UNIVERSITY OF JAMMU

(NAAC ACCREDITED 'A' GRADE' UNIVERSITY)
(Baba Sahib Ambedkar Road, Jammu-180006 (J&K)

Academic Section
Email: academicsectionju14@gmail.com

NOTIFICATION

(23/November/Adp./94)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of the Syllabi and Courses of Studies in the subject of **Statistics** for **Master Degree Programme** of Semester **Ist, IInd, IIIrd and IVth** under the **Choice Based Credit System (as given in the annexure)** for the examinations to be held in the years as per the details given below:

Subject	Semester	For the examinations to be held in the year
Statistics	Semester-I	Dec. 2023, 2024 and 2025
	Semester-II	May 2024, 2025 and 2026
	Semester-III	Dec. 2024, 2025 and 2026
	Semester-IV	May 2025, 2026 and 2027

The Syllabi of the courses is also available on the University website: www.jammuuniversity.ac.in

Sd/-
DEAN ACADEMIC AFFAIRS

No. F. Acd/II/23/11740-11748
Dated: 13-11-2023.

Copy for information and necessary action to:

1 Dean, Faculty of Mathematical Science
2 Convener, Board of Studies in **Statistics**
3 Programmer, Computer Section, Examination Wing
4 Incharge, University Website for Uploading of the notification.

Sumitra Saeno 13/11/23.
Deputy Registrar (Academic)

10/11/23 10/11/23 10/11/23

ANNEXURE-A I

Distribution of Courses and Credits

M.Sc. Statistics (CBCS)

Semester – I

Course Code	Paper	Credits	Percentage Change made as per recommendations of expert committee	Contact Hours per week L-Tu-P
PSSSTC101	**Probability and Distribution Theory**	4	12%-15% change in syllabus	4-1-0
PSSSTC102	**Programming with C++**	4	Course interchanged with 10%-12% change	4-1-0
PSSSPC103	**Statistical Computing - I**	4	12%-15% change in syllabus	0-0-4
PSSSPC104	**Computations with C++**	4	Course interchanged with 20%-25% change	0-0-4
Any Two of the following:				
PSSSTE105	**Real Analysis and Measure Theory**	4	100% New course introduced	4-1-0
PSSSTE106	**Linear Algebra**	4	10%-15%	4-1-0
PSSSTE107	**Information Theory**	4	12%-15%	4-1-0
PSSSTE108	**Biostatistics**	4	15%-20%	4-1-0
PSSSTE109*	**Basic Statistics** (for the students who have not studied Statistics at UG Level)	NC	100% New course introduced	4-1-0
Total		**24**		**16-4-8**

* course marked with asterik is non credited and is meant for those students who have not studied Statistics at UG Level. It is just a qualifying course in nature which the concerned students must pass.

Semester – II

Course Code	Paper	Credits	Percentage Change made as per recommendations of expert committee	Contact Hours per week L-Tu-P
PSSSTC201	**Advanced Probability Theory**	4	10%-15% change in syllabus	4-1-0
PSSSTC202	**Linear Models & Regression Analysis**	4	Course interchanged with 10%-15% change	4-1-0
PSSSTC203	**Statistical Inference-I**	4	15%-20%	4-1-0
PSSSTC204	**Sample Surveys**	4	Course interchanged with 10%-12% change	4-1-0
PSSSPC205	**Statistical Computing – II (MATLAB)**	4	100% New course introduced	0-0-4
PSSSPC206	**Practical (Based on PSSSTC 202 and PSSSTC 204) SPSS**	4	100% New course introduced	0-0-4
Total		**24**		**16-4-8**

L – Number of Lecture, Tu – Number of Tutorials, P – Number of Practical hours.

ANNEXURE-~~I~~ G1

Distribution of Courses and Credits

M.Sc. Statistics (CBCS)

Semester – III

Course Code	Paper	Credits	Percentage Change made as per recommendations of expert committee	Contact Hours per week L-Tu-P
PSSSTC301	**Design of Experiments**	4	Course interchanged with 10%-15% change in syllabus	4-1-0
PSSSTC302	**Multivariate Analysis**	4	Course interchanged with 10%-12% change in syllabus	4-1-0
PSSSTC303	**Artificial Intelligence & Statistical Learning**	4	100% change with introduction of new course	3-0-1
PSSSPC304	**Practical's based on PSSSTC301&302** (SPSS)	4	15% change in syllabus	0-0-4
PSSSTOXXX	**MOOC Course**	4	15%-20% change in syllabus	4-1-0
PSSSPC305	**Summer Internship**	4	100% change with introduction of new course	0-0-4
Any One of the following Elective Courses:				
PSSSTE306	**Advanced Statistical Inference**	4	15%-20% change in syllabus	4-1-0
PSSSTE307	**Advanced Statistical Computing (Python)**	4	15% change in syllabus	3-0-1
PSSSTE308	**Non-Parametric Inference**	4	15%-20% change in syllabus	4-1-0
PSSSTE309	**Demography**	4	15%-20% change in syllabus	4-1-0
	Total	**24**		**16-4-8**

Semester – IV

Course Code	Paper	Credits	Percentage Change made as per recommendations of expert committee	Contact Hours per week L-Tu-P
PSSSTC401	**Stochastic Processes**	4	10%-15% change in syllabus	4-1-0
PSSSTC402	**Optimization Techniques**	4	12%-15% change in syllabus	4-1-0
PSSSPC403	**Data Analytics (R)**	4	100% change with introduction of new course	0-0-4
PSSSPC404	**Practical (Based on one elective course)**	4	10%-12% change in syllabus	0-0-4
PSSSTO405*	**Applied Statistical Methods**	4	15%-20% change in syllabus	4-1-0
Any One of the following Elective Courses:				

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

PSSSTE406	**Econometrics**	4	15%-20% change in syllabus	4-1-0
PSSSTE407	**Operations Research**	4	15%-20% change in syllabus	4-1-0
PSSSTE408	**Actuarial Statistics**	4	10%-12% change in syllabus	4-1-0
PSSSTE409	**Statistical Modelling and Computing**	4	15%-20% change in syllabus	4-1-0
Total		**24**		**16-4-8**

L – Number of Lecture, Tu – Number of Tutorials, P – Number of Practical hours.

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor-I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

SCHEME OF EXAMINATIONS

Each paper shall carry 100 marks and distribution of marks in each theory and practical paper shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

ANNEXURE-~~F~~ E

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.: PSSSTC101 **Title: Probability and DistributionTheory**

Credits :4 **Maximum Marks :100**

Duration of Examination: 3 Hrs

a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: The objectives of this course are to make the students familiar with Distribution Theory.

Unit-I

Review of random variable and basic distribution theory. Joint, marginal and conditional p.m.fs. and p.d.fs, Functions of random variable and their distribution using Jacobean transformation and other tools, Standard discrete distributions viz., Binomial, Poisson, Rectangular, Negative binomial, Hyper Geometric.

Unit II

Standard continuous distributions viz., Normal, Uniform, Cauchy, Beta, Gamma, Log normal, Exponential, Bivariate normal, Bivariate Exponential (Laplace); Order statistics and their distribution, Joint and marginal distributions of order statistics, Distribution of median and range

Unit III

Introduction to special distributions: Degenerate, Two-point, negative Hypergeometric, Multinomial, Pareto, Logistic, Weibul and Rayleigh distributions. Conditional expectation & conditional variance, Simple, partial and multiple correlations, linear and multiple regression. (in terms of conditional expectation)

Unit IV

Compound, truncated and mixture distributions, Sampling distributions, Central and Non-central Chi- square, t-and F- distributions and their properties.

Books Recommended:

1.	Fisz, M. (2012)	Probability Theory and Mathematical Statistics, John Wiley & sons
2.	Rohtagi, V.K. & Ehsanes Saleh, A.K. (2014)	An Introduction to Probability Theory and Mathematical Statistics, Wiley Series.
3.	Kendall, M.G., Stuart, A. (2001)	The Advanced theory of Statistics: Distribution Theory Vol 1, John Wiley & Sons
4.	Johnson, N.L. and Kotz, S. and Balakrishnan, N (1995)	Continuous Univariate Distributions, vol 1 and vol 2, John Wiley & Sons
5.	Rohtagi, V,K (1993)	An introduction of Probability Theory and Mathematical Statistics, John Wiley & Sons
6.	Johnson, N.L., Kemp, A.W. and Kotz, S. (2005)	Univariate Discrete Distributions, John Wiley & Sons
7.	Thomopoulos, N. T. (2017)	Probability Distributions: With Truncated, Log and Bivariate Extensions

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.: PSSSTC101
Credits :4
Duration of Examination: 3 Hrs

Title: Probability and Distribution Theory
Maximum Marks :100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.: PSSSTC102
Credits :4
Duration of Examination: 3 Hrs

Title: Programming with C++
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: The aim of this course is to provide the knowledge of programming language C++ to the students.

Unit I

Flowchart, Algorithm and problem solving. General concepts of programming. C++ character set, C++ tokens (identifiers, keywords, constants, and operators), structure of C++ program, cout, cin, Use of I/O operators, Cascading of I/O operators. Data Types: Built-in data types- int , char, float, double, Integer constants, Character Constants, String Constants. Variable: Declaration of variable of built-in data types. Operators: Arithmetic operators, Relational Operators. Logical operators. Increment and decrement operator. Conditional operator, Precedence of operators. Type Conversion: Automatic type conversion, type casting. C++ short hands (--, ++, =), Assignment statement, variables initialization.

