Kurukshetra University, Kurukshetra

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Syllabus
for
Post Graduate Programme

M.Sc. Statistics (IIIrd & IVth Semesters)

as per NEP 2020

Curriculum and Credit Framework for Postgraduate Programme

With CBCS-LOCF

w.e.f. the session 2025-26

DEPARTMENT OF STATISTICS AND OPERATIONAL RESEARCH

FACULTY OF SCIENCES

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119

HARYANA, INDIA

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Sampling Theory		
Course Code	M24-STA-301		
Course Type	CC-9		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 301.1: Understand the distinctive features of sampling schemes and its related estimation problems. • CLO 301.2: Learn about the applications of sampling techniques: systematic, stratified and cluster sampling. • CLO 301.3: Use the supplementary information for the purpose of estimation. • CLO 301.4: Learn about probability proportionate to sampling (PPS) with replacement and without replacement methods and how to compare the results obtained under different sampling designs.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Basic finite population sampling techniques: Simple random sampling with replacement, Simple random sampling without replacement, stratified sampling and related results on estimation of population mean/total, Relative precision of Stratified and Simple random sampling techniques, Allocation problems in stratified sampling.	15
II	Use of supplementary information: Ratio estimation, bias and mean square error, estimation of variance, comparison with SRS, ratio estimator in stratified sampling, unbiased ratio-type estimators, regression and difference estimators, comparison of regression estimator with SRS and ratio estimator.	15

III	Systematic sampling (excluding circular systematic sampling) comparison with stratified and simple random sampling, double sampling for stratification and ratio estimate. Cluster sampling (equal clusters) and its efficiency relation between the variance of the mean of a single cluster and its size, Jesson's cost function and determination of optimum sampling unit. Sampling with unequal clusters, estimates of the means and their variances.	15
IV	Two stage sampling with equal first stage units, estimate of the population mean and its variance Repetitive surveys: Sampling over two occasions, probability proportionate to sampling (PPS) with replacement and without replacement methods [Cumulative total and Lahiri's method] and related estimators of a finite population mean[Horvitz Thompson and Desraj estimators for a general sample size and Murthy's estimator for a sample of size two].	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Chaudhuri A and Mukerjee R. (2017) : Randomized Response, Theory and Techniques, New York Marcel, DekkerInc.
2. Cochran W.G. (2007) : Sampling Techniques 3rd Edition, Wiley.
3. Des Raj and Chandak (2013) : Sampling Theory, Narosa Publications House.
4. Murthy.M.N (1977) : Sampling Theory & Statistical Method Publishing Society, Calcutta.
5. Sukhatme P.V. (1984) : Sample Theory of Surveys with Applications, Lowa State University Press &IARS.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Linear Estimation and Design of Experiments		
Course Code	M24- STA -302		
Course Type	CC-10		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 302.1: Understand the concepts based on Markov models, BLUE and Tests of General Linear hypotheses. • CLO 302.2: Apply experimental design techniques in real problems. • CLO 302.3: Argue the necessity of Factorial experiments and Confounding. • CLO 302.4: Understand the concepts of IBD, BIBD and construction of BIB designs.		
Credits	Theory	Tutorial	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Basic concept of linear model and its various types, Linear estimation : Least Square estimates of regression coefficients, Standard Gauss-Markov models, estimability of parameters, best linear unbiased estimators (BLUE), Method of least squares and Gauss Markov theorem; Variance-Covariance matrix of BLUES, Distributional Properties. Tests of General Linear hypothesis.	15
II	One-way and two way classifications: ANOVA for Fixed, random and mixed effects Models (One observation per cell). Terminology in experimental designs. Basic principles of design of experiments, balance and orthogonality, Layout and analysis of completely randomized, randomized blocks and Latin-square designs, General block design and its information matrix.	15
III	Factorial experiments: 2^2-experiment, 2^3-experiment and 2^n-experiment in 2^k blocks per replicate. Confounding in Factorial Experiments: Complete confounding for 2^2-experiment and 2^3-	15

	experiment, Partial confounding for 2^2-experiment and 2^3-experiment., Advantages and Disadvantages of Confounding. Split-plot design (without complete analysis).	
IV	Incomplete Block Design , Balanced incomplete block design, parametric relationship of Balanced incomplete block design, Symmetric Balanced incomplete block design, construction of Balanced incomplete block design by developing initial blocks, analysis of Balanced incomplete block design. Orthogonal Latin squares: construction of orthogonal Latin squares of order 4.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Searle,S.R.(1997) :Linear Models, John Wiley & sons New York.
2. AlokeDey,(1987) : Theory of Block Designs, Wiley Eastern Ltd.
3. Chakrabarti,M.C(1970) : Mathematics of Design and Analysis of Experiments, Asia Publishing House.
4. Joshi, D.D., (1987) : Linear Estimation and Design of Experiments ,Wiley Eastern Ltd.
5. Das, M.N.andGiri, N(1979) :Design and Analysis of Experiments, Wiley Eastern. Analysis of Variance, South Asian Publishers.
6. Montogomery, C.D.(2012) : Design and Analysis of Expertiments, Wiley, New York.
7. Goon, A.M.,Gupta, M.K. and Dasgupta. B (2013) : An Outline of Statstical Theory, Vol.II, World Press.
8. Raghavarao, D. (1971) :Constructions and combinatorial problems in design of experiments

Session: 2025-26			
Part A - Introduction			
Name of the Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Applied Statistical Techniques		
Course Code	M24-STA-303		
Course Type	DEC-1		
Level of the course (As per Annexure-I	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 303.1: Understand the basic concept of various measures of mortality and Life table. • CLO 303.2: Describe the Abridged life tables and methods of population projection. • CLO 303.3:Apply the results based on Demand Analysis • CLO 303.4: Understand the concept of Index Numbers and Official Statistics.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Methods of obtaining demographic data, Rates and ratios, measurement of population at a given time , measurement of mortality : crude death rate, specific rates, infant mortality rate, perinatal mortality rate , standard death rates . Graduation of mortality rates: Makehams and Gompertz graduation formula, Life table: Construction of a complete life table and its uses.	15
II	Abridged life tables: Kings method, Reed and Merrell's method, Greville's method, Keyfitz and Frauenhal's method and Chiang's method . Measurement of fertility: Crude birth rate , general fertility rate , age specific fertility rate , total fertility rate , gross reproduction rate and net reproduction rate . Stable and quasi-stable population, Methods of population projection, survival rates : UN model lifetable. Life table of Coale and Demeny.	15

