

## ANNEXURE-D

### 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
PSSSPC303	Advanced Statistical Computing	4	Course interchanged with 30%-40% change in syllabus	0-0-4
PSSSPC304	Practicals based on PSSSTC301 &302	4	100% change with introduction of new course	0-0-4
PSSSTOXXX	MOOC Course	4	100% change with introduction of MOOC course	4-1-0
<i>Any One of the following Elective Courses:</i>				
PSSSTE306	Statistical Inference-II	4	15%-20% change in syllabus	4-1-0
PSSSTE307	Artificial Intelligence and Statistical Learning	4	100% change with introduction of new course	4-1-0
PSSSTE308	Non-Parametric Inference	4	Course interchanged with 50%-60% change in syllabus	4-1-0
PSSSTE309	Demography	4	15%-20% change in syllabus	4-1-0
<b>Total</b>		<b>24</b>		<b>16-4-8</b>

#### 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	4	Nomenclature changed 30%-40% change in syllabus	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
<i>Any One of the following Elective Courses:</i>				

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### Distribution of Courses and Credits

#### M.Sc. Statistics (CBCS)

#### Semester – IV

PSSSTE406	Econometrics	4	15%-20% change in syllabus	4-1-0
PSSSTE407	Operations Research	4	100% change with introduction of new course	4-1-0
PSSSTE408	Actuarial Statistics	4	10%-12% change in syllabus	4-1-0
PSSSTE409	Statistical Modelling and Computing	4	100% change with introduction of new course	4-1-0
<b>Total</b>		<b>24</b>		<b>16-4-8</b>

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	Mark s	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**.

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## ANNEXURE-E

### Syllabus (CBCS) M.A./M.Sc. (Statistics) III<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023

**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

**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 (), 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

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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

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### Syllabus (CBCS) M.A./M.Sc. (Statistics) III<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023

**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
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**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

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### Syllabus (CBCS) M.A./M.Sc. (Statistics) III<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023

**Course No: PSSSPC 303**  
**Credits:4**  
**Duration of examination: 3 hours**

**Title: Advanced Statistical  
Computing**

Max. Marks :100  
Internal :50  
External :50

**Objectives:** To make students familiar with the computational work and data analysis. There shall be at least twenty computing exercises on the computation work and data analysis.

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

ANNEXURE-E

Syllabus (CBCS) M.A./M.Sc. (Statistics) III<sup>rd</sup> Semester for the examinations to be held in  
December 2021, 2022 & 2023

Course No. PSSSPC 304  
Credits:4  
Duration of examination: 3 hours

Title: Practicals based on  
PSSSTC 301& 302

Maximum Marks :100  
Internal :50  
External :50

**Objectives:** To make students familiar with the computation work based on PSSSTC 301 and 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 <b>Written Exam: 16 Marks (two Practicals of 08 Marks Each)</b> <b>Viva Voce :12 Marks</b> <b>Attendance: 10 Marks</b> <b>Day to Day Performance: 12 Marks</b>
External	50	On completion of 100% syllabus <b>Written Exam: 40 Marks (two Practicals of 20 Marks Each)</b> <b>Viva Voce :10 Marks</b>
Total	100	



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

**Title: Statistical Inference-II**  
**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 multiparameter 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

Single Sample problems, problem of location, Mathisen-Median test, Rosenbaum Statistics I and II, Linear rank statistics, Prediction intervals, Goodness of fit tests, Kolmogrov-Smirnov-one sample Statistic, sign test, Wilcoxon- Signed rank statistics, Walsh averages, general Linear rank statistics, Noether's Conditions, asymptotic distributions of above statistics.