Unit II

Flow of control: Conditional statements, General form of if-else statement, if else if ladder, Nested if? As an alternative to if, General form of switch, Nested Switch. Simple control statement, for loop statement, while loop, do while loop. Variation in loop statements; Nested Loops, Loop termination: break, continue, goto, exit (), gets and puts functions. Structured Data Type: Array, General form of Declaration and Use: one dimensional array, String two-dimensional, Array initialization. Pointer: Declaration, Arithmetic, Pointer and Arrays

Unit III

Functions: General form, Function Prototype, definition of function, accessing a function. Passing arguments to function, specifying argument Data type, Default argument, Constant argument, Call by value and Call by reference, returning value and their types, Calling function with arrays, Scope rules of function and variables, Local and Global variables, Storage class specifiers: extern, auto, register and static. Standard Header files – string.h, math.h, stdlib.h , iostream.h. Standard library functions
,Mathematical functions: fabs(), frexp() ,fmod (), log(), log10(), pow(), sqrt(), cos(), abs().Creating header file and to use them in a programme. Unions: Union Tag, Processing with Unions, Initialization with Union, Anonymous Union

Unit IV

Structures: specifying a structure, defining a structure variable, accessing structure members. Functions and structures, arrays of structures, arrays within a structure, Structure within structure Class: Specifying a class, public and private data members and member functions, defining objects, calling member function,
constructor and destructor functions, concept of data hiding, encapsulation, inheritance, polymorphism. Pointer and classes, Union and classes

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No. :PSSSTC102
Credits :4
Duration of Examination: 3 Hrs

Title: Programming with C++
Maximum Marks :100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Books Recommended:

1.	Lafore, R. (2002)	C ++ Programming SAMS (USA)
2.	Al Stevens (1997)	Teach Yourself C++, fifth Edition, Wiley Publications, New Delhi.
3.	Ravichandran,D. (2011)	Programming in C++, McGraw Hill
4.	Asthana ,A. (2007)	Programming in C++, Narosa Publication
5.	Stroustrup, B. (2013)	The C++ Programming Language, Addison-Wesley
6.	Eckel,B. (2003)	Thinking in C++, Pearson
7.	Kanetkar , Y. (2020)	Let Us C++ ,BPB Publications
8.	Walter, S. and Mock, K. (2017)	Problem Solving with C++ ,Pearson
9.	Balagurusamy ,E. (2017)	Object Oriented Programming with C++ , McGraw Hill

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Course No.: PSSSPC103
Credits :4
Duration of Examination: 3 Hrs

Title: Statistical Computing -I
Maximum Marks :100
Internal Examnation:50 Marks
External Examination:50Marks

Objectives: To make students familiar with the compilation and Statistical analysis of data using Statistical Softwares.

There shall be at least twenty computing exercises covering the applications of Statistical Softwares and computing tools.

Practicals:

1. Practicals based on graphical representation.
2. Practicals based on t-test for Single mean and Difference of means.
3. Practicals based on Paired t-test.
4. Practicals based on Simple and Multiple correlation
5. Practicals based on Regression.
6. Practicals based on outlier detection
7. Practicals based on Chi Square test.
8. Practicals based on One way and Two way ANOVA

SCHEME OF EXAMINATIONS

Each practical paper shall carry 100 marks and distribution of marks shall be as under:

Component	**Marks**	**Remarks**
Internal	50	After 60 days on completion of 50 % of syllabus **Written Exam: 16 Marks (two Practicals of 08 Marks Each)** **Viva Voce :12 Marks** **Attendance: 10 Marks** **Day to Day Performance: 12 Marks**
External	50	On completion entire syllabus **Written Exam: 40 Marks (two Practicals of 20 Marks Each)** **Viva Voce :10 Marks**
Total	100	

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.:PSSSPC104
Credits :4
Duration of Examination: 3 Hrs

Title: Computation with C++
Maximum Marks :100
Internal Examnation:50 Marks
External Examination:50Marks

Objectives: To make students familiar with the computation work based on Course No. PSSSTC 102

There shall be at least twenty computing exercises covering the applications of C++ language

Component	**Marks**	**Remarks**
Internal	50	After 60 days on completion of 50 % of syllabus **Written Exam: 16 Marks (two Practicals of 08 Marks Each)** **Viva Voce :12 Marks** **Attendance: 10 Marks** **Day to Day Performance: 12 Marks**
External	50	On completion entire syllabus **Written Exam: 40 Marks (two Practicals of 20 Marks Each)** **Viva Voce :10 Marks**
Total	100	

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No. :PSSSTE105 **Title: Real Analysis and Measure Theory**

Credits :4 **Maximum Marks:100**

Duration of Examination: 3 Hrs **a) Minor Test -I : 20**

b) Minor Test -II : 20

c) Major Test 60

Objectives: This course introduces the students to concepts of Real Analysis.

Unit- I

Introduction to Real number system, introduction to n-dimensional Euclidean space: Limit Points of a set, open sets, closed sets etc. (will be developed through general metric space and R^n will be considered as a special case, Compact sets, Bolzano-Weirsstrass theorem, Heine-Borel Theorem.

Unit -II

Limit superior, limit inferior and limit of a sequence, their convergence, Cauchy sequence, Convergence of series, tests for convergence for series, Uniform convergence of sequences and series, Stone-Weirsstrass theorem (Statement Only).

Unit- III

Fields, sigma minimal sigma field, sigma-field generated by a class of subsets, Borel fields. Sequence of sets, limsup and liminf of sequence of sets, Measure, probability measure, propertiesof a measure, Continuity theorem of measure.

Unit- IV

Idea of Lebesgue and Lebesgue-Steiltjes measure, Signed measure, Jordan-Hahn decomposition theorem. Measurable functions, integration of a measurable function with respect to a measure, Monotone convergence theorem, Fatou's lemma, dominated convergence theorem, Radon Nikodym Theorem, Product measure, Fubini's Theorem

Books Recommended

1.	Apostol, T.M. (2002)	Mathematical Analysis, Narosa, Indian Edition.
2.	Rudin, W. (2013)	Principles of Mathematical Analysis, McGraw.
3.	Bartle, R.G. and Sherbat (2007)	Elements of Real Analysis (Wiley)
4.	Courant, R. and John, F. (1974)	Introduction to Calculus and Analysis (Vol I and II), Wiley
5.	Goldberg, R. R. (1970)	Methods of Real Analysis, Oxford and IBH Publisher
6.	Royden, H.L. (1988)	Real Analysis, MacMillan
7.	Ghorpade, S.R. and BV Limaye (2006)	A Course in Calculus and Real Analysis, Springer
8.	Ajit Kumar and S.Kumaresan|(2015)	A Basic Course in Real Analysis, CRC Press
9.	Torence Tao (2006)	Analysis I, Hindustan Book Agency, India.
10.	Malik S. C. & Arora S.(2008)	Mathematical Analysis-New Age International Publications Wiley Eastern Limited 4th edition.

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.: PSSSTE105 **Title: Real Analysis and Measure Theory**

Credits :4 **Maximum Marks:100**

Duration of Examination: 3 Hrs

a) Minor Test -I : 20

b) Minor Test -II : 20

c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.: PSSSTE106
Credits :4
Duration of Examination: 3 Hrs

Title: Linear Algebra
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: This course introduces the students to concepts of Linear Algebra and Matrices.

Unit -I

Vector spaces with an inner product, sub spaces, linear dependence and independence, basis and dimension of a vector space, finite dimensional vector spaces, linear transformations, completion theorem, examples of vector spaces over real and complex fields, Gram-Schmidt Orthogonalization process.

Unit- II

Algebra of matrices, elementary matrices, row and column spaces of a matrix, rank and inverse of a matrix, null space and nullity, partitioned matrices, Kronecker product, Hermite canonical form, generalized inverse, Moore Penrose generalized inverse, left weak and right weak g-inverses, Idempotent matrices, solution of matrix equations.

Unit- III

Real quadratic forms, reduction and classification of quadratic forms, index and signature, triangular reduction of a positive definite matrix, characteristic roots and vectors, Cayley-Hamilton theorem, similar matrices, Hermitian quadratic forms.

Unit -IV

Algebraic and geometric multiplicity of a characteristic root, spectral decomposition of a real symmetric matrices, reduction of a pair of real symmetric matrices, singular values and singular value decomposition.

Books Recommended:

1.	Graybill, F.A. (2001)	Matrices with applications in Statistics, Cengage Learning.
2.	Rao, C. R. (2002)	Linear Statistical Inference and its Applications, John Wiley &Sons.
3.	Searle, S.R. (1982)	Matrix Algebra Useful for Statistics, John Wiley & Sons.
4.	Bellman, R. (1997)	Introduction to matrix Analysis, McGraw Hill.
5.	Biswas, S. (2012)	Topics in Algebra of matrices Academic publications.
6.	Hadley, G. (2006)	Linear Algebra, Narosa Publishing House.
7.	Halmos, P.R. (1958)	Finite Dimensional Vector Spaces, Springer.
8.	Dutta, K. B. (2014)	Matrix and Linear Algebra, PHI Learning
	DeFranza,J.and Gagliardi,D.(2017)	Introduction to Linear Algebra and Applicatins, Tata McGraw Hill
9.	Harville,D.A.(2001)	Matrix Algebra from a Statistician's Perspective, Springer

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.: PSSSTE106
Credits :4
Duration of Examination: 3 Hrs

Title: Linear Algebra
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.: PSSSTE107
Credits :4
Duration of Examination: 3 Hrs

Title: Information Theory
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: To introduce information theoretic concepts.