III	Demand Analysis– Laws of Demand and Supply, Price and Supply Elasticity of Demand. Partial and Cross Elasticity of Demand. Income Elasticity of Demand. Utility Function Methods of Determining Demand and Supply Curves from Family Budget and Time Series Data, Leontief's Method, Pigou's Method Engel Curve and its Different Forms,. Pareto's Law of Income Distribution. Curves of Concentration.	15
IV	Index Numbers and their Construction, Uses of Index Numbers, problems in the construction of index numbers. Price, Quantity and Value Relatives, Link and Chain Relatives, Laspeyer's, Paashce's, Marshall –Edge Worth and Fisher's Index Numbers, Chain Base Index Numbers, Tests for Index Numbers. Base Shifting, Splicing and Deflating of Index Numbers. Cost of Living Index Numbers. Official Statistics: National Sample Survey Office (NSSO) and Central Statistics Office (CSO) and their role in national development.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Ramakumar, R. (1986) : Technical Demography, Wiley, Eastern Limited.
2. Gupta, S.C. &Kapoor, V.K. (1990) :Fundamental of applied Statistics, Sultan chand and sons.
3. Cox, P.R. (1970) : Demography, Cambridge University Press.
4. Keyfitz, N (1977) : Applied Mathematical Demography, Springer Verlag.
5. Spiegelman, M. (1969) : Introduction to Demographic Analysis, Harvard University.
6. Goon, A.M., Gupta, M.K & Dasgupta,B. (2016) : Fundamental of Statistics Volume-II, World Press.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Econometrics		
Course Code	M24- STA -304		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 304.1: Acquire knowledge of Two Variable Linear Regression Models. • CLO 304.2: Apply the Tests based on Linear Restrictions on Regression Coefficients. • CLO 304.3: Understand the concept of Hetero-scedasticity and Tests for Heteroscedasticity. • CLO 304.4:Deal with Simultaneous Equations Models		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Two Variable Linear Regression Model- Least Squares Estimators of Coefficients and Their Properties, Inference in Least Squares Model, The General Linear Regression Model, Ordinary Least Squares Estimator and its Properties, Inference in General Linear Regression Model. Maximum likelihood Estimates.	15
II	Tests of Linear Restrictions on Regression Coefficients, Use of Extraneous Information on Regression Coefficients – Restricted Regression, Restricted Least Squares and its Properties, Mixed Regression and Properties of Mixed Regression Estimator, Specification Errors Analysis- Inclusion and Deletion of Explanatory Variables, Effect on Estimation of Parameters and Disturbance Variance.	15

III	Heteroscedasticity, Tests for Heteroscedasticity –Bartletts's, Breusch-Pagan and Goldfeld Quand t- Tests Multicollinearity - Exact and Near Multicollinearity, Consequences and Detection of Multicollinearity, Farrar Glauber Test, Remedies for Multicollinearity, Ridge Regression Autocorrelation, Tests for Autocorrelation, Durbin Watson Test, Generalized Least Squares Estimation.	15
IV	Simultaneous Equations Models: Structural and Reduced forms, Identification Problem. Rank and Order Conditions of Identification, Estimation in Simultaneous Equations Models: Indirect Least Squares 2SLS Estimators, Instrumental Variable Method of Estimation. Limited Information maximum likelihood (LIML). Dummy Variable Technique for Testing Structural Stability of Regression Models and Comparing two regressions	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Johnston, J. (1996) : Econometric Models, McGraw Hills.
2. Jan Kmenta(1986) : Elements of Econometrics, University of Michigan Press.
3. Intriligatore, M.D. (1971) : Mathematical Optimization and Economic Theory, Prentice Hall.
4. Maddala, G.S.(2009) : Econometrics, North Holland.
5. Koutsoyiannis,A.(2001) : Theory of Econometrics, Palgrave.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Bio-Statistics		
Course Code	M24- STA -305		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 305.1: Explain biostatistics and its uses in the field of public health. • CLO 305.2: Understand the different types of mating. • CLO 305.3: Apply the results based on genetic correlation and repeatability methods of estimation. • CLO 305.4: Apply descriptive techniques commonly used to summarize public health data.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Bioassays : Quantitative and quantal response, dose response relation. estimation of median effective dose, estimation of unknown concentration or potency, probit and logit transformations, Parallel line and slope ratio assays , potency, ratio, Feller's theorem. Tests for non-validity, symmetric and asymmetric : assays, Toxic action of mixtures.	15
II	Types of mating: Random mating, Hardy-Weinberg equilibrium, Random mating in finite population. Inbreeding (Generation Matrix Approach) Segregation and linkage. Estimation of segregation and linkage parameters.	15
III	Concept of gen frequencies. Estimation of gene frequencies Quantitative inheritance, Genetic parameters heritability, genetic correlation and repeatability methods of estimation. Selection and its effect, Selection Index, dialled and partially dialled Crosses.	15
IV	Genotype environment interactions. Components of variance and Genotypic variance, Components of Covariance, Correlations between relatives, Genetic parameters; Heritability, Repeatability.	15

		Total Contact hours	60
Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Kempthorne, O. (1957) :An Introduction to Genetical Statistics, Wiley.
2. Jain, l.R. (2017) : Statistical techniques in quantitative genetics. Tata-McGraw Hill.
3. Poti, S.J. (1984) : Quantitative study in life sciences, Vikas Publishing Ltd.
4. Prem Narain Bhatia (1990) :Handbook of Statistical Genetics, I.A.S.R.I.P.K.
5. Daniell, W.W., Chad L. Cross(2014) : Bio Statistics – A foundation for analysis In health sciences , 3rd ed. John wiley.
6. Falconer, D.S.(2009) :Introduction to quantitative Genetics, Longman Group Ltd.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Linear Algebra and Numerical Analysis		
Course Code	M24- STA -306		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 306.1: Describe the fundamentals of linear algebra and Numerical Analysis. • CLO 306.2: Understand the concepts of Vector Spaces and Linear transformations • CLO 306.3: Apply the results based on real quadratic forms, its reduction and classification. • CLO 306.4: Apply the results and formulas based on interpolation, divided differences and Numerical Integration.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Vector Spaces: Linear dependence and independence , Basis and dimension of a vector space, examples of vector spaces .Linear transformations , Algebra of matrices , row and column spaces of a matrix , elementary matrices , determinant , rank and inverse of a matrix , null space and nullity ,Hermit canonical form. Solutions of matrix equations.	15
II	Orthogonal Transformations and Orthogonal matrix, Gram-Schmidt orthogonalisation process, characteristic roots and characteristic vectors, diagonalisation of a matrix, triangular form of a matrix .Real quadratic forms, reduction and classification of quadratic forms.	15
III	Difference and shift operators, identities involving separation of symbols and differences of zero, Newton's forward and backward interpolation formulae and estimation of the missing terms . Divided differences, Newton's and Lagrange's interpolation formulae for unequal intervals. Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidal methods.	15

