circular systematic sampling –Two stage sampling with equal number of second stage units and cluster sampling.

Unit-5

Varying Probability Sampling: Probability proportional to size(PPS)sampling (with and without replacement)–Stratified PPS–Selection procedures–Ordered and unordered estimates– Desraj, Horwitz–Thompson and Murthy's estimates. Ratio Estimates–Methods of estimation, approximate variance of the Ratio Estimate-Regression Estimators–Difference Estimators, Regression Estimators in Stratified Sampling.

Text Books

For Units 1 - 4
   1. Cochran, W.G.(1977). Sampling Techniques, Third Edition, John Wiley & Sons, NY.
For Unit 5
   2. Singh D. and Chowdhary,F.S.(2018).Theory and Analysis of Sample Survey Design, New Age International Private Ltd., New Delhi.

Reference Books

   1. Des Raj (1978): Sampling Theory, Tata-McGrawHill, New Delhi.
   2. Sukhatme, P. V. and Sukhatme, B. V. (1970): Sampling Theory of Surveys with Applications, Asia Publishing House, New Delhi.

3. Sampath,S.(2000): Sampling Theory and Methods, Narosa Publishing Company, New Delhi.
4. Murthy,M.N.(1967): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.

Course outcomes

1. After studying unit-1, the student will be able to understand concepts related to census, sampling schemes and surveys.
2. After studying unit-2, the student will be able to understand concepts of simple random sampling scheme and its associated results.
3. After studying unit-3, the student will be able to understand stratified random sampling scheme and its associated results.
4. After studying unit-4, the student will be able to understand different systematic sampling schemes and its associated results.
5. After studying unit-5, the student will be able to understand different probability sampling schemes, ratio and regression estimators and their properties.

Name of the course/subject: M.Sc. Statistics   **Semester: II**
Name of the Paper: Estimation Theory   **Credits: 4   Hours of teaching: 6**
Paper type: Core

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Course Objective(s)

To enable students to understand various concepts of point and interval estimation, Bayesian estimation and their associated results

Unit-1: Parametric point estimation – properties of estimators – Consistency and its different forms - Sufficient statistics, Factorization theorem, the existence and construction of minimal sufficient statistics, Minimal sufficient statistics and exponential family, sufficiency and completeness, sufficiency and invariance.

Unit-2: Unbiased estimation: Minimum variance unbiased estimation, locally minimum variance unbiased estimators, Rao Blackwell – theorem. Completeness- Lehmann Scheffe theorems, Necessary and sufficient condition for unbiased estimators

Unit-3: Cramer- Rao lower bound, Bhattacharya system of lower bounds in the one-parameter regular case. Chapman -Robbins inequality.

Unit-4: Maximum likelihood estimation, computational routines, strong consistency of maximum likelihood estimators, Asymptotic Efficiency of maximum likelihood estimators, Best Asymptotically Normal estimators, Method of moments.

Unit- 5: Interval estimation – Pivotal method of construction – shortest confidence intervals and their construction (minimum average width) – Baye's and minimax estimation: The structure of Baye's rules, Baye's estimators for quadratic and convex loss functions, minimax estimation.

Text Books

 For Units 1 to 5

1. Rajagopalan, M. and Dhanavanthan, P. (2012): Statistical Inference, PHI Learning, New Delhi.

Reference Books

1. Lehmann, E.L and Casella G. (1998): Theory of Point Estimation, 2/e, Wiley Eastern Ltd.
2. B.K.Kale and K.Muralidharan (2015): Parametric Inference – An Introduction, Narosa Publishing House.
3. Kale, B.K. (1999): A First course on Parametric Inference, Narosa Publishing House.
4. Zacks,S. (1981): Parametric Statistical Inference, John Wiley, NY.
5. Srivastava, Khan and Srivastava (2014): Statistical Inference: Theory of Estimation, PHI, India
6. Rohatgi, V.K. and Md. Saleh, A.K. (2002): An introduction to probability & Statistics, John Wiley and Sons.