Unit I

Concept of Entropy and information measures, Formal requirements of the average uncertainty, Shanon's measure of information and its properties, Joint and Conditional Entropy, Relative entropy and mutual information, Uniqueness of the entropy function Jensen's Inequality and its consequences, Fano's Inequality, Asymptotic Equipartition Property, Entropy Rate.

Unit-II

Elements of encoding, redundancy and efficiency, binary codes, Shannon Fano Encoding ,Necessary and sufficient condition for noiseless coding, Average length of encoded message Kraft Inequality, McMillan Inequality, Optimal Codes, Huffman Code, Fundamental theorem of discrete noiseless coding.

Unit-III

Differential Entropy, Joint and Conditional Differential Entropy, Properties of Differential and Relative Entropy, Differential Entropy of distribution, Relationship of Differential Entropy to Discrete Entropy, Differential entropy bound on discrete entropy Entropy Optimization Principles, Maximum Entropy Principle, MaxEnt Formalism, Maximum Entropy Distribution

Unit-IV

Channel capacity, symmetric channels, Binary symmetric channel, Binary Erasure channel, Properties of channel capacity. Joint AEP theorem, channel coding theorem (statement only), Fano's inequality and converse to the coding theorem, Hamming codes.

Books Recommended:

1.	Shannon, C.E. (1948)	The mathematical theory of communication. Bell Syst.Tech. J, Vol. 27, pp. 379-423 and pp 623-656.
2.	Vander, L. (1997)	Information Theory, Cambridge University Press.
3.	Thomas T. M. and Cover (2006)	Elements of Information Theory. Wiley, New York.
4.	Kapur,J.N. and Kesavan H.K(1992)	Entropy Optimization Principles with Applications, Academic Press, New York.
5.	Reza, F.M. (2007)	An Introduction to Information Theory, Dover Publications.
6.	Robert Ash (1965)	Information Theory, Dover Publications
7.	Dehmer, M. and Frank E. S. (2009)	Information Theory and Statistical Learning, Springer
8.	Gray, R.M. (2011)	Entropy and Information Theory 2nd edition.Springer

15

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No.: PSSSTE107
Credits :4
Duration of Examination: 3 Hrs

Title: Information Theory
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No. :PSSSTE108
Credits :4
Duration of Examination: 3 Hrs

Title: Biostatistics
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: This course introduces the students to various applications of statistics in biology and medical fields.

UNIT-I

Basic biological concepts in genetics, Mendel's law, Hardy- Weinberg equilibrium, random mating, distribution of allele frequency (dominant/co-dominant cases), Approach to equilibrium for X-linked genes, natural selection, mutation, and genetic drift, equilibrium when both natural selection and mutation are operative.

UNIT-II

Planning and design of clinical trials, Phase I, II, and III trials. Consideration in planning a clinical trial, designs for comparative trials. Sample size determination in fixed sample designs.

UNIT-III

Functions of survival time, survival distributions and their applications viz. Exponential, Gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shape hazard function. Tests of goodness of fit for survival distributions (WE test for exponential distribution, W-test for lognormal distribution, Chi-square test for uncensored observations).

UNIT-IV

Type I, Type II and progressive or random censoring with biological examples, Estimation of mean survival time and variance of the estimator for type I and type II censored data with numerical examples. Idea of Stochastic epidemic models: Simple epidemic models (by use of random variable technique).

Books Recommended:

1.	Biswas, S. (1995)	Applied Stochastic Processes. A Biostatistical and Population Oriented Approach, Wiley Eastern Ltd.
2.	Cox, D.R. & Oakes, D. (1984)	Analysis of Survival Data, Chapman and Hall.
3.	Ewens, W. J. (1979)	Mathematics of Population Genetics, Springer Verlag.
4.	Ewens, & Grant, (2010)	Statistical methods in Bio informatics.: An Introduction, Springer.
5.	Friedman, L.M., Furburg, C. and DeMets, D.L (1998)	Fundamentals of Clinical Trials, Springer Verlag.
6.	Gross, A. J. and Clark V.A. (1976)	Survival Distribution; Reliability Applications in Biomedical Sciences, John Wiley & Sons.
7.	Lee, Elisa, T. (1992)	Statistical Methods for Survival Data Analysis, John Wiley & Sons.
8.	Arora, P.N. & Malhan, P.K. (2010)	Biostatistics, Himalaya Publications
9.	Friedman, L. M.,., David L., & Christopher B. G. (2015)	Fundamentals of Clinical Trials, Springer

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

Course No. :PSSSTE108
Credits :4
Duration of Examination: 3 Hrs

Title: Biostatistics
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

***Course No. :PSSSTE109**
Credits: NIL
Duration of Examination: 3 Hrs

Title: Basic Statistics
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: This course aims at acquainting about the basic tools and techniques of Statistics to those students who have not opted Statistics ad DSC at under graduate level.

Unit I

Measures of Central Tendency, Measures of Dispersion, Classical and axiomatic definitions of Probability. Additive and multiplicative laws of probability, Conditional probability, Bayes' theorem and applications. Discrete and continuous random variables. Distribution functions and their properties.

Unit II

Expectation, Moment Generating Function, Correlation: Simple, Partial and multiple correlation, Intraclass correlation, Correlation ratio, Regression lines, regression coefficients and their properties. Principle of least squares and fitting of a straight line. Bivariate and multivariate data, Association and Contingency, Curve fitting and Orthogonal Polynomials,

Unit III

Testing of Hypothesis: Statistical hypothesis, Null and alternative hypothesis, simple and composite hypothesis, two types of error, Critical region, Different types of critical regions and similar regions, power of test, level of significance. Best Critical Region, NP Lemma, its applications, Properties of good estimator and methods of estimation

Unit IV

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

Official Statistics: (a) Need, Uses, Users, Reliability, Relevance, Limitations, Transparency, its visibility (b) Compilation, Collection, Processing, Analysis and Dissemination.
National Statistical Organization: Vision and Mission, NSSO and CSO, roles and responsibilities, important activities, Publications etc.
National Statistical Commission: Need, Constitution, its role, functions etc, Legal Acts/ Provisions/ Support for Official Statistics; Important Acts.

Books Recommended:

1.	Gupta,S.C. and Kapoor V.K.(2017)	Fundamentals of Mathematical Statistics, S Chand publication
2.	Mood,A.M., Graybill,F. and Boes,D.(2017)	Introduction to Theory of Statistics, McGraw Hill
3.	Hogg ,R. and Craig,A (2012)	Introduction to Mathematical Statistics, Pearson

Syllabus: M.A./M.Sc. (Statistics) Semester-I for the examination to be held in Dec-2023, 2024, 2025

***Course No. PSSSTE109**
Credits: NIL
Duration of Examination: 3 Hrs

Title: Basic Statistics
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

4.	Das,M.N. and Giri,N. (1987)	Design and Analysis of Experiments, New Age International Publication
5.	Gupta,S.C. and Kapoor V.K.(2017)	Fundamentals of Applied Statistics, S Chand publication
6.	Goon,A.M.,Gupta M.K. and Dasgupta,B(2013)	Fundamentals of Statistics, World Press
7.	Rohtagi,V.K. and Saleh A.K.M.E. (2015)	An Introduction to Probability and Statistics, Wiley
8.	Yule G.U. (2019)	An introduction to the theory of Statistics, Wiley–Blackwell
9.	Schiller,J. Srinivasan, A. R.and Spiegel, M. (2012)	Outline of Probability and Statistics, Mc Graw Hill

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

ANNEXURE-~~C~~ F

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No.: PSSSTC 201
Credits :4
Duration of Examination: 3 Hrs

Title: Advanced Probability Theory
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: This course introduces the students to concepts of Probability and Measure Theory.

UNIT-I

Recap of Basic Concepts of Probability and Measure Theory, Chebyshevs, Markov, Holder,Minkowaski, Jensen and Lyapunov inequalities, Characteristic functions and their properties, Parseval relation, Uniqueness theorem, Inversion theorem.

UNIT-II

Convergence of sequence of random variables, Almost sure convergence, convergence in mean, convergence in probability, convergence in distribution, and their relationships with illustrations.

Unit- III

Borel-Cantelli Lemma, Zero-One Laws of Borel and Kolmogorov, Kolmogorov's inequality, weak law and strong law of large numbers of sequences of r.v.'s with illustrations, three series criterion.

Unit- IV

Limiting and asymptotic distributions, Levy's continuity theorem, continuity correction, Central Limit Theorems of Lindeberg-Levy,Liapounov and Lindberg-Feller with suitable illustrations.