IV	Numerical Integration : Simpson's one-third and three eighth and Weddle's formulae, The Euler-Meclaurin's summation formula . Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.	15
	Total Contact hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Hadley,G., (2002) :Linear Algebra, Narosa Publishing House.
2. Datta,K.B.,(2016) : Matrix and Linear Algebra, Prentice Hall India Pvt., Limited.
3. Holt, J. (2017) : Linear Algebra with Applications, Macmillan Learning.
4. Saxena.H.C (2010) : Calculus of Finite differences and numerical analysis, S. Chand Publishing.
5. Jain, M.K. (2019) :Numerical Methods for Scientific and Engineering, New Age International Publishers.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Categorical Data Analysis		
Course Code	M24- STA -307		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 307.1: Analyze categorical data using contingency tables, association measures, and likelihood-based inference to test goodness of fit and independence. • CLO 307.2: Evaluate the performance of screening tests using sensitivity, specificity, predictive values. CLO 307.3: Apply generalized linear models for binary and categorical data using various link functions. • CLO 307.4: Fit and interpret logit and log-linear models, perform conditional logistic regression and exact tests.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Categorical response variables: Nominal, ordinal, interval Categorical data describing two-way contingency tables, measures of nominal and ordinal association, inference for two-way contingency tables, likelihood functions and maximum likelihood estimates, testing goodness of fit and testing independence.	15
II	Screening tests, sensitivity, specificity, and predictive value positive and negative, partitioning chi-squared, large sample confidence intervals, delta method to estimate standard error, exact tests for small samples.	15

III	Models for binary response variables: Generalized linear models, logit, log linear, linear probability and logistic regression models. Logit models for categorical data, probit and extreme value models, models with log-log link, model diagnostics.	15
IV	Fitting logit models, conditional logistic regression, exact trend test. Log linear models for two dimensions –independence model, saturated model and models for cell probabilities. Log linear model for three dimensions. Fitting Log linear models. Strategies in model selection, analysis of residuals, Cochran-Mantel-Haenszel test.	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Agresti, A. (2002) : Categorical Data Analysis, 2nd Ed. Wiley Publication.
2. Kleinbaum, D.G. (1994): Logistic Regression, Springer Verlag.
3. Bowerman,O.(2000) : Linear Statistical Models, Duxbury.
4. Agresti,A. (2007) : An introduction to categorical data Analysis, Wiley.
5. Agresti,A. (2010) : Analysis of ordinal categorical data, Wiley.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Programming with Python		
Course Code	M24- STA -308		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 308.1: Solve simple to advanced problems using Python language. • CLO 308.2: Implement different data structures using Python. • CLO 308.3: Implement Object-oriented approach and numerical computations using Python and NumPy. • CLO 308.4: Use python for data science and machine learning.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Introduction to Python Programming: Using Python, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations (Operators. Type conversions, Expressions), More about Data Output. Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Logical Operators, Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops. Functions: Introduction, Defining and Calling a Void Function, Designing a Program to Use Functions, Local Variables, Passing Arguments to Functions, Global Variables and Global Constants, Value-Returning Functions Generating Random Numbers, Writing Our Own Value-Returning Functions, The math Module, Storing Functions in Modules.	15

II	File and Exceptions: Introduction to File Input and Output, Using Loops to Process Files, Processing Records, Exceptions. Lists and Tuples: Sequences, Introduction to Lists, List slicing, Finding Items in Lists with the in Operator, List Methods and Useful Built-in Functions, Copying Lists, Processing Lists, Two-Dimensional Lists, Tuples. Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings. Dictionaries and Sets: Dictionaries, Sets, Serializing Objects. Recursion: Introduction, Problem Solving with Recursion, Examples of Recursive Algorithms.	15
III	Object-Oriented Programming: Procedural and Object-Oriented Programming, Classes, Working with Instances, Techniques for Designing Classes, Inheritance, Polymorphism. NumPy - Introduction, Ndarray Object ,Data types, Array Attributes, Array Creation Routines, Indexing & Slicing, Advanced Indexing, Broadcasting, Iterating Over Array, Array Manipulation, Binary Operators, String Functions, Mathematical Functions, Mathematical Functions, Arithmetic Operations, Statistical Functions, Linear Algebra.	15
IV	Basic functions of matplotlib: Simple Line Plot, Scatter Plot, Density and Contour Plots, Histograms, Customizing Plot Legends, Colour Bars-Three-Dimensional Plotting in Matplotlib. Introduction to Pandas Objects: Data indexing and Selection, Operating on Data in Pandas, Handling Missing Data, Hierarchical Indexing, Combining Data Sets. Using Scikit-Learn for Linear Regression, Logistic Regression, Decision Tree, Naive Bayes, KNN, SVN, k Mean Clustering, Random Forest.	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Zhang.Y., (2016) : An Introduction to Python and Computer Programming, Springer Publications.
2. Gaddis T (2023) :Starting Out With Python, Pearson.
3. Vander Plas Jake (2016) :Python Data Science Handbook - Essential Tools for Working with Data, O'Reily Media,Inc,.
4. Guttag John V, (2013) : Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press.
5. Joel Grus , (2016) : Data Science from Scratch First Principles with Python, O'Reilly Media.
6. Padmanabhan T. R., (2016) : Programming with Python, Springer Publications.
7. Lambert K.A.(2015). : Fundamentals of Python Programming, Course Technology.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Bayesian Inference		
Course Code	M24- STA -309		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 309.1: Apply bayes' theorem to derive posterior distributions, compare Bayesian and likelihood approaches. • CLO 309.2: Perform Bayesian estimation using generalized maximum likelihood and various loss functions. • CLO 309.3: Formulate Bayesian hypothesis testing problems by appropriately specifying prior distributions for both simple and composite hypotheses. • CLO 309.4: Implement Markov Chain Monte Carlo (MCMC) techniques, including the Gibbs sampler and the Metropolis-Hastings algorithm, for parameter estimation in complex models.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Bayes theorem, Bayesian Concept to priors and posteriors, computation of the posterior distribution. Comparing Likelihood and Bayesian Approaches, Concept of Inverse Probability and Bayes Theorem. Classes of Prior Distributions. Conjugate Families for One Parameter Exponential Family Models, Models admitting sufficient statistics of fixed dimension.	15
II	Generalized Maximum Likelihood Estimate. Types of Loss Functions. Bayes estimation under various loss functions. Posterior Risk. Bayesian interval estimation: Credible intervals, HPD intervals, Comparison with classical confidence intervals. Situation specific case studies to conduct posterior analysis.	15