7. Gupta, S. C., and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi

Course outcomes

1. After studying unit-1, the student will be able to understand properties of estimators and concept of sufficient statistic and different ways of obtaining sufficient statistic.
2. After studying unit-2, the student will be able to understand concepts results pertaining to unbiased estimators and minimum variance unbiased estimators.
3. After studying unit-3, the student will be able to understand inequalities related to variance of unbiased estimators.
4. After studying unit-4, the student will be able to understand the methods of moment and maximum likelihood estimation and its associated properties.
5. After studying unit-5, the student will be able to understand the method of performing interval estimation and Bayes estimation.

Name of the course/subject: M.Sc. Statistics   **Semester: II**
Name of the Paper: Statistical Practical-1   **Credits: 3   Hours of teaching: 4**
Paper type: Practical
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Course Objective(s)

To enable students to solve problems related to probability distributions, sampling techniques, methods of estimation and Markov chains using real life data

Problems relating to the following topics which are covered in Semester I and Semester II shall form the basis for practical:

1. **Distribution Theory** (problems related to standard discrete and continuous distributions)

2. **Sampling Theory** (problems related to simple random, stratified, linear systematic sampling schemes, ratio and regression estimators)

3. **Estimation Theory** (problems related to method of moments, maximum likelihood, interval estimation)

4. **Stochastic Processes** (problems related to transition probability, classification of states, time series modeling)

Text Books

Books prescribed in the respective core papers shall be used.

Note

The maximum marks for continuous internal assessment and end semester University examination for Statistical Practical-1 shall be fixed as 40 and 60, respectively. The continuous internal assessment shall involve test and record work. The question paper at the end semester examination shall consist of **four questions with internal choice**. A candidate shall attend all the four questions, each of which shall carry 15 marks. The examination shall be conducted at the end of Semester II.

Name of the course/subject: M.Sc. Statistics   **Semester: II**
Name of the Paper: Statistical Software Practical-1(Using R)   Credits:3 Hours of teaching:4
Paper type: Practical
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Course Objective(s)

To enable students to utilize the theoretical knowledge gained in the core papers and to develop computational and technical skills for real life applications emphasizing the importance of R programming.

Problems relating to the following topics shall form the basis for the practical.

1. Using R command-Operations on vectors, logical vector, index vector and matrices. Creating and Manipulation of data frames, using various user defined functions.

2. Matrix addition, multiplication, inverse, transpose, determinant and trace of matrix.

3. Construction of table with one or more variables.

4. Graphical procedures– Pie chart, Bar chart, Histograms and Boxplots.

5. Computation of various descriptive measures such as Measures of central tendency, measures of dispersion, skewness and kurtosis.

6. Sample selection under various sampling methods.

7. Calculations of probability functions and generation of random samples for various discrete and continuous distributions.

8. Computation of correlations and regression co-efficient. Fitting of Linear and non linear models.

Text Books

Books as prescribed in core paper Programming in R of semester I.

E-Resources

www.r-project.org

Note

The maximum marks for continuous internal assessment and end semester University examination for Statistical Software Practical-1(Using R) shall be fixed as 40 and 60, respectively. The continuous internal assessment shall involve test and record work. The question paper at the end semester examination shall consist of **four questions with internal choice**. A candidate shall attend all the four questions, each of which shall carry 15 marks.

Name of the course/subject: M.Sc. Statistics   Semester: I
Name of the Paper: Official Statistics   Credits: 3 Hours of teaching: 3
Paper type: Core Elective
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Course Objectives

To enable students to learn about Survey Organizations, to know about Data Collection, to study about Agriculture Statistics, to study the Index numbers, to study measures of national income

Unit-1: Statistical System in India: Central and State Government Organizations, Functions of Central Statistical Organization (CSO), National Sample Survey Organization (NSSO). Organization of large scale sample surveys. General and special data dissemination systems.

Unit-2: Official statistics: Meaning, methods of collection, limitations and reliability. Principal publications containing data on the topics such as population, agriculture, industry, trade, prices, labour and employment, transport and communications - Banking and finance.

Unit-3: System of Collection of Agricultural Statistics - Crop forecasting and estimation - Productivity, fragmentation of holdings - Support prices - Buffer stocks - Impact of irrigation projects**.** Statistics related to industries, foreign trade - Balance of payment - Inflation - Social statistics.