Books Recommended:

1.	Robert Ash (1972)	Real Analysis and Probability, Academic Press
2.	Billinsley, P. (1986)	Probability and Measure, Wiley
3.	Dudley, R.M. (2002)	Real Analysis and Probability, Cambridge University Press
4.	Kingman,J.F.C. and Taylor, S.J.(1966)	Introduction to measure and probability, Cambridge University press
5.	Bhat, B. R. (2014)	Modern Probability Theory, New Age International Private Limited
6.	Basu, A.K. (2012)	Probability and Measure theory, Narosa Pub. House
7.	Rohtagi,V. K. and Saleh A.K.M.E. (2015)	An Introduction to Probability and Statistics, Wiley
8.	Chung, K. L. (2001)	A Course in Probability Theory, Academic Press
9.	Feller, W. (1998)	Introduction to Probability and its Application Vol. II, Wiley Eastern Ltd.

ANNEXURE-C

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No.: PSSSTC 201
Credits :4
Duration of Examination: 3 Hrs

Title: Advanced Probability Theory
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No. :PSSSTC 202
Credits :4
Duration of Examination: 3 Hrs

Title: Linear Models & Regression Analysis
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: The aim of this course to provide the knowledge of Linear Models and Regression analysis.

Unit- I

Gauss-Markov set-up, Normal equations and Direct Least squares estimates, Error and estimation spaces, variances and covariances of least squares estimates, estimation of error variance, least squaresestimates with exact restriction on parameters.

Unit -II

Simultaneous Estimates of linear Parametric functions, Tests of hypothesis for one and more than one linear parametric functions, confidence intervals and regions, Analysis of Variance, Multiple comparisontests due to Tukey and Scheffe, simultaneous confidence intervals.

Unit -III

Introduction to One-way random effects linear models and estimation of variance components, Simple linear Regression, multiple and polynomial regression, orthogonal polynomials, reparameterization of linear models.

Unit -IV

Residuals and their plots as tests for departure from assumptions such as fitness of the model, normality, homogeneity of variances and detection of outliers, Remedies, Introduction to non-linear models; least squares in non-linear case, transformation of the model.

Books Recommended:

1.	Cook, R.D. and Weisber, S. (1982)	Residual and Influence in Regression, Chapman and Hall.
2.	Graybill, F.A. (2000)	Theory and Application of the Linear Models, Cengage Learning Models.
3.	Draper, N.R. and Smith, H. (1998)	Applied Regression Analysis 3rd Ed. Wiley.
4.	Gunst, R.F. and Mason,R.L.(1980)	Regression Analysis and its Application-A Data Oriented Approach, Marcel and Dekker.
5.	Rao, C.R. (2002)	Linear Statistical Inference and its Applications, Wiley.
6.	Weisber, S. (1995)	Applied Linear Regression, Wiley Eastern.
7.	Montgomery, D.C. and E.A. Peck (2012)	Introduction to Linear Regression Analysis, John Wiley &sons

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No.: PSSSTC 202
Credits :4
Duration of Examination: 3 Hrs

Title: Linear Models & Regression Analysis
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No.: PSSSTC203
Credits :4
Duration of Examination: 3 Hrs

Title: Statistical Inference -I
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: The aim of this course is to provide the knowledge of Inference to the students.

Unit -I

Introduction to estimation; unbiasedness, consistency, sufficiency and Minimal sufficiency, Factorization Criterion, Fisher information and sufficiency, CAN estimators, Mean Square Error, Completeness and Bounded completeness, Finite and asymptotic efficiency.

Unit -II

UMVUE, Cramer-Rao inequality, Chapman-Robbins-Keifer lower bound, Rao-Blackwell Theorem, Lehmann Scheffe Theorem, Exponential and Pitman families Methods of Estimation: Maximum Likelihood method, methods of moments and percentiles.

Unit -III

Testing of hypothesis; Basic concepts, randomized and nonrandomized test procedures, Neyman-Pearson Lemma, Families with MLR property, UMP Test with applications to exponential families, UMP unbiased tests, with application to one sample and two sample problems in normal populations.

Unit -IV

Likelihood ratio test and its properties (without proof) and applications to normal distribution, Interval estimation, confidence level, construction of confidence, intervals using pivots, shortest expected length confidence interval, Wald's SPRT.

Books Recommended:

1.	Kale, B.K. (2007)	A first course a Parametric Inference, Narosa Publishing House
2.	Rohtagi, V.K. and Saleh, A.K.M.E.D. (2015)	An introduction to probability and Mathematics Statistics, Wiley Eastern Ltd.
3.	Rao, C.R. (2003)	Linear Statistical Inference and its applications, Wiley
4.	Zacks, S. (1971)	New Theory of Statistical Inference, John Wiley and sons, New York.
5.	Lehman, E.L. and Casella, G. (1998)	Theory of Point Estimation, Springer.
6.	Lehman, E.L. and Romano J.P. (2005)	Testing Statistical Hypothesis, Springer.
7.	Rajagopalan, M. and Dhanavanthan, B. (2012)	Statistical Inference PHI Learning Pvt. Ltd.
8.	Casella, G. and Berger R.L. (2001)	Statistical Inference, Duxbury

25

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No.: PSSSTC203
Credits :4
Duration of Examination: 3 Hrs

Title: Statistical Inference -I
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No.: PSSSTC 204
Credits :4
Duration of Examination: 3 Hrs

Title: Sample Surveys
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

Objectives: The objectives of this course are to make the students familiar with various sampling methods.

Unit- I

Review of SRS WR and WOR, Estimation of sample size, Stratified random sampling, different methods of allocation, relative precision of stratified random sampling with S.R.S., formation and construction of strata and Post Stratification.

Unit-II

Systematic sampling, estimation of mean and sampling variance, comparison of systematic sampling with stratified and S.R.S., Varying probability sampling methods of selecting sample with p.p.s, p.p.s, sampling W.R., efficiency of p.p.s. sampling. PPS WOR, H.T. estimator, Des Raj Sampling strategy, Murthy estimator, Sen-Midzuno method.

Unit-III

Ratio estimator, bias and mean square error, estimation of variance, comparison with SRS, ratio estimator in stratified sampling, unbiased type ratio estimators Difference estimator, regression estimator, comparison of regression estimator with SRS and ratio estimator,

Unit-IV

Cluster sampling with equal and unequal cluster sizes, relative efficiency with SRS and optimum cluster size, Two stage sampling with equal and unequal s.s.u's, estimation of mean and sampling variance. Successive sampling, sampling on two occasions.

Books Recommended:

	Cochran, W.G. (2013)	Sampling techniques, Wiley & Sons
2.	Murthy, M.N. (1967)	Sampling Theory and Methods, Statistical PublishingSociety, Calcutta.
3.	Des Raj (1999)	Sampling Theory, Create Space Publishers, USA.
4.	Mukhopadhayay, P. (2014)	Theory and methods of survey sampling, PHI Learning.
5.	Singh,D. and F.S Chaudhary (2002)	Theory and Analysis of sample Survey Designs, New age International Publications.
6.	Sampath,S. (2005)	Sampling Theory & Methods, Alpha Science India Ltd.
7.	Singh, S (2003)	Advanced Sampling Theory with Applications: How Michael' selected' Amy Volume I, Springer
8.	Arijit Chaudhuri (2014)	Modern Survey Sampling, CRC Press
9.	Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C.	Sampling Theory of Surveys with Applications, Pusa Publisher

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No. :PSSSTC 204
Credits :4
Duration of Examination: 3 Hrs

Title: Sample Surveys
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025, 2026

Course No. :PSSSTC 204
Credits :4
Duration of Examination: 3 Hrs

Title: Sample Surveys
Maximum Marks:100
a) Minor Test -I : 20
b) Minor Test -II : 20
c) Major Test 60

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections A and B. Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations: Question paper will have two sections A and B. Section-A will consist of five questions of three marks each; candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025,2026

Course No.: PSSSPC 205
Credits :4
Duration of Examination: 3 Hrs

Title: Statistical Computing -II (MATLAB)
Maximum Marks :100
Internal Examnation:50 Marks
External Examination:50Marks

Objective: To make students familiar with the computational work of MATLAB software based on theDescriptive and inductive statistics.
There shall be at least twenty computing exercises on Statistical Computing and analysis of statistical data using SPSS software.

Component	**Marks**	**Remarks**
Internal	50	After 60 days on completion of 50 % of syllabus **Written Exam: 16 Marks (two Practicals of 08 Marks Each)** **Viva Voce :12 Marks** **Attendance: 10 Marks** **Day to Day Performance: 12 Marks**
External	50	On completion entire syllabus **Written Exam: 40 Marks(two Practicals of 20 Marks Each)** **Viva Voce :10 Marks**
Total	100	

Syllabus: M.A./M.Sc. (Statistics) Semester-II for the examination to be held in May-2024, 2025,2026

Course No.: PSSSPC 206
Credits :4
Duration of Examination: 3 Hrs

Title: Practical based on PSSSTC 202 and PSSSTC 204 (SPSS)
Maximum Marks :100
Internal Examnation:50 Marks
External Examination:50Marks

Objective: To make students familiar with the computation work based on Course No. PSSSTC 202& PSSSTC 204 using SPSS.

There shall be at least twenty computing exercises on the computation work based on Course No. PSSSTC 202& PSSSTC 204.

Component	**Marks**	**Remarks**
Internal	50	After 60 days on completion of 50 % of syllabus **Written Exam: 16 Marks (two Practicals of 08 Marks Each)** **Viva Voce :12 Marks** **Attendance: 10 Marks** **Day to Day Performance: 12 Marks**
External	50	On completion entire syllabus **Written Exam: 40 Marks(two Practicals of 20 Marks Each)** **Viva Voce :10 Marks**
Total	100	

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTC 301 | **Title: Design of Experiments**
Credits:4 | **Maximum Marks: 100**
Duration of examination: 3 hours

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: The aim of this course is to provide the knowledge of Design and Analysis of Experiments.