III	Bayesian testing of Hypothesis: Specification of the appropriate form of the prior Distribution for a Bayesian testing of hypothesis problem. Prior odds, Posterior odds, Bayes factor for various types of testing hypothesis problems depending upon whether the null hypothesis and the alternative hypothesis are simple or composite. Bayesian prediction problem. Large sample approximations for the posterior distribution.	15
IV	Estimation of parameters using Markov Chain Monte Carlo methods: Gibbs Sampler and Metropolis-Hasting Method and other computer simulation methods. Bayesian calculations for non-conjugate priors: (i) Importance sampling, (ii) Obtaining a large sample of parameter values from the posterior distribution using Acceptance - Rejection methods.	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Aitchison, J. and Dunsmore, I.R. (1975): Statistical Prediction Analysis, Cambridge University Press.
2. Box, G.E.P. and Tiao, G.C. (1973) :Bayesian Inference in Statistical Analysis, Addison & Wesley.
3. DeGroot, M.H. (1970) :Optimal Statistical Decisions, McGraw Hill.
4. Leonard, T. and Hsu, J.S.J. (1999) :Bayesian Methods, Cambridge University Press.
5. Lee, P. M. (1997) :Bayesian Statistics: An Introduction, Arnold Press.
6. Robert, C.P. (2001) :The Bayesian Choice: A Decision Theoretic Motivation, 2nd ed., Springer Verlag.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Actuarial Statistics		
Course Code	M24- STA -310		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 310.1: Able to recognize the basic concepts of mortality rates and other indices • CLO 310.2: Understand the concept of different models of population dynamics and Industrial assurance. • CLO 310.3: Apply the typical long-tailed distributions representing claim size and those representing claim numbers • CLO 310.4: Use statistical models to analyze the risk factors for categories of policy holders and apply appropriate mathematical methods to get solutions for some problems in risk theory.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Concepts of mortality rates and other indices, construction of mortality table from graduated data, determination and use of the functions in mortality table, graph of force of mortality, laws of mortality, mortality funds, Sources and collection of data for the continuous mortality investigation.	15
II	Models of population dynamics: Lotka' theory. Relationship between the number of births and the number of women in the population. Population with unvarying age distribution. Nature of reserve, prospective and retrospective reserves, fractional premiums and fractional durations, modified reserves, (continuous reserves, surrender values and paid up policies, Industrial assurance; children's. deferred assurances, Joint life and last survivorship.	15

III	Pure endowments, Life Annuities; Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportion able annuities-due. Accumulations, Assurances, family income benefits, capital sums on retirement and death.	15
IV	Widows pensions, Sickness benefits, disability benefits. Orphan's benefits, Benefits dependent on marriage. Contingent probabilities, contingent assurances, reversionary annuities, multiple-decrement table, forces of decrement, construction of multiple decrement table.	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. King, G. (2011) : Institute of actuaries text book of part II second ed. Charles and Edwin.
2. Edward W. Frees (2012) : Regression Modeling with Actuarial and Financial Applications, Cambridge University Press
3. Neil1, A. (1977) : Life Contingencies, Heinemann, London.
4. Donald, DWA (2016) : Compound interest and annuities, Heinemann London.

Session: 2025-26			
Part A - Introduction			
Name of the Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Practical-3 (based on Calculator and R)		
Course Code	M24- STA -311		
Course Type	PC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 311.1: Design and implement simple random sampling (SRS) with and without replacement, estimating population parameters. • CLO 311.2: Allocate samples using proportional and Neyman methods, comparing their efficiencies. • CLO 311.3: Analyze treatment effects using CRD, RBD, LSD. • CLO 311.4: Design and analyze factorial experiments (2^2 and 2^3).		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B-Contents of the Course

	Contact Hours 120

Note: There will be 4 questions, the candidate will be required to attempt any 3 questions

Practicals

1. To select simple random Sample with and without replacement and estimate population mean and population variance for a given sample size.
2. Compare the efficiency of SRSWR and SRSWOR through simulation.
3. Implement stratified sampling using proportional allocation.
4. Allocation of sample using proportional and Neyman method of allocation and comparing their efficiencies relative to SRS.
5. Systematic Sampling.
6. To estimate population mean in case of sampling with varying probabilities of selection.
7. Single-stage cluster sampling (equal size clusters)
8. PPS cluster sampling (unequal size clusters)
9. Comparison of cluster sampling and SRS
10. Two-stage cluster sampling
11. Analyze treatment effects using CRD.
12. Analyze treatment and block effects (RBD)
13. Analyze LSD for controlling two nuisance variables.
14. Analyze 2^2 and 2^3 Factorial Designs.

15. Analyze Partial and Complete Confounding.			
Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/e-resources/LMS:			

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Third**		
Name of the Course	Introductory Statistical Methods		
Course Code	M24- OEC -347		
Course Type	OEC		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 347.1: Understand the importance and scope of Statistics. • CLO 347.2: Understand the significance of correlation coefficient and probability in the real world. • CLO 347.3: Understand the concept of random variable and its characterises. • CLO 347.4: Assess the nature of various probability distributions.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Meaning, importance and scope of statistics, Types of statistical data: primary and secondary data, qualitative and quantitative data, time series data, discrete and continuous data, ordinal, nominal, ratio and interval scales, Frequency distributions, cumulative frequency distributions, Diagrammatic representation of data: Bar diagrams, histogram, pie chart, measures of central tendency, Measures of dispersion, moments, skewness, kurtosis.	8
II	Correlation coefficient, rank correlation, regression lines, partial correlation coefficient, multiple correlation coefficient, Basic concepts of probability: Random experiment, sample space, events, different definitions of probability, Additive law of probability, conditional probability.	8

III	Random variables: discrete and continuous random variables, Probability density function, distribution functions, mathematical expectation, moment generating function and characteristic function, Bivariate probability distributions: marginal and conditional distributions.	7
IV	Probability distributions: Binomial, Poisson, Geometric, Normal, exponential, uniform.	7
	Total Contact hours	30