Unit-4: Index Numbers: Price, Quantity and Value indices. Price Index Numbers: Construction, Uses, Limitations, Tests for index numbers, Chain Index Number. Consumer Price Index, Wholesale Price Index and Index of Industrial Production – Construction of index numbers and uses.

Unit-5: National Income – Measures of national income - Income, expenditure and production approaches - Applications in various sectors in India. Measurement of income inequality: Gini's coefficient, Lorenz curves, Application of Pareto and Lognormal as income distribution.

Text Books

1. Allen R. G. D. (1975). Index Numbers in Theory and Practice, Macmillan.
2. Bhaduri, A. (1990). Macroeconomics: The Dynamics of Commodity Production, Macmillan India Limited, New Delhi.
3. Branson, W. H. (1992). Macroeconomic Theory and Policy, Third Edition, Harper Collins Publishers India (P) Ltd., New Delhi.
4. C. S. O. (1990). Basic Statistics Relating to the Indian Economy.
5. C.S.O. (1995). Statistical System in India.
6. C. S. O. (1999). Guide to Official Statistics.

Reference books

1. Goon A. M., Gupta M. K., and Dasgupta. B. (2001), Fundamentals of Statistics, Vol. 2, World Press, India.
2. Mukhopadhyay, P. (2011). Applied Statistics, Second Edition, Books & Allied Ltd, India.
3. Panse, V. G. (1964). Estimation of Crop Yields (FAO), Food and Agriculture Organization of the United Nations.

Course Outcomes

1. **After studied unit-1, the student will be able to know D**ifferent organizations
2. **After studied unit-2, the student will be able to know** Methods of Data Collection
3. **After studied unit-3, the student will be able to know** Crop forecasting
4. **After studied unit-4, the student will be able to know Index numbers**
5. **After studied unit-5, the student will be able to know** measures of national income.

Name of the course/subject: M.Sc. Statistics   **Semester: I**
Name of the Paper: Advanced Operations Research   **Credits: 3 Hours of teaching: 3**
Paper type: Core Elective
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Course Objectives

To enable students to learn various optimization techniques such as Integer programming, Dynamic Programming, Non-linear Programming, Stochastic Models, Inventory Models

Unit-1: Integer Programming – Pure and Mixed Integer programming problems – Cutting Plane Algorithm – Mixed Algorithm With proof. Additive and Zero One algorithm – Branch and Bound method

Unit-2: Dynamic Programming – Modelling and solving of recursive equations – Cargo Loading Model – Reliability Model – Warehousing Model – Investment Model. Solving of optimization problems of mathematical nature using dynamic programming models.

Unit-3: Non-Linear programming – Kuhn-Tucker conditions – Wolfe's and Beale's method – with proof – Simple applicaitons.

Unit-4: Stochastic programming – Chance constrained optimization problems – E, V and EV models – Simple applications.

Unit-5: Inventory models – Single item and multi-item (Deterministic and Nondeterministic) inventory models with and without back logs.

Text Books

1. Taha, H : Operations Research, Prentice Hall of India, 8th edition,2007
2. Rao. S.S. : Engineering Optimization, New Age International (P) Ltd, New Delhi 2004
3. Kambo,N S : Mathematical Programming techniques, Affiliated East-west Press Pvt. Ltd.1991
4. Sharma J K : Operations Research, Macmillan, New Delhi, 3rd Edition, 2007

Reference books

1. Manmohan, Kanti Swarup and Gupta, Operations Research – Prentice Hall – New Delhi

Course Outcomes

1. After studied unit-1, the student will be able to know Inter programming problem
2. After studied unit-2, the student will be able to know Dynamic programming
3. After studied unit-3, the student will be able to know Non-Linear Programming
4. After studied unit-4, the student will be able to know Stochastic programming
5. After studied unit-5, the student will be able to know Inventory models.

Name of the course/subject: M.Sc. Statistics   **Semester: II**
Name of the Paper: Linear Regression Analysis   Credits: 3 Hours of teaching: 3
Paper type: Core Elective
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Course Objectives

To enable students to learn about Least square estimation, removal of heteroscedasticity, to study about Multicollinearity, to study the Robust Estimators, to study Binomial, Poisson regression and Logistics regressions

Unit-1: Linear models, Estimation – Least square estimation of parameters and properties (BLUE), Gauss Markov theorem – Estimation by MLE, Testing – general linear hypothesis and sub hypothesis, Interval estimation – classification of linear models (Fixed, random and mixed).