Unit-I

Review of best point estimates/interval estimates of estimable linear parametric functions and testing of linear hypothesis, Fixed, random and mixed effects linear models, Introduction to Design of Experiments: General Block Design and its information matrix (C), Criteria for connectedness, balance and orthogonality, intrablock analysis (Estimability).

Unit-II

Review of RBD and LSD, Missing plot techniques in RBD and LSD, Symmetrical Factorial experiments with factors at two and three levels (2^n, 3^2, 3^3), Confounding-Total and Partial in factorial experiments, Split plot Design, Strip plot design.

Unit-III

Balanced incomplete block designs, partially balanced incomplete block design, methods of constructions and their analysis and Lattice.

Unit-IV

Analysis of Covariance in RBD, LSD and CRD, Analysis of Covariance in Non-orthogonal Data in two-way classification, Covariance and Analysis of experiments with missing observation.

Books Recommended:

1.	Joshi, D.D. (2003)	Linear Estimation and Design of Experiments, New Age International Publishers
2.	Kempthorne, O. (2008)	Design and Analysis of Experiments, Wiley
3.	Das, M.N. & Giri N.C. (2017)	Design and Analysis of Experiment, New Age Publishers
4.	Cochran, W.G. & Cox, G.M. (1992)	Design of Experiments, John Wiley & Sons
5.	Aloke Dey (1987)	Theory of Block Designs, Wiley-Blackwell
6.	Montgomery,C.D. (2013)	Design and Analysis of Experiments, Wiley, New York

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTC 301
Credits:4
Duration of examination: 3 hours

Title: Design of Experiments
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

7.	Searle, S.R., Casella, G. & McCulloch, C.E. (1992)	Variance Components, Wiley
8.	Anderson, V.L. & McLean, R.A. (2019)	Design of Experiments: A Realistic Approach, CRC Press
9.	Angela, D., Voss D. & Draguljić, D. (2017)	Design and Analysis of Experiments, Springer
10.	Nigam, A. K., Puri, P.D. & Gupta, V.K. (1988)	Characterizations and Analysis of Block Designs, Wiley–Blackwell

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	**Marks**	**Remarks**
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTC 302
Credits:4
Duration of examination: 3 hours

Title: Multivariate Analysis
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: The aim of this course is to provide the knowledge of Multivariate Analysis to the students.

Unit-I

Multivariate normal distribution and its properties, Maximum likelihood estimates of mean vector and dispersion matrix, Distribution of sample mean vector, Wishart matrix-its distribution and properties.

Unit-II

Null distribution of simple, partial and multiple correlation coefficients and their testing of significance. Hotelling's T^2 statistic-its distribution and application in testing of mean vector for one and more multivariate normal populations, Mahalanobis D^2 statistic and its applications.

Unit-III

Problem of classification, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations, Discrimination procedures for discriminating between two multivariate populations-sample discriminant function.

Unit-IV

Principal Components Analysis, Factor Analysis, Canonical variates and canonical correlations, Multivariate Analysis of Variance (MANOVA) of one- and two-way classified data.

Books Recommended:

1.	Anderson, T.W. (2003)	An introduction to Multivariate Statistical Analysis, Wiley
2.	Morrison, D.F. (2003)	Multivariate Analysis, McGraw Hill
3.	Johnson, R.A. & Wichern D.W. (2012)	Applied Multivariate Statistical Analysis, PHI.
4.	Jobson, D.B. (1997)	Applied Multivariate Analysis, Springer
5.	Hardle, W. & Simar, L. (2012)	Applied Multivariate Statistical Analysis, Springer International Ltd.
6.	Searle, S.R., Casella, G. & McCulloch, C.E. (1992)	Variance Components, Wiley.
7.	Srivastava, M.S. & Khatri, C.G. (1983)	An introduction to multivariate statistics, Elsevier North Holland, Inc. New York

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTC 302
Credits:4
Duration of examination: 3 hours

Title: Multivariate Analysis
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

8.	Muirhead, R.J. (1982)	Aspects of multivariate statistical theory, Wiley-Interscience
9.	Rencher, A.C. & Christensen, W.F. (1995)	Methods of Multivariate Analysis, Wiley International Ltd.
10.	Mardia, K.V., Kent, J.T. & Bibby, J.M. (1979)	Multivariate Analysis, Academic Press

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSPC305 | **Title: Summer Internship cum Project**

Credits:04 | **Maximum Marks: 100**

Objectives:

It shall be a short-term internship/Project of 15 days duration at the end of Semester 2nd during the summer vacations. Student will go for a job/professional training in a suitable organization or hands on training or activity-based course at university level in order to gain work experience.

All students will undergo internships/ Apprenticeships/project in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions during the summer term. Students will be provided with opportunities for internships with local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability.

Community engagement and service: The curricular component of 'community engagement and service' seeks to expose students to the socio-economic issues in society so that the theoretical learning can be supplemented by actual life experiences to generate solutions to real-life problems. This can be part of summer term activity.

Field-based learning/minor project: The filed-based learning/minor project will attempt to provide opportunities for students to understand the different socio-economic contexts. It will aim at giving students exposure to development-related issues in rural and urban settings. It will provide opportunities for students to observe situations in rural and urban contexts, and to observe and study actual field situations regarding issues related to socioeconomic development. Students will be given opportunities to gain a first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process. They would have the opportunity to gain an understanding of the complex socio-economic problems in the community, and innovative practices required to generate solutions to the identified problems. This may be a summer term project.

SCHEME OF EXAMINATION

The internship shall be under a departmental teacher who will be designated as Internship Supervisor. After completion of summer internship students will have to produce a report related to the work carried out signed by internship supervisor and Head of the department. The internship will be evaluated internally by a Board of Examiners consisting of Head of the department (Convener) , external examiner and Internship supervisor.

Note: The minimum passing criteria for the summer internship is 40%.

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTE 307
Credits:4
Duration of examination: 3 hours

Title: Artificial Intelligence and Statistical Learning
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: To acquaint students with advanced knowledge of Artificial Intelligence and Statistical Learning.

Unit-I

Artificial Intelligence, Foundation and History of AI, Applications of AI, AI Representation, Future of AI, Issues in Design of Search Programs - Blind Search or Depth First Search, Breadth First Search, Logic Programming.

Unit-II

Heuristic Search, Heuristic Search Methods - Generate and Test, Hill Climbing Problem, reduction – constraint satisfaction - Means-end analysis., Simulated Annealing.

Unit-III

Introduction: Basic definitions – Learning - Machine Learning vs AI - Machine Learning – features – samples – labels - Real-world applications and problems – hypothesis test - approaches of machine learning model - Data preprocessing. Representation of formal ML model: The statistical learning framework – training - testing – validation - cross validation - parametric and non-parametric methods - Difference between Parametric and Non-Parametric Methods and examples.

Unit-IV

Supervised learning Algorithms: Introduction-Approaches for classification-Decision Tree classification algorithm-Tree Pruning-Rule based Classification-IF-THEN rules classification Naïve Bayesian classification, Neural Network classification, classification by Back propagation algorithm. Support Vector Machine (SVM)-Lazy learners; k-Nearest Neighbor(k-NN) Algorithm-Case Based reasoning (CRR)-Random Forest Algorithm.

Books Recommended:

1.	Rich, E. & Knight K. (2010)	Artificial Intelligence, 3rd Edition, Tata McGraw-Hill
2.	Ela Kumar (2008)	Artificial Intelligence, I.K. International Publishing House Pvt. Ltd., New Delhi
3.	Srinivasaraghavan, A. & Joseph, V. (2019)	Machine Learning, Wiley

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTC 303
Credits:4
Duration of examination: 3 hours

Title: Artificial Intelligence and Statistical Learning
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test 60

4.	Natarajan, B.K. (1991)	Machine Learning: A Theoretical Approach, Morgan Kaufmann
5.	Alpaydin, E. (2014)	Introduction to Machine Learning, third edition, MIT Press
6.	Dinesh Kumar, U. & Pradhan, M. (2019)	Machine learning using Python, Wiley
7.	Motwani, B (2020)	Data Analytics using Python, Wiley
8.	Hastie,T., Tibshirani R. & Friedman J. (2017)	The Elements of Statistical Learning: Data Mining, Inference, and Prediction,2nd Edition Springer

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	**Marks**	**Remarks**
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No. PSSSPC 304

Credits:4

Duration of examination: 3 hours

Title: Practicals based on PSSSTC 301& 302(SPSS)

Maximum Marks :100
Internal 50
External 50

Objectives: To make students familiar with the computation work based on PSSSTC 301and 302. There shall be at least twenty computing exercises on the computation work and data analysis.

Component	Marks	Remarks
Internal	50	After 60 days on completion of 50 % of syllabus **Written Exam: 16 Marks (two Practicals of 08 Marks Each)** **Viva Voce :12 Marks** **Attendance: 10 Marks** **Day to Day Performance: 12 Marks**
External	50	On completion of 100% syllabus **Written Exam: 40 Marks (two Practicals of 20 Marks Each)** **Viva Voce :10 Marks**
Total	100	

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTE 306
Credits:4
Duration of examination: 3 hours

Title: Advanced Statistical Inference
Maximum Marks: 100

Minor Test-I : 20
Minor Test-II : 20
Major Test : 60

Objectives: To provide advanced knowledge of Inferential Statistics for decision making.