Suggested Evaluation Methods

Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory:**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Gupta, S.C. & Kapoor,V.K. (2010) : Fundamentals of Mathematical Statistics, Sultan Chand and Sons.
2. Gupta, S.C. &Kapoor, V.K. (2014) : Fundamentals of Applied Statistics, Sultan Chand and Sons.
3. Goon, A.M., Gupta, M.K & Dasgupta,B. (2016) : Fundamentals of Statistics, Vol. II, ed.VI, Word Press.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Multivariate Analysis		
Course Code	M24-STA-401		
Course Type	CC-11		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 401.1: Describe the multivariate analysis tools in relation to univariate tools • CLO 401.2: Understand sampling distribution and maximum likelihood estimators of total, partial and multiple correlation coefficients • CLO 401.3: Conduct statistical inference by using Hotteling's T^2 and Mahalanobis D^2-Statistic • CLO 401.4: Undertake statistical analyses using Discriminant, Principal component and Canonical correlation analysis.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Notion of multivariate distribution, multivariate normal distribution of linear combination of normal variates, Marginal and Conditional distributions, Multiple and partial correlation coefficients. Characteristic function of a random vector, characteristic function when the random vector is normally distributed. Moments and semi-invariants of multivariate normal distribution. Estimation of the mean vector and covariance matrix, maximum likelihood estimator of the parameters of multivariate normal distribution.	15
II	The distribution of the sample mean vector and sample dispersion matrix. Sample correlation coefficient, maximum likelihood estimators of total, partial and multiple correlation coefficients; sampling distribution of simple, partial and multiple correlation coefficients when the corresponding population correlation coefficients are zero. Testing hypotheses of significance of these distributions.	15

III	Hotteling's T^2 and Mahalanobis D^2-Statistic; Justification , distribution and uses . The multivariate Behren's Fisher Problem and its solution. Classification Problem : Standards of good classification, Baye's and minimax regions for classification into one of two known multivariate normal populations when the parameters are known and unknown. Fisher's linear discriminator, Anderson's discriminator.	15
IV	Wishart Distribution: Definition, Characteristic function and properties. Sample generalized variance, asymptotic distribution of sample generalized variances. Principal components in the population, Canonical correlation in the population.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Anderson, T.W.(1984) : An Introduction to Multivariate Statistical analysis, Second Edition John Wiley.
2. Narayan, C. Giri (2003) : Multivariate Statistical analysis, Marcel Dekker.
3. Srivastava, M.S.& Khatri C.G.(1979) : An introduction to Multivariate Statistics, North Holland.
4. Kshirsagar, A.M. &Wichern, D.W (1972) : Multivariate Analysis, Marcell-Dekher
5. Johnson, R.A (2007) : Applied Multivariate Statistical Analysis, PHI Learning.
6. Bhuyan, K.C (2005) : Multivariate Analysis and its applications, New Central Book Agency(P) Ltd.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Optimization Techniques		
Course Code	M24- STA -402		
Course Type	CC-12		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 402.1: Understand the techniques to solve the LPP using Two phase method, Big M-method and revised Simplex method. • CLO 402.2: Understand the Non-Linear Programming Problems (NLPP) and integer programming problem. • CLO 402.3: Solve the Quadratic Programming, Separable Programming and Geometric Programming. • CLO 402.4: Explain the concepts of Dynamic Programming and Fractional Programming.		
Credits	Theory	Tutorial	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Artificial and unrestricted Variables, Two phase method, Big M-method, degeneracy and breaking the ties, Charne's perturbation method, revised Simplex method, Duality theory : Formulation and solution of dual problems, dual simplex algorithm and primal dual algorithm.	15
II	Non-Linear Programming Problems (NLPP): formulation of NLPP. Kuhn-Tucker Necessary and Sufficient Conditions of Optimality and Saddle Points. Integer Programming Problems (IPP), formulation of IPP, Solution of IPP: Gomory's algorithm for all integer programming problems, Branch and Bound Algorithm.	15
III	Quadratic Programming: Wolfe's and Beale's Method of Solutions. Separable Programming and its Reduction to LPP. Separable Programming Algorithm. Geometric Programming: Constrained and Unconstrained.	15

IV	Fractional Programming and its Computational Procedure. Dynamic Programming: Balman's Principle of Optimality. Application of Dynamic Programming in Production, Linear Programming and Reliability Problems. Goal Programming and its formulation .Stochastic Linear Programming.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Hadley, G.(1997) : Linear programming, Narosa Publications House.
2. Vejda, S.(2009) : Mathematical Programming, Dover Publications.
3. Saul I.Gauss. (2003) : Linear programming Methods and Applications, Dover Publications.
4. Kambo, N. S. (2008) : Mathematical Programming Techniques, East –West PressPvt. Ltd.
5. Mittal, K.V.(2016) : Optimization Methods, New Age International (P)Ltd.
6. Hadley, G.(1970) : Non linear and Dynamic programming.

Session: 2025-26			
Part A - Introduction			
Name of the Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Reliability and Renewal Theory		
Course Code	M24-STA-403		
Course Type	DEC-3		
Level of the course (As per Annexure-I	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 403.1: Describe the basic concepts of reliability and Renewal Theory in real life scenario. • CLO 403.2: Understand the appropriate methodologies and tools for enhancing the inherent and actual reliability of components /systems, taking into consideration cost aspects. • CLO 403.3: Apply various Reliability and Availability evaluation Techniques for systems having different numbers of components • CLO 403.4: Define various Renewal processes and to derive the distribution of the number of renewals.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Concept of reliability, early age failures, wear out failures and chance failures. Derivation of general reliability function failure rate, failure density function and mean time between failures (MTBF). System reliability evaluation: series system, parallel system, partially redundant system, standby system with perfect switching / imperfect switching. Effect of spare components (identical / non- identical) on the system reliability.	15

