Department of Statistics, University of Jammu

Course Structure for PG Programme in Statistics- Two Years (NEP 2020)

Programme code – PGFMS005

Semester-III

Course Code	Course Title	Credit Hours	Contact Hours per week L-Tu-P
P2STTC301	Advanced Design of Experiments	04	4-1-0
P2STTC302	Artificial Intelligence and Machine Learning	04	4-0-1
P2STTC303	Statistical Modelling and Computing	04	4-0-1
P2STRC304	Internship/Survey/Industrial Training	01	0-0-1
P2STPC305	Computing with R	04	0-0-4
P2STPC306	Advanced Data Analytics with SPSS	04	0-0-4
P2STPC307	Seminar	01	0-1-0
Any One of the following Elective Courses (From courses ending with TE308 to 313)			
P2STTE308	Advanced Statistical Inference-II	04	4-1-0
P2STTE309	Information Theory	04	4-1-0
P2STTE310	Advanced Sampling Techniques	04	4-1-0
P2STTE311	Advanced Biostatistics	04	4-1-0
P2STTE312	Advanced Reliability Theory	04	4-1-0
P2STTE313	Advanced Bayesian and Sequential Inference	04	4-1-0
P2STMO351	MOOC/SWAYAM	04	4-0-0
Total Credits		**30**	

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC301 — **Title: Advanced Design of Experiments**
Credit Hours: 04 — **Maximum Marks: 100**
Duration of examination: 3 hours — **Minor Test-I: 20**
Minor Test-II:20
Major Test: 60

Course Outcomes:

- **CO1**: Understand key estimation techniques, hypothesis testing methods, and fixed, random, and mixed effects models, along with the principles of the Gauss-Markov theorem.
- **CO2**: Apply factorial experiment designs, missing plot techniques, confounding methods, and advanced block designs to optimize experimental analysis.
- **CO3**: Develop expertise in constructing and analysing balanced and partially balanced incomplete block designs, nested block designs, lattice designs, and Youden Square designs.
- **CO4**: Utilize response surface designs for optimization, perform covariance analysis, and address non-orthogonal data challenges in experimental setups.
- **CO5**: Implement robust statistical techniques for handling missing observations and enhancing the validity and reliability of experimental results.

Unit-I

Review of best point estimates/interval estimates of estimable linear parametric functions, estimability of linear parametric functions, and testing of linear hypothesis, Fixed, random and mixed effects linear models, Gauss-Markov theorem. Introduction to Design of Experiments: General Block Design and its information matrix (C), Criteria