#### **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<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023

**Course No: PSSSTE 306**

**Credits:4**

**Duration of examination: 3 hours**

**Title: Statistical Inference-II**

**Maximum Marks: 100**

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

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Total	100	

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## ANNEXURE-E

### Syllabus (CBCS) M.A./M.Sc. (Statistics) III<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023

**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<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023**

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

**Title: Artificial Intelligence**  
**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, 2 <sup>nd</sup> Edition Springer

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#### **Syllabus (CBCS) M.A./M.Sc. (Statistics) III<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023**

**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: Kendall'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<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023

**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

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**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<sup>rd</sup> Semester for the examinations to be held in December 2021, 2022 & 2023**

**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 <sup>th</sup> 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:

<b>Component</b>	<b>Mark s</b>	<b>Remarks</b>
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) IV<sup>th</sup>Semester for the examinations to be held in  
May 2022, 2023 & 2024**

**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

Branching process, Galton-Watson branching process, probability of ultimate extinction, distribution of 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) IV<sup>th</sup>Semester for the examinations to be held in May 2022, 2023 & 2024

**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) IV<sup>th</sup> Semester for the examinations to be held in**

**May 2022, 2023 & 2024**

**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

**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) IV<sup>th</sup> Semester for the examinations to be held in**

**May 2022, 2023 & 2024**

**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) IV<sup>th</sup> Semester for the examinations to be held in

May 2022, 2023 & 2024

Course No. PSSSPC 403

Credits:4

Duration of examination: 3 hours

Title: Data Analytics

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

		<b>Written Exam: 16 Marks (two Practicals of 08 Marks Each)</b> <b>Viva Voce :12 Marks</b> <b>Attendance: 10 Marks</b> <b>Day to Day Performance: 12 Marks</b>
<b>External</b>	50	On completion of 100% syllabus <b>Written Exam: 40 Marks (two Practicals of 20 Marks Each)</b> <b>Viva Voce :10 Marks</b>
<b>Total</b>	100	

#### ANNEXURE-F

**Syllabus (CBCS) M.A./M.Sc. (Statistics) IV<sup>th</sup>Semester for the examinations to be held in**  
**May 2022, 2023 & 2024**

**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.

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

#### ANNEXURE-F

**Syllabus (CBCS) M.A./M.Sc. (Statistics) IV<sup>th</sup>Semester for the examinations to be held in**

**May 2022, 2023 & 2024**

**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**

**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) IV<sup>th</sup> Semester for the examinations to be held in May 2022, 2023 & 2024**

**Course No: PSSSTO 405**

**Credits:4**

**Duration of examination :3 hours**

**Title: Applied Statistical Methods**

**Maximum Marks: 100**

**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) IV<sup>th</sup> Semester for the examinations to be held in May 2022, 2023 & 2024**

**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) IV<sup>th</sup> Semester for the examinations to be held in**

**May 2022, 2023 & 2024**

**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	Mark s	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) IV<sup>th</sup> Semester for the examinations to be held in**

**May 2022, 2023 & 2024**

**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

**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) IV<sup>th</sup> Semester for the examinations to be held in**

**May 2022, 2023 & 2024**

**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
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8.	Ackoff, R.L. & Sasieni, M.W. (1968)	Fundamentals of Operational Research, John Wiley
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### 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) IV<sup>th</sup> Semester for the examinations to be held in

May 2022, 2023 & 2024

**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) IV<sup>th</sup> Semester for the examinations to be held in

May 2022, 2023 & 2024

**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.
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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) IV<sup>th</sup>Semester for the examinations to be held in

May 2022, 2023 & 2024

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

**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) IV<sup>th</sup> Semester for the examinations to be held in**

**May 2022, 2023 & 2024**

**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



## SCHEME OF EXAMINATIONS

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

Component	Mark s	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
8.	Simonoff, J.S. (1998)	Cover 20% of syllabus covered in Minor- I and Minor- II and Smoothing Methods in Statistics, Springer
9.	Haykin, S. (1998)	80% of syllabus not covered in 2 Minors) Neural Networks: A Comprehensive Foundation, Pearson Education U.S.
Total	100	
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

**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**.