II	Wear out and Component reliability, Combined effect of wear out and chance failures. Reliability of a two component system with single repair facility. Reliability evaluation Techniques : Conditional probability approach , cut set method, approximation evaluation, Deducing the minimal cut sets. Tie set method , connection matrix technique, Boolean function technique.	15
III	Availability and Reliability evaluation in Repairable system, evaluation of time dependent probabilities with single repairable component, two repairable components. Evaluating limiting state probabilities with single repairable component, two identical repairable components Matrix multiplication method: reliability evaluation in repairable system, mean time to failure. Stochastic transitional probability matrix method to evaluate MTTF of two components parallel system, two component series system.	15
IV	General Introduction. The distribution of the number of renewals: The asymptotic distribution of N. The asymptotic normality of N_t with mean t/μ and variance t/ μ3 The number of renewals in a random time, the renewal function , the asymptotic form of the renewal function. The renewal density, variance of the number of renewals. Backward and forward recurrence times. Limiting distribution of recurrence times.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Cox D.R. & Miller H.D. (1994) : Theory of Stochastic Processes, Chapman and Hall Ltd.
2. Billinton, R. & Ronald N. Allan (1997) : Reliability Evaluation of Engineering systems: Concepts and Techniques Plemum Press New York London.
3. Cox, D.R.(1967) : Renewal Theory, Methuen & Co. Ltd
4. Medhi,J. (2010) : Stochastic Processes New Age International (P) Limited.
5. Igor Bazovsky (1961) : Reliability Theory and Practice, 2nd ed. Prentice Hall.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Fuzzy Set Theory and its Applications		
Course Code	M24- STA -404		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 404.1: Learn about fuzzy sets; understand fuzzy-set-related notions such as α level sets, convexity, normality, support, etc., their properties and various operations on fuzzy sets. • CLO 404.2: Understand the concepts of t-norms, t-conforms, fuzzy numbers; extend standard arithmetic operations on real numbers to fuzzy numbers. • CLO 404.3: Understand various type of fuzzy relations. • CLO 404.4: Apply fuzzy set theory to possibility theory and Fuzzy logic.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Fuzzy set theory: Introduction, Fuzzy versus Crisp, Fuzzy sets: Definition, different types, fuzzy-cuts and their properties, decomposition theorems.α-set basic concepts.	15
II	Operations on Fuzzy sets: Extension principle for fuzzy sets, fuzzy compliments, t-norms and t-conorms, Definition of intersection and union by Hamacher, Yager's union and intersection of two fuzzy sets, intersection and union of two fuzzy sets as defined by Dubois and Prade, Combination of operations, Aggregation operations.	15

III	Fuzzy numbers and arithmetic: Introduction, Fuzzy numbers, Interval analysis, Fuzzy Arithmetic, Arithmetic operations on fuzzy numbers, lattice of fuzzy numbers. Fuzzy relations: Introduction, Projections and cylindrical fuzzy relations, Composition, properties of Min-max composition, binary relations and their compositions.	15
IV	Fuzzy logic: Fuzzy propositions, fuzzy quantifiers, Fuzzy hedges, Fuzzy implications, Inference from conditional fuzzy propositions. Generalization of hypothetical syllogism, Inference from conditional and qualified propositions.	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. G.J. Klir and B Yuan (1997) : Fuzzy sets and fuzzy logic, Prentice Hall of India Ltd.
2. H. J. Zimmermann (1991) : Fuzzy Set Theory and its Applications, Allied Publishers Ltd.
3. Kwang H. Lee (2005) : First Course on Fuzzy Theory and Applications, Springer.
4. J. Yen & R. Langari (1999) : Fuzzy Logic - Intelligence, Control and Information, Pearson edu.
5. A.K. Bhargava (2013) : Fuzzy Set Theory, Fuzzy Logic & their Applications, S. Chand & Company

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Real and Complex Analysis		
Course Code	M24- STA -405		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 405.1: Demonstrate an understanding of the concepts of real and complex number systems. • CLO 405.2: Explain the concepts of Topology of Real Numbers • CLO 405.3: Apply the results based on Functions of a Complex Variable and Singularities. • CLO 405.4: Apply the techniques of real and complex analysis in statistical applications.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Topology of Real Numbers: Open Set, Closed Set, Limit Point of a Set, Bounds of a Set. Convergence and Divergence of Sequences. Cauchy's Theorem on Limits, Sequence and Series of Functions and Their Convergence Properties.	15
II	Functions of a Complex Variable and Their Analytic Properties. Cauchy's Riemann equations. Power Series and its Radius of Convergence. Elementary idea of Mobius Transformation, Cross Ratio, Invariant Point and Critical point.	15
III	Regular and Rectifiable Arcs. Contour. Domains: Connected, Simply Connected and Multiply Connected. Complex Line integrals. Cauchy's Theorem, Cauchy's Integral Formulae and Inequality. Morera's Theorem. Liouvelle's Theorem. Taylor and Laurent Series	15
IV	Singularities and Their Classification. Poles and Zeros of a Meromorphic Function, Argument Principle. Rouches Theorem. Fundamental Theorem of Algebra. Residues. Cauchy's Residue	15

	Theorem. Application of Cauchy's Residue Theorem for Evaluation of Integrals of Real Valued Functions.	
	Total Contact hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Narayan, Shanti, Mittal P.K. (2005): A Course of Mathematical Analysis ,S.Chand.
2. Malik,S.C. & Arora, Savita(2017) :Mathematical Analysis, New Age International.
3. Copson, E.T. (1970) :Introduction to the Theory of Functions of a Complex Variable, Clarendon Press Oxford.
4. Convey, John B. (1996) :Functions of one Complex Variable, Springer.
5. Sharma, J.N. (2014) :Function of a Complex Variable, Krishna Parkashan, Media Ltd., Meerut.
6. Goyal and Gupta.(2016) : Function of a complex Variable, Pargati Parkashan Meerut.
7. Malik, S.C. (2016) : Real and Complex Analysis, Jeevan Sons Publication, New Delhi.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Theory of Queues		
Course Code	M24- STA -406		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 406.1: Deep understanding of the theoretical background of queueing systems. • CLO 406.2: Acquire skills in handling situations involving more than one random variables and functions of random variables. • CLO 406.3: Analyze the performance of computer systems and queues by applying basic concept of probability techniques and models. • CLO 406.4: Compute measures of effectiveness for different queueing systems also apply & extend queueing models to analyze real world systems.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Queueing system. Components of a queueing system, measures of effectiveness, notations, exponential distribution and its various properties, stochastic processes, definition and examples, Poisson process and its some important properties related to queues. Markov chains and its properties (without proof).Concepts of steady state and transient state, K-Erlang distribution. Birth and death process.	15
II	M/M/1 queueing system steady state and time dependent solutions, measures of effectiveness, busy period distribution, 'waiting time distribution, Little's formulae. Probability generating function for M/M/1/N queueing system and its steady state probabilities measures of effectiveness, Time dependent solutions of M/M/∞ queuing system and M/M/∞ queueing system with time dependent input parameter, measures of effectiveness.	15

III	M/M/1 queueing system with phase type service, busy period time distribution, waiting time distribution, Mu1tiple channel queueing system with Poisson input and constant service time (M/D/C), Measures of effectiveness. Erlang service model M/Ek/1, Erlang arrival model Ek/M/1.	15
IV	Departure point steady state system size probabilities for M/G/1 queueing system, special cases M/Ek/1 and M/D/1 Pollaczek-Khintchine formula, waiting time, busy period analysis.Arrival point steady state system size probabilities for GI/ M/1 queueing system. Machine interference Model	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Gross, D. & Carl M. Harris (1998) :Fundamental. of queuing theory, John Wiley and Son..
2. Saaty, T.L.(2000) :Elements of queuing theory with applications. McGraw Hill Book Company Inc.
3. Allen, A.O.(2010) :Probability, Statistics and Queuing Theory with Computer Science Applications, Academic Press
4. Kashyap, B.R.K & Chaudhary, M.L (1988) : An Introduction to Queueing Theory, AARKAY Publications, Calcutts