Unit-I

Generalization of Neyman-Pearson Lemma (without proof), Unbiasedness in hypothesis testing, UMPU tests for two-sided hypothesis – in case of exponential families, similar tests and tests of Neyman structure and its relation to bounded completeness, UMPU test for multi-parameter exponential families and its applications to Binomial and Poisson populations.

Unit-II

Review of maximum likelihood estimation, MLE in Pitman family, MLE in censored and truncated distribution, Cramer family, Cramer-Huzurbazar theorem, solution of likelihood equation by method of scoring, Introduction to Sequential Estimation and Sequential Cramer –Rao inequality.

Unit-III

Probability Integral Transform and its inverse, Order Statistics and their distributions, Coverage probabilities and confidence intervals, tolerance intervals, empirical distribution function and its properties, asymptotic distributions of order-statistics, bounds on expected values.

Unit-IV

Statistical Decision Problem: non –randomized and randomized decision rules, loss functions, risk function, admissibility, Bayes rule, minimax rule, least favorable distribution, priori and posterior distributions, admissible, Bayes and minimax estimators with illustrations.

Books Recommended:

1.	Lehman, E.L. (1998)	Theory of Point Estimation, Springer
2.	Lehman, E.L. (1998)	Testing Statistical Hypothesis, Springer
3.	Goon, A.M., Gupta, M.K. & Das Gupta, B. (2003)	An outline of Statistical Theory, World Press Pvt. Ltd.
4.	Rohatgi, V.K. (1998)	An Introduction to Probability Theory and Mathematical Statistics, Wiley
5.	Rohatgi, V.K. (1997)	Statistical Inference, Wiley
6.	Kale, B.K. (2007)	Parametric Inference, Alpha science Int. Ltd.
7.	Zacks, S. (1981)	Theory of Statistical Inference, John Wiley

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTE 306 **Title: Advanced Statistical Inference**
Credits:4 Maximum Marks: 100
Duration of examination: 3 hours

Minor Test-I :20
Minor Test-II :20
Major Test :60

8.	Ferguson, T.S. (1967)	Mathematical Statistics: A Decision Theoretic Approach, John Wiley
9.	Gibbons, D. & Chakraborty, S. (2011)	Non-parametric Statistical Inference, Chapman and Hall
10.	Randles, H.R. & Wolfe, D.A. (1991)	Introduction to the Theory of Nonparametric Statistics, Krieger Publishing Company

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTE 307
Credits:4
Duration of examination: 3 hours

Title: Advanced Statistical Computing (Python)

Max. Marks :100
Internal 50
External 50

Objectives: To make students familiar with the computation work and data analysis based on Course No. PSSSTC 304 There shall be at least twenty computing exercises on the computation work and data analysis.

Component	Marks	Remarks
Internal	50	After 60 days on completion of 50 % of syllabus **Written Exam: 16 Marks (two Practicals of 08 Marks Each)** **Viva Voce :12 Marks** **Attendance: 10 Marks** **Day to Day Performance: 12 Marks**
External	50	On completion of 100% syllabus **Written Exam: 40 Marks (two Practicals of 20 Marks Each)** **Viva Voce :10 Marks**
Total	100	

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTE 308
Credits:4
Duration of examination: 3 hours

Title: Non Parametric Inference
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: To make students familiar with non-parametric concepts related to inference.

Unit-I

Concept of Non parametric and distribution free methods, Review of Single Sample Problems for Location and standard non parametric tests, Two sample problems, Mann-Whitney-Wilcoxon test, Wilcoxon test, Run Test and Median Test. Tests of Goodness of fit viz., Chi square, Empirical distribution function and Kolmogrov Smirnov test.

Unit-II

General linear rank statistic, Its Distributional Properties, Statement and applications of Terry Hoeffding, Vander Warden test Statistic, Mood Statistic, Freund-Ansari-Bradley-David-Barton statistics, Siegel-Tukey Statistic, Klotz-Normal Score Test, Percentile modified Rank test and Sukhatme test.

Unit-III

Efficiency of tests, asymptotic relative efficiencies Hoeffding's, U-Statistics, Asymptotic distribution of U-Statistics, Measures of Association for Bivariate samples/population: Kandall's Tau coefficient and its sample estimate, Spearman's rank Correlation Coefficient. Spearman's R test against trend and relations between R and T, E(R), Kendalls Tau and Pearsons R, Measure of Association related to R for paired samples.

Unit-IV

Tests for the K-sample problem: Kruskal Wallis, Jonckheere-Terpstra Tests, Concept of Jackknifing, Method of Quenouille for reducing bias, Bootstrap method.

Books Recommended:

1.	Gibbons, J.D. (2020)	Non-parametric Statistical Inference, Chapman and Hall/CRC Press
2.	Fraser, D.A.S. (1996)	Non-parametric Methods in Statistics, Wiley
3.	Rohatgi, V. K. (1998)	An Introduction to Probability Theory & Mathematical Statistics, John Wiley & sons
4.	David, H.A. & Nagaraja, H.N. (2003)	Order Statistics, John Wiley & sons
5.	Govindarajulu Z. (2007)	Nonparametric Inference, World Scientific
6.	Puri, M.L. (2007)	Nonparametric Techniques in Statistical Inference, Cambridge University Press
7.	Conover, W.J. (2017)	Practical Nonparametric Statistics, Wiley

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTE 308
Credits:4
Duration of examination: 3 hours

Title: Non Parametric Inference
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

8.	Ghosh, J.K. (2003)	Bayesian Non-parametrics, Springer
9.	Tiku, M. L.,Tan W.Y. & Balakrishnan, N.(1986)	Robust Inference, Marcel and Dekker
10.	Davison, A. C. & Hinkley, D.V. (1997)	Bootstrap Methods and their application, Cambridge University Press
11.	Hajek, J. & Sidak, Z. (1967)	Theory of rank tests, Academic Press

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTE 309
Credits:4
Duration of examination: 3 hours

Title: Demography
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: To introduce application of Statistics in the field of Vital statistics Demography and Population studies.

UNIT-I

Vital statistics: Methods of collection, their merits and demerits, various fertility rates and their computations, factors affecting fertility rates, differential fertilities, graduation of fertility rates, Gross and net reproduction rates.

UNIT-II

Crude mortality rates, infant mortality rates standardized fertility and mortality rates. Life tables: its classification, properties and methods of action with special reference to King, Graville-Reed-Morrel and Chiang methods for construction of abridged life tables.

UNIT-III

Financial calculation, cause deleted tables and multiple detection, Sample variance of life table functions, Probability distribution of life table functions- Probability distribution of the number of survivors and observed expectation of life, joint probability distribution of the number of survivors and the number of distributions.

UNIT-IV

Makeham's and Gompertz curves, Population estimation and projection. Mathematical and component methods of projection. A brief account of other methods of population projection. Migration its concepts and estimation.

Books Recommended:

1.	Speigelman, M. (1969)	Introduction to Demography, Harvard University Press
2.	Cox, P.R. (1985)	Demography, Cambridge University Press
3.	Keyfitz, N. (2005)	Applied Mathematical Demography Springer Verlag
4.	Alho, J.M. & Spencer B.D. (2005)	Statistical Demography and Forecasting, Springer-Verlag
5.	Preston, S.H. & Guillot, M. (2000)	Demography: Measuring and Modelling Population, Blackwell Publishing

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III[rd] Semester for the examinations to be held in December 2024, 2025 & 2026

Course No: PSSSTE 309
Credits:4
Duration of examination: 3 hours

Title: Demography
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

6.	Lundquist, J.H., Anderton, D.L. & Yaukey, D. (2014)	Demography: The Study of Human Population, 4[Th] edition, Waveland Press
7.	Thomas, K. B. (2017)	Model-Based Demography: Essays on Integrating Data, Technique and Theory, Springer Open
8.	Weinstein, J. & Pillai, V.K. (2001)	Demography: The Science of Population, Rowman and Littlefield

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-F H

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No: PSSSTC 401
Credits:4
Duration of examination: 3 hours

Title: Stochastic Processes
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: The aim of this course is to provide the knowledge of Stochastic Processes to the students.

Unit-I

Introduction to stochastic processes (SP's), Classification of SP's according to state space and time domain, Countable state Markov Chains (MC's), Chapman-Kolmogorov equations; calculation of n-step transition probability and its limit, Stationary distribution, Classification of states; transient MC, Random walk and gambler's ruin problem.

Unit-II

Discrete state space continuous time MC's, Kolomogorav-Feller differential equations, Poisson Process, Birth and Death processes, Applications to queues and storage problems, Brownian motion process, Black Scholes formula, Wiener process as a limit of random walk, first passage time and other problems.

Unit-III

Renewal Theory; Elementary renewal theorem and applications, statement and uses of key renewal theorem, study of residual life time process, stationary process, weakly stationary and strongly stationary process.

Unit-IV

Galton-Watson branching process, probability of ultimate extinction, distributionof populations size, Martingale and its properties.