Unit-2: Model Adequacy checking – Residual analysis, detection and treatment of outliers, Transformation to correct model adequacies – variance stabilizing transformation, transformation to achieve linearity, removal of heteroscedasticity – principle of weighted least squares.

Unit-3: Multicollinearity – Sources and effects of multicollinearity, multicollinearity diagnostics, methods of dealing with multicollinearity, impact on forecasting.

Unit-4: Robust estimators – need for robust regression, types of estimators, properties and computational aspects of robust regression.

Unit-5: Generalized Linear models – models with Binary response variable, estimation and testing in a logistic regression model, Poisson regression, link functions, estimation and inference in the GLM.

Text Books

1. D.C. Mongomery et al (2003) -. Introduction to Linear Regression Analysis (3rd ed.) Wiley & Sons

Reference books

1. P.McCullagh and J.A. Nelder (1989) 2nd ed Generalised Linear Models, Chapman and Hall, London

2. Doshi, D.D. (1987) : Linear estimation and design of experiments, Wiley Eastern Ltd. Searle, S.R. (1971) Linear Models John Wiley,NY
3. Anand M. Kshirsagar(1983) A Course on Linear Models, Marcel dekker, NY

Course Outcomes

1. **After studied unit-1, the student will be able to know** Estimation (BLUE)
2. **After studied unit-2, the student will be able to know** Residual Analysis
3. **After studied unit-3, the student will be able to know** Multicollinearity
4. **After studied unit-4, the student will be able to know** Robust estimators
5. **After studied unit-5, the student will be able to know** GLM.

Name of the course/subject: M.Sc. Statistics   **Semester: II**
Name of the Paper: Actuarial Statistics   **Credits: 3 Hours of teaching: 3**
Paper type: Core Elective
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Course Objectives

To enable students to learn about Compund Interest, present values, annuities, to know about Mortality table, to study about Average yield on Funds, to study premiums and loading effect, to study Policy Values

Unit-1: Elements of Compound Interest (nominal and effective rates of interests). Annuities certain, Present values, accumulated amounts, deferred annuities – Simple problems.

Unit- 2: Redemption of loans, Sinking funds, The Average yield on the life fund of an insurance office. Simple Problems

Unit-3: The mortality table – construction, characteristics and uses of mortality table . The features of Indian assured lives, Orientals 1925-1935 mortality tables. The LIC (1961-64) table and the LIC(1970-73) table – Simple Problems.

Unit-4: Premiums, general principles, natural premiums, level premiums, office premiums, loading for expenses. With profit and without profit premiums, adequacy of premiums relative consistency

Unit-5: Life office valuation, General principles, Policy values, Retrospective and prospective methods of valuation of liabilities. (net premium, gross premium and bounds reserve) Sources of surplus principle method of surplus.

Text Books

1. Federation of Insurance Institutes study courses: Mathematical Basic of the Life Assurance.

Reference Books

1. Donald D.W.A. (2016). Compound Interest and Annuities-Certain, Cambridge University

Press, UK.

2. Neil, A. (1977). Life Contingencies, Heinemann for the Institute of Actuaries and the Faculty of Actuaries.
3. Deshmukh, S.R. (2009). Actuarial Statistics, Pune University Press.
4. Gupta, S. C., and Kapoor, V. K. (2014). Fundamentals of Applied Statistics, Fourth Edition, Sultan Chand & Sons, New Delhi

Course Outcomes

1. After studied unit-1, the student will be able to know Present values and annuities

2. After studied unit-2, the student will be able to know Insurance sectors

3. After studied unit-3, the student will be able to know Mortality table and LIC table

4. After studied unit-4, the student will be able to know Premiums and Profits

5. After studied unit-5, the student will be able to know Net Premium and Surplus.

Open Elective Subjects (for students of other departments)

Name of the course/subject: PG   **Semester: I**
Name of the Paper: Basic Statistics   **Credits: 3 Hours of teaching: 3**
Paper type: Open Elective
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COURSE OBJECTIVES

To enable the students to analyze the given data and make them solve simple real life problems related to descriptive measures in statistics.