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Machine Learning		
Course Code	M24- STA -407		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 407.1: Understand basics of machine learning. • CLO 407.2: Have in-depth knowledge of supervised learning. • CLO 407.3: Understand non-parametric methods along with decision trees. • CLO 407.4: Understand about the basics and importance of unsupervised learning and artificial neural networks.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	What is Machine Learning, Why Machine Learning is Required, Relation to Artificial Intelligence, Current Applications & Future of Machine Learning in Various Industries, Basic Process of any Machine Leaning System, Terminologies used in Machine Learning, Evaluation Metrics in Machine Learning, Machine Learning Categories , Supervised Learning, Unsupervised learning, Reinforcement Learning.	15
II	Understanding of Supervised Learning with example, Vapnik-Chervonenkis (VC) Dimension, PAC Learning, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm, Bayesian Decision Theory, Parametric Methods : Maximum Likelihood Estimation, Regression, Model Selection Procedure, Multivariate Methods: Multivariate Data, Multivariate Classification, Tuning Complexity, Multivariate Regression; Support Vector Machines, Random Forest.	15

III	Non Parametric Methods: Histogram Estimator, Kernal Estimator, k Nearest Neighbor Estimator, Non Parametric Classification, Condensed Nearest Neighbor, Non Parametric Regression – Smoothing Models, How to Choose Smoothing Parameter. Decision Trees :Univariate Trees, Classification Trees, Regression Trees, Pruning, Rule Extraction from Trees, Learning Rules from Data, Multivariate Trees.	15
IV	Unsupervised Machine Learning: k-Means Clustering, Expectation Maximization Algorithm, Supervised Learning after Clustering, Hierarchical Clustering, Choosing the number of Clusters. Neural Network(NN) : Introduction, Important Concepts in NN, The Perceptron, Training a Perceptron, Learning Boolean Functions, Multilayer Perceptron, MLP as a Universal Approximator, Backpropogation Algorithm, Training Procedures, Tuning the Network Size, Bayesian View of Learning, Dimensionality Reduction, Learning Time.	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Alpaydin E.,(2006) : Introduction to Machine Learning, Prentice Hall of India.
2. Mitchell T. M. (1997) : Machine Learning, McGraw-Hill,
3. Bishop C.M. (2016) : Pattern Recognition and Machine Learning, Springer.
4. Hastie, T., Tibshirani, R. & Friedman, J (2009) : The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer, 2nd Edition.
5. Murphy K. P. (2012) : Machine Learning A Probabilistic Perspective, MIT Press.
6. Shwartz, S.S. & David, S.B. (2014) : Machine Learning – From Theory to Algorithms Cambridge University Press.
7. Marsland, Stephen (, 2009) : Machine Learning- An Algorithmic Perspective, CRC Press.

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Official Statistics		
Course Code	M24- STA -408		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 408.1: Understand the concept of Indian and International Statistical Systems. • CLO 408.1: Deep understanding of population growth in Developed and Developing Countries. • CLO 408.1: Deal with System of Collection of Agricultural Statistics. • CLO 408.1: Know the responsibilities of various Agencies for data collection like CSO, NSSO and office of Registrar General.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Introduction To Indian and International Statistical Systems. Present official Statistical Systems In India, Role, Functions and Activates of Central and State Organization. Organizations of Large Scale Sample Surveys Methods of Collection of official Statistics, Their Reliability and Imitations.	15
II	General and Special Data Dissemination Systems, Population Growth in Developed and Developing Countries. Evaluation of Performance of Family Welfare Programs Projection of Labour force and Manpower. Scope and Content O Population of Census of India.	15
III	System of Collection of Agricultural Statistics. Crop forecasting and Estimation. Productivity, Fragmentation of Holdings, Support Prices Buffer Stock. Principle Publications Containing Such Statistics.	15
IV	Statistics Related To Industries, Balance of Payment, Cost of Living, Inflation, Educational and Other Social Statistics. Various Agencies Responsible for The Data Collection CSO, NSSO, office of Registrar General.	15

		Total Contact hours	60
Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Basic Statistics relating to the Indian Economy (CSO)1990.
2. Statistical system in India (CSO)1975.
3. Guide to official Statistics (CSO)1999.
4. Principles and accommodation of National Populations Census UNESCO.
5. Panse, V.G., Estimation of Crop Fields (FAO).

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Information Theory		
Course Code	M24- STA -409		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 409.1: Define measure of information, uncertainty and their properties. • CLO 409.2: Relate the joint, conditional, and marginal entropies of variables in terms of their coupled probabilities. • CLO 409.3: Define channel capacities and properties using Shannon's Theorems. • CLO 409.4: Construct efficient codes for data on imperfect communication channels.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Introduction : communication process, communication system, measure of information, unit of information. Memory less finite scheme: Measure of uncertainty and its properties, sources and binary sources. Measure of information for two dimensional discrete finite probability scheme: conditional entropies, Noise characteristics of a channel, Relations among different entropies.	15
II	Measure of Mutual information, Shanan's fundamental inequalities, Redundancy, Efficiency and channel capacity, capacity of channel with symmetric noise structures, BSC and BEC, capacity of binary channels, Binary pulse width communication channel, Uniqueness of entropy function.	15
III	Elements of encoding : separable binary codes, Shannon-Fano encoding, Necessary and sufficient conditions for noiseless coding. Theorem of decodibility, Average length .of encoded messages; Shannon's Binary Encoding.	15

IV	Fundamental theorem of discrete noiseless encoding, Huffman's minimum redundancy code, Gilbert-Moore encoding. Error detecting and Error correcting codes, Geometry of binary codes, Hammings single error correcting code.	15
	Total Contact hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Reza, F.M. (2003) : An Introduction to Information Theory, McGraw Hillok: Company Inc.
2. Feinstein, A. I(2013) : Foundations of Information Theory, McGraw Hill Book Company Ioc.
3. Kullback, S. (I) (1997) : Information Theory and Statistic., John Wiley and Sons.
4. Middleton, D. (1996) : An Introduction to Statistical Communication Theory, McGraw Hill

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Survival Analysis		
Course Code	M24- STA -410		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 410.1: Analyze censored data using appropriate likelihood functions and apply life distribution models. • CLO 410.2: Draw inference for exponential models under censoring, and analyze failure rate, mean residual life, ageing classes, and bathtub-shaped failure rate characteristics. • CLO 410.3: Estimate survival functions using actuarial and Kaplan-Meier methods, and test exponentiality against non-parametric alternatives using Total Time on Test and Deshpande tests. • CLO 410.4: Apply tests for two-sample survival analysis and fit Cox and competing risks models.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Concepts of Type-I (time), Type-II (order) and random censoring likelihood in these cases. Life distributions, exponential, gamma, Weibull, lognormal, Pareto, linear failure rate.	15
II	Inference for exponential, gamma, Weibull distributions undercensoring. Failure rate, mean residual life and their elementary properties. Ageing classes and their properties, bathtub failure rate.	15
III	Estimation of survival function – Actuarial estimator, Kaplan– Meier estimator, Tests of exponentiality against non-parametric classes: Total time on Test, Deshpande Test.	15
IV	Two sample problem: Gehan test, Log rank test. Mantel-Haenszel test, Cox's proportional hazards model, competing risks model.	15

		Total Contact hours	60
Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Cox,D.R. and Oakes,D. (1984) : Analysis of Survival Data, Chapters1,2,3,4. Taylor andFrancis
2. Crowder M.J.(2001) : Classical Competing Risks, Chapman & Hall, CRC, London.
3. Miller,R.G.(1998) : Survival Analysis, Second Edition, Wiley Interscience.
4. Gross,A.J. & Clark,V.A.(1976): Survival Distributions-Reliability Applications in Bio-medical Sciences, Chapters3,4, John Wiley and Sons.
5. KalbfleischJ.D.and Prentice R.L. (1980) : The Statistical Analysis of Failure Time Data, John Wiley and Sons.

Session: 2025-26			
Part A - Introduction			
Name of the Programme	M.Sc. Statistics		
Semester	**Fourth**		
Name of the Course	Practical-4 (Calculator and SPSS/SYSTAT based)		
Course Code	M24- STA -411		
Course Type	PC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 411.1: Perform exploratory analysis of multivariate data using SPSS and SYSTAT. • CLO 411.2: Conduct statistical inference about multivariate means including hypothesis testing and different types of confidence intervals estimation; • CLO 411.3: Design and conduct experiments, as well as analyze and interpret data. • CLO 411.4: Check the affects of different factors under study and analyze Split-plot design & BIBD		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B-Contents of the Course

	Contact Hours 120

Note: There will be 4 questions, the candidate will be required to attempt any 3 questions

Practicals

1. Estimating parameters of multi normal distribution.
2. Calculation of multiple and partial correlation coefficients.
3. Estimating the parameters of conditional distribution.
4. Test based on total, partial and multiple correlations.
5. Test based on Hotelling - T^2 and Mahalanobis - D^2 Statistics.
6. Fisher's linear discriminate function.
7. Calculation of principal components.
8. Analysis of three basic designs- Basic analysis and splitting of treatment S. S. for different contrasts.
9. Analysis of 2^2 – factorial experiment.
10. Analysis of 2^3 – factorial experiment.
11. Analysis of completely confounded factorial experiment.
12. Analysis of partially confounded factorial experiment.
13. Analysis of split plot design.
14. Analysis of BIB Design.

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		
Part C-Learning Resources			
Recommended Books/e-resources/LMS:			

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Statistics		
Semester	**Fouth**		
Name of the Course	Data Analysis using Statistical Softwares		
Course Code	M24- STA -412		
Course Type	EEC		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	• CLO 412.1: Understand SPSS environment and the available in-built statistical tools. • CLO 412.2: Perform statistical analysis using SPSS. • CLO 412.3: Understand the basics of R programming language such as data types, operators, control structures and functions. • CLO 412.4: Handle data manipulations and various statistical models using R.		
Credits	Theory	Practical	Total
	1	1	2
Teaching Hours per week	1	2	3
Internal Assessment Marks	10	5	15
End Term Exam Marks	20	15	35
Max. Marks	30	20	50
Examination Time	3 hours	3 hours	

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Knowledge and familiarity with statistical package SPSS, The Fundamental Mechanics of SPSS, Getting Data into and out of SPSS, Graphical representation of data, Tabulation of data, Descriptive Statistics, Summarizing Data, Creating & Editing Charts, Modifying data values, Sorting & Selecting Data Values.	4
II	Advance features of SPSS: Correlation & Regression, Chi- Square, t- test: one sample and two sample problems, One-way ANOVA.	3
III	Introduction to R: Overview of R programming, Evolution of R, Applications of R programming, Basic syntax; Basic Concepts of R: Reserved Words, Variables & Constants, Operators, Operator Precedence, Data Types, Input and Output; Data structures in R: Vectors, Matrix. Control flow: If...else, If else () Function, For loop, While Loop, Break & next.	4
IV	R packages: Study of different packages in R; R Data Reshaping: Joining Columns and Rows in a Data Frame, Merging Data Frames, Melting and Casting; Working with files: Read and writing into different types of files.	4

Total Contact hours	15
Practicum	30

1. Finding the mean and standard deviation of given data.
2. Computation of Moments, Skewness and Kurtosis of given data.
3. Computation of Karl Pearson's and Partial correlation coefficient.
4. Computation of Spearman's rank correlation coefficient.
5. Fitting of lines of regression.
6. Testing the significance of the mean of a random sample from a normal population.
7. Testing the significance of difference between two sample means,
8. Testing the significance of an observed correlation coefficient.
9. Testing the significance of the ratio of two independent population variances.
10. To test the goodness of fit.

Suggested Evaluation Methods

Internal Assessment: 10		**End Term Examination: 20**	
➢ **Theory**	**10**	➢ **Theory:**	**20**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc,:	0		
• Mid-Term Exam:	6		
➢ **Practicum**	**5**	➢ **Practicum:**	**15**
• Class Participation:	0	**Lab record, Viva-Voce, write-up and execution of the practical**	
• Seminar/presentation/assignment/quiz/class test etc,:	5		
• Mid-Term Exam:	0		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Argyrous, G. (2011) : Statistics for Research: With a Guide to SPSS, Sage South Asia; Third Edition.
2. Griffith, A. (2007) : SPSS For Dummies, Published by Wiley. Publishing, Inc.
3. Kirkpatric L.A. & Feeney B. C. (2015) : A Simple Guide to SPSS, Cengage.
4. Matloff, N. (2011) : The Art of R Programming-a tour of statistical software design, No Starch Press.
5. Teetor, P. (2011) : R Cookbook Proven Recipes for Data. Analysis, Statistics, and Graphics, O'Reilly Cookbooks.
6. Kabacoff, R. (2022) : R in Action Book, Simon and Schuster.
7. Zumel, N., & Mount, J. (2014) : Practical Data Science with R, Manning.