Books Recommended:

1.	Bhat, B.R. (2020)	Stochastic Models: Analysis and Applications, New Age International Pvt. Ltd.
2.	Karlin, S. & Taylor H.M. (1975)	A First course in stochastic Process, Vol. I Academic Press
3.	Medhi, J. (2019)	Stochastic Processes, New Age International Pvt. Ltd.
4.	Parzen, E. (1999)	Stochastic Processes, SIAM
5.	Ross, S. M. (1996)	Stochastic process, John Wiley & sons
6.	Basu, A.K. (2007)	Introduction to Stochastic Process, Alpha Science International Ltd.

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No: PSSSTC 401
Credits:4
Duration of examination: 3 hours

Title: Stochastic Processes
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

7.	Ross, S.M. (2009)	Introduction to probability models, Academic Press
8.	Dharmaraja, S., Arunachalam, V. & Castaneda, L.B. (2012)	Introduction to Probability and Stochastic Processes with Applications, Wiley
9.	Papoulis, A. & Pillai, S.U. (2008)	Probability, Random Variables, and Stochastic Processes, Tata McGraw Hill
10.	Feller, W. (1968)	An introduction to probability theory and its applications, John Wiley

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions.** Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions.**

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No: PSSSTC 402 **Title: Optimization Techniques**
Credits:4 **Maximum Marks: 100**
Duration of examination: 3 hours

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: The aim of this course is to make students acquaint with various Techniques of Optimization.

Unit-I

Linear programming problem, formulation of LPP, Graphical method for solving LPP's, Slack and surplus variables, FS, BS, BFS, Simplex method for solving LPP, two phase method (Artificial Variable Technique), Big-M-Method and degeneracy in LPP and its resolution.

Unit-II

Duality in LPP, Correspondence between dual and primal, theorems on duality, Fundamental duality theorem, Basic duality theorem, existence theorem, Revised Simplex Method, Standard form for revised simplex method, formulation of LPP in standard form, Application of computation procedure for standard form, sensitivity analysis.

Unit-III

Transportation problem (TP), formulation of TP, FS, BFS and optimum solution, existence of FS, optimal solution method, Methods for finding BFS, U-V (MODI's) method for finding optimal solution, unbalance transportation problem, assignment problems, fundamental theorems of assignment problems, Hungarian method for assignment problems, Routing problems, Theory of games, rectangular games Minimax (Maximin) Criterion and optimal strategy, saddle point, optimal strategies and value of Game, solution of saddle point, Minimax-Maximin principle mixed strategy Games and their solutions through different methods including LPP, Minimax theorem.

Unit-IV

CPM and PERT, Determination of critical path's different float times crashing, applications of CPM, PERT and Job sequencing, solutions of sequencing problems, processing n-job's through two-machines, Johnson's algorithm for n-jobs's for 2- machines, processing 2-job's through n-machines graphical method, processing n-job's through m-machines.

Books Recommended:

1.	Taha, H.A. (2016)	Operations Research, Pearson Education India
2.	Rao, S.S. (1984)	Optimization: Theory and applications, John Wiley
3.	Kanti Swarup, Gupta, P.K. and Manmohan (2014)	Operations Research, Sultan Chand & Sons
4.	Sharma, S.D. (2017)	Operations Research, Kedar Nath Ram Nath & Sons

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No: PSSSTC 402
Credits:4
Duration of examination: 3 hours

Title: Optimization Techniques
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

5.	Harris, C.M. & Gross, D. (2018)	Fundamentals of Queueing Theory, Wiley
6.	Ravindran, A., Phillips, T.D. & Solberg, J.J. (2007)	Operations Research: Principles and Practice, Wiley India
7.	Wagner, H.M. (1980)	Principles of Operations Research, with Applications to Managerial Decisions, PHL Private Limited
8.	Hadley, G. (2002)	Linear Programming, Narosa Publications
9.	Richard Bronson (1981)	Schaum's Outline of Theory and Problems of Operations Research, McGraw Hill
10.	Foulds, L. R. (1981)	Optimization Techniques: An Introduction, Springer Verlag

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No. PSSSPC 403 **Title: Data Analytics (R)**
Credits:4
Duration of examination: 3 hours

Max. Marks:100
Internal 50
External 50

Objectives: To make students acquainted with the software R and to do practicals using this software.

There shall be at least twenty computing exercises on the computation work and programming using R software.

Component	**Marks**	**Remarks**
Internal	50	After 60 days on completion of 50 % of syllabus **Written Exam: 16 Marks (two Practicals of 08 Marks Each)** **Viva Voce :12 Marks** **Attendance: 10 Marks** **Day to Day Performance: 12 Marks**
External	50	On completion of 100% syllabus **Written Exam: 40 Marks (two Practicals of 20 Marks Each)** **Viva Voce :10 Marks**
Total	100	

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No. PSSSPC 404

Title: Practicals (Based on one elective course)

Credits:4
Duration of examination: 3 hours

Max. Marks: 100
Internal 50
External 50

Objectives: To make students familiar with the computation work based on chosen elective course. There shall be at least twenty computing exercises on the computation work and Statistical Analysis.

Component	Marks	Remarks
Internal	50	After 60 days on completion of 50 % of syllabus **Written Exam: 16 Marks (two Practicals of 08 Marks Each)** **Viva Voce :12 Marks** **Attendance: 10 Marks** **Day to Day Performance: 12 Marks**
External	50	On completion of 100% syllabus **Written Exam: 40 Marks (two Practicals of 20 Marks Each)** **Viva Voce :10 Marks**
Total	100	

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No: PSSSTO 405

Title: Applied Statistical Methods

Credits:4
Duration of examination :3 hours

Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: Emphasis would be on applied aspects of the course rather than theoretical derivations.

Unit-I

Concept of statistical population, Attributes and variables (discrete and Continuous), Different types of scales – nominal, ordinal, ratio and interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondary data; scrutiny of data for internal consistency and detection of errors of recording, Ideas of cross validation. Presentation of data; classification, tabulation, diagrammatic & graphical representation of grouped data, Frequency distributions, cumulative frequency distributions and their graphical representations, histogram, frequency polygon, Ogives, Stem & Leaf Plot and Box Plot.

Unit-II

Measures of Central tendency and dispersion, merits and demerits of these measures, Moments, Skewness and Kurtosis and their measures, Measures based on Partition values, Bivariate data, Correlation and regression, Their properties and interrelationship, rank correlation (Spearman's and Kendall's measure), Intra-class correlation, Correlation ratio.

Unit-III

Partial and Multiple Correlation & Multiple Regression for Trivariate data, Analysis of Variance, One way classification, Assumptions regarding model, Two-way classification with equal number of observations per cell, Principles of Design of experiments: randomization, replication and local control, Randomized block design, Latin square Design: Lay-out, ANOVA table, Factorial Experiments: Basic Concepts and examples.

Unit-IV

Testing of hypotheses: Statistical Hypotheses (null, alternative simple and composite), Type I and Type II errors, significance level, p-values, power of a test, Point and confidence Interval Estimation, Standard error, Tests based on t, F and $\chi 2$ distributions, large sample tests.

Books Recommended:

1.	Goon, A.M., Gupta, M.K. & Dasgupta, B. (2003)	An Outline of Statistical Theory, Vol. I, World Press, Kolkata
2.	Gupta, S.P. (2011)	Statistical Methods. S Chand and Sons
3.	Goon, A.M., Gupta, M.K. & Dasgupta, B. (2005)	Fundamentals of Statistics, Vol. I, World Press, Kolkata
4.	Kapoor, V.K. & Gupta, S.C. (2007)	Fundamentals of Mathematical Statistics & Fundamentals of Applied Statistics, S Chand and Sons

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No: PSSSTO 405

Title: Applied Statistical Methods

Credits:4

Maximum Marks: 100

Duration of examination :3 hours

Minor Test-I :20
Minor Test-II :20
Major Test :60

5.	Yule, G.U. (2000)	An Introduction to the theory of Statistics, Charles Griffin & Company Ltd.
6.	Montgomery, C.D. (2013)	Design and Analysis of Experiments, Wiley, New York
7.	Kendall, M.G. (1983)	The Advanced Theory of Statistics, Charles Griffin & Company Ltd.
8.	Ramachandran, K.M. & Tsokos P.C. (2009)	Mathematical statistics with applications, Elsevier
9.	Morris, L. M. & Larsen, R. (1981)	An Introduction to Mathematical Statistics and its Applications, Pearson International Ltd.

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	**Marks**	**Remarks**
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No: PSSSTE 406
Credits:4
Duration of examination :3 hours

Title: Econometrics
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: The aim of this course is to provide the knowledge of Econometric methods to the students.

Unit-I

A review of least squares and maximum likelihood methods of estimation of parameters in classical linear regression model and their properties (BLUE), Generalized Least Square Models, construction of confidence regions and tests of hypothesis, prediction, use of extraneous information in the form of exact and stochastic linear constraints, Restricted regression and mixed regression methods of estimation and their properties. Testing of extraneous information.

Unit-II

Multicollinearity, its effects and deletion, Remedial methods including the ridge regression. Specification error analysis, inclusion of irrelevant variables and deletion of dominant variables, their effects on the efficiency of optimization procedure.

Unit-III

Heteroscedasticity, consequences and tests for it, estimation procedures under heteroskedastic disturbances. Auto correlated disturbances, Effects on estimation of parameters, Cochran Orcutt and Prais-Winston transformation, Durbin-Watson test. Errors-in-variables model, Inconsistency of least squares procedures, Consistent estimation of Parameters by instrumental variables.

Unit-IV

Seemingly unrelated regression equation model, Ordinary least squares and feasible generalized least squares methods and their asymptotic properties. Simultaneous equation model, problem of identification, A necessary and sufficient condition for the identifiability of Parameters in a structural equation, Ordinary Least squares, indirect least squares, two stage least squares and limited information maximum likelihood method, K-class estimators, Asymptotic properties of estimators

Books Recommended:

1.	Vinod ,H.D. & Ullah, A. (1981)	Recent Advances in Regression Methods, Marcel Dekkar
2.	Jonsten, J. (1997)	Econometric Methods, McGraw Hill Book Company
3.	Srivastava, V.K. & Giles, D.E.A. (1987)	Seemingly unrelated Regression Equations Models: Marcel Dekkar

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No: PSSSTE 406
Credits:4
Duration of examination :3 hours

Title: Econometrics
Maximum Marks: 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

4.	Maddala, G.S. (2006)	Econometrics McGraw Hill Koga Kusha Ltd.
5.	Koutsoyiannis, A. (2001)	Theory of Econometric, Palgrave Macmillan
6.	Theil, H. (1978)	Principles of Econometrics, John Wiley
7.	Gujarati, D. (2017)	Basic Econometric, McGraw Hill
8.	Madanani, G.M.K. (2015)	Introduction to Econometrics, Oxford and IBH Publishing Company Ltd.
9.	Baltagi, B.H. (2011)	Econometrics, Springer-Verlag Berlin and Heidelberg
10.	Wooldridge, J.M. (2010)	Econometric Analysis of Cross Section and Panel Data, MIT Press

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No. PSSSTE 407 **Title: Operations Research**
Credits:4 **Maximum Max. 100**
Duration of examination: 3 hours

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: This course introduces the students to various optimization techniques of operations Research.

Unit-I

Integer Linear Programming: Introduction, Algorithms: Branch-and-Bound (B&B) algorithm, Cutting-Plane Algorithm. Computational considerations in Integer Linear Programming. Goal Programming (GP), single-goal models, Multiple- goal models. Formulation of GP models, graphical and extended simplex solution of GP problems.

Unit-II

Nonlinear Programming: Generalized Convexity, Quasi and Psuedo convex functions and their properties. The general Nonlinear Programming Problem; Difficulties introduced by nonlinearity. The Kuhn-Tucker necessary conditions for optimality; Insufficiency of K-T conditions; Sufficiency conditions for optimality; Solution of simple NLPP using K-T conditions.

Unit-III

Quadratic Programming: Beale's Method; Restricted basis entry method (Wolfe's method); Proof of termination for the definite case; Resolution of the semi definite case. Duality in Quadratic Programming.

Unit-IV

Dynamic Programming (DP), Introduction, Recursive nature of computations in DP, Forward and Backward recursion. Knapsack/Fly-Away/Cargo-Loading Model, Work-Force Size Model, Equipment Replacement Model, Investment Model, Problem of Dimensionality.

Books Recommended:

1.	Hadley, G. (1970)	Nonlinear and Dynamic Programming, Addison Wesley
2.	Bazaraa, M.S. & Sherali, H.D. (2006)	Nonlinear Programming: Theory and Algorithms, John Wiley
3.	Rao, S.S. (1989)	Optimization Theory and Applications, Wiley Eastern
4.	Sharma, S.D. (2017)	Operations Research, Kedar Nath Ram Nath & Sons
5.	Taha, H.A. (2014)	Operations Research, Pearson Education India
6.	Vohra, N.D. (2017)	Quantitative Techniques, Tata McGraw Hill

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No. PSSSTE 407
Credits:4
Duration of examination: 3 hours

Title: Operations Research
Maximum Max. 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

7.	Bertsekas, D. P. (2016)	Nonlinear Programming, Athena Scientific
8.	Ackoff, R.L. & Sasieni, M.W. (1968)	Fundamentals of Operational Research, John Wiley

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No. PSSSTE 408
Credits:4
Duration of examination: 3 hours

Title: Actuarial Statistics
Maximum Max. 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: To introduce and expose students to application of statistics in actuarial field.

Unit-I

Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality, Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables. Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws.

Unit-II

Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrements, net single premiums and their numerical evaluations. Distribution of aggregate claims, compound Poisson distribution and its applications.

Unit-III

Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.
Life insurance: Insurance payable at the moment of death and at the end of the of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions.

Unit-IV

Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportionable annuities-due.

Books Recommended:

1.	Atkinson, M.E & Dickson, D. (2011)	An Introduction to Actuarial Studies, Edward Elgar Publishing Ltd.
2.	Bedford,T. &Cooke, R. (2012)	Probabilistic risk analysis, Cambridge University Press
3.	Bowers, N. L., Hickman, J. C. & Nesbitt, C. J. (2014)	Actuarial Mathematics, Society of Actuaries, Ithaca, Illinois, U.S.A.
4.	Medina, P. K. & Merino, S. (2003)	A discrete introduction: Mathematical finance and Probability, Berkhouser Publishers

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No. PSSSTE 408
Credits:4
Duration of examination: 3 hours

Title: Actuarial Statistics
Maximum Max. 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

5.	Neill, A. (1977)	Life Contingencies, Butterworth- Heineman Ltd.
6.	Philip, M. (2004)	Modern Actuarial Theory and Practice, Chapman and Hall
7.	Spurgeon, E.T. (2011)	Life Contingencies, Cambridge University Press
8.	Schmidt, V., Teugels, J.L. & Rolski, T.(2008)	Stochastic Processes for Insurance and Finance, Wiley

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	**Marks**	**Remarks**
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No. PSSSTE 409

Title: Statistical Modelling and Computing

Credits:4
Duration of examination: 3 hours

Maximum Max. 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

Objectives: To introduce students to the concept of Statistical Modelling and Computing.

Unit-I

Random numbers: Pseudo-Random number generation, tests, Generation of non-uniform random deviates-general methods, generation from specific distributions.

Unit-II

Simulation-Random Walk, Monte-Carlo integration and its Applications, Simulating multivariate distributions; simulating stochastic processes.

Unit-III

Markov Chain Monte Carlo methods: The Metropolis–Hastings Algorithm; Gibbs sampling, EM algorithm, Smoothing with kernels: density estimation, choice of kernels, Bootstrapping methods Variance reduction, Stochastic differential equations, Markov Chain Monte Carlo methods-Gibbs sampling; Simulated annealing, cooling schedule, convergence, applications.

Unit-IV

EM algorithm and applications. Smoothing with kernels: density estimation, choice of kernels, Variable selection techniques, LASSO and its variants.

Books Recommended:

1.	Bishop, C.M. (1996)	Neural Networks for pattern Recognition, Oxford University Press
2.	Duda, R.O., Hart, P.E. & Stork, D.S. (2007)	Pattern Classification, John Wiley& Sons
3.	Silverman, B.W. (1986)	Density Estimation for Statistics and Data Analysis, Chapman and Hall
4.	Gentle, J.E., Härdle, W.K. & Mori, Y. (2012)	Handbook of computational statistics —Concepts and methods, Springer-Verlag
5.	Ross, S.M. (2012)	Simulation, Academic Press
6.	Han, J. & Kamber, M. (2011)	Data Mining: Concepts and Techniques, Morgan Kaufmann
7.	Rubinstein, R.Y. (2008)	Simulation and the Monte Carlo Method, Wiley-Blackwell

ANNEXURE-F

Syllabus (CBCS) M.A./M.Sc. (Statistics) IVth Semester for the examinations to be held in May 2025, 2026 & 2027

Course No. PSSSTE 409

Credits:4
Duration of examination: 3 hours

Title: Statistical Modelling and Computing
Maximum Max. 100

Minor Test-I :20
Minor Test-II :20
Major Test :60

8.	Simonoff, J.S. (1998)	Smoothing Methods in Statistics, Springer
9.	Haykin, S. (1998)	Neural Networks: A Comprehensive Foundation, Pearson Education U.S.
10.	McLachlan, G.J. & Krishnan, T. (2008)	The EM Algorithms and Extensions, Wiley-Interscience
11	Hand, D.J., Mannila, H. & Smyth, P. (2001)	Principles of Data Mining, Bradford Book
12	Nakhaeizadeh, G. & Taylor, C.C. (1996)	Machine Learning and Statistics, John Wiley & Sons

SCHEME OF EXAMINATIONS

Each Theory paper shall carry 100 marks and distribution of marks shall be as under:

Component	Marks	Remarks
Minor-I	20	After 30 days on completion of 25 % of syllabus
Minor-II	20	After 60 days on completion of 50 % of syllabus
Major/End Semester	60	On completion of 100% syllabus (Question Paper Would Cover 20% of syllabus covered in Minor- I and Minor- II and 80% of syllabus not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations: Question paper will have two sections, A and B. Section-A will consist of **six questions** (Short Answer Type) of **two marks** each and candidate has to attempt **five questions**. Section B will consist of **three questions** (Long Answer Type) of **five marks** each and candidate has to attempt **two questions**.

Major Examinations: Question paper will have two sections, A and B. Section-A will consist of **five questions** of **three marks** each; candidate will have to attempt **four questions** out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor-I and Minor-II. Section- B will consist of **six questions** of **12 marks** each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt **four questions selecting two questions from each unit.**