UNIT I:
Collection of data – Primary and Secondary data – Methods of Collecting Primary data – Drafting the Questionnaire – Pretesting the Questionnaire – Specimen Questionnaire – Sources of Secondary data – Editing Primary and Secondary data – Precautions in the use of Secondary data.

UNIT II:
Classification of data – Meaning and Objectives of Classification – Types of Classification – Formation of a Discrete Frequency Distribution - Formation of a Continuous Frequency Distribution – Tabulation of data – Parts of a Table – General rules of Tabulation – Types of Tables.

UNIT III:
Presentation of data – Significance of Diagrams and Graphs – General rules for Constructing Diagrams – Types of Diagrams – Graphs – Graphs of Frequency Distributions.

UNIT IV:
Measure of Central tendency – Objectives of Averaging – Requisites of a Good Average – Types of Averages – Arithmetic Mean – Median – Mode – Geometric Mean – Harmonic Mean – trimmed mean

UNIT V:
Measures of variation - Significance of Measuring Variation – Properties of a Good Measure of Variation- Methods of Studying Variation – range – standard deviation – variance – coefficient of variations

Text Books

1. Gupta, S. P. (2012). Statistical Methods, Sultan Chand & Sons, New Delhi.
2. Gupta, S C., and Kapoor, V. K. (2018). Fundamentals of Mathematical Statistics, Eleventh Edition, Sultan Chand & Sons, New Delhi.

Reference Books

1. Goon, A. M., Gupta, M. K., and Das Gupta, B. (2013). Fundamentals of Statistics, Vol.1, World Press Private Ltd, Calcutta.
2. Rohatgi, V. K. (1988). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern (India) Ltd., New Delhi.

COURSE OUTCOMES

1. After studied unit-1, the student will be able to know various methods of data collection
2. After studied unit-2, the student will be able to know various methods of classification
3. After studied unit-3, the student will be able to know various presentations of data
4. After studied unit-4, the student will be able to know measure of central tendency
5. After studied unit-5, the student will be able to know measure of variation

Name of the course/subject: PG   **Semester: I**
Name of the Paper: Operations Research   **Credits: 3 Hours of teaching: 3**
Paper type: Open Elective
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Course Objectives

To enable students to learn optimization techniques such as graphical method, simplex programming, transportation and assignment problem, network model, queueing models and decision theory

UNIT-1: Introduction to OR – Meaning and scope – Characteristics – models in OR.LPP-Formulation graphical method – Simplex method- Big M Method application in Business – merits and Demerits.

UNIT-2: Transportation model – basic feasible solution – formulation, solving a TP. Assignment models – formulation – solution.

UNIT-3: Network analysis – work break down analysis – construction – numbering of event. Time Calculation – critical path, slack, float – application.

UNIT-4: Queuing models- elements of queuing system – characteristics of queuing model.

UNIT-5: Decision theory – statement of Baye's theorem application. Probability – decision trees. Game theory meaning and characteristics – saddle point – Dominance property.

Text Books

1. V.K.Kapoor, Introduction to Operational Research – Sultan Chand & sons – New Delhi

Reference Books

1. P.K.Gupta and Man Mohan, Problems in Operations Research – Sultan Chand & sons – New Delhi
2. Hamdy A Taha, Operation Research – An Introduction prentice Hall of India- New Delhi.

Course Outcomes

1. After studied unit-1, the student will be able to know solving graphical and simplex programming problems

2. After studied unit-2, the student will be able to know solving transportation and assignment problems

3. After studied unit-3, the student will be able to know solving network models

4. After studied unit-4, the student will be able to know solving various queueing models.

5. After studied unit-5, the student will be able to know decision theory and games.

Name of the course/subject: PG   **Semester: II**
Name of the Paper: Probability and Statistics   **Credits: 3 Hours of teaching: 3**
Paper type: Open Elective
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Course Objectives

To enable students to learn probability and distributions, estimation of parameters and testing of hypothesis, time series analysis and statistical quality control techniques.

Unit-1
Sample spaces – Events – Probability axioms – Conditional Probability – Independent events – Baye's formula - simple problems - Random variables - Distribution functions – Marginal distributions, Conditional distribution – Expectation – Conditional expectation and Conditional Variance. Moment generating functions.

Unit-2
Probability distributions – Binomial, Poisson, geometric, uniform, exponential, normal distributions – computation of mean, variance and simple problems.

Unit-3
Estimation - Point estimation – Characteristics of estimation – Interval estimation – Interval estimates of Mean, Standard deviation, proportion, Tests for means, variances and proportions – ANOVA.

Unit-4
Time series analysis - Components of time Series – Methods of measuring Trend and Seasonal variations – correlation and regression - problems related to simple regression.

Unit-5
Statistical quality control – Statistical basis for control charts – Control limits – Control Charts for variables – X-bar, R Charts, Charts for defective – P, nP Charts – Charts for defects – C Charts.

Text Books

1. Trivedi, K. S. (1982). Probability and Statistics with Reliability, Queueing & Computer Applications, Prentice Hall, NJ..

2. Gupta, S C., and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics, Eleventh Edition, Sultan Chand & Sons, New Delhi..

Reference Books

1. Montogomery, D, C., and Johnson, .L. A. (1976). Forecasting and Time Series Analysis, McGraw Hill, NY.

2. Besterfield, D. H. (1998). Quality Control, Fifth Edition, Prentice Hall, NJ.

Course Outcomes

1. After studied unit-1, the student will be able to know basics of probability
2. After studied unit-2, the student will be able to know various distributions
3. After studied unit-3, the student will be able to know estimation of parameters and testing of hypothesis
4. After studied unit-4, the student will be able to know time series analysis.
5. After studied unit-5, the student will be able to know various statistical quality control charts

Name of the course/subject: PG   Semester: II
Name of the Paper: Indian Official Statistics   Credits: 3 Hours of teaching: 3
Paper type: Open Elective
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Course Objectives

To enable students to learn about functions of Indian Official statistical system, functioning of various statistical organizations and applications of statistics.

Unit-1: Statistical System in India: Central and State Government Organizations, Functions of Central Statistical Organization (CSO), National Sample Survey Organization (NSSO) - Sampling fundamentals – sampling and non-sampling errors - large scale sample surveys.

Unit-2: Official statistics: Meaning, methods of collection, limitations and reliability. Principal publications containing data on the topics such as population, agriculture, industry, trade, prices, labour and employment, transport and communications - Banking and finance.

Unit-3: System of Collection of Agricultural Statistics - Crop forecasting and estimation - Productivity, fragmentation of holdings - Support prices - Buffer stocks - Impact of irrigation projects – Industrial statistics.

Unit-4: Index Numbers - Price, Quantity and Value indices. Price Index Numbers: Construction, Uses, Limitations, Tests for index numbers - Consumer Price Index, Wholesale Price Index and Index of Industrial Production – Construction of index numbers and uses.

Unit-5: National Income – Measures of national income - Income, expenditure and production approaches – Applications in various sectors in India - Wage Statistics – Trade Statistics – Financial Statistics

Text Books

1. Saluja, M.R (1972): Indian official statistical systems: Statistical publishing society, Calcutta and The Indian Econometric Society, Hyderabad.
2. Central Statistical Organisation (1995), Statistical System in India, Ministry of Statistics and Programme Implementation, India
3. Central Statistical Organisation (1999), Guide to Official Statistics, Ministry of Statistics and Programme Implementation, India.

Reference Books

1. Goon A. M., Gupta M. K., and Dasgupta. B. (2001), Fundamentals of Statistics, Vol. 2, World Press, India.
2. Allen R. G. D. (1975). Index Numbers in Theory and Practice, Macmillan.
3. Bhaduri, A. (1990). Macroeconomics: The Dynamics of Commodity Production, Macmillan India Limited, New Delhi.
4. Branson, W. H. (1992). Macroeconomic Theory and Policy, Third Edition, Harper Collins Publishers India (P) Ltd., New Delhi.

Course Outcomes

1. After studied unit-1, the student will be able to know functioning of statistical organization in India.

2. After studied unit-2, the student will be able to know concept of official statistics

3. After studied unit-3, the student will be able to know agricultural and industrial statistics

4. After studied unit-4, the student will be able to know index numbers and its usages.

5. After studied unit-5, the student will be able to know national income and its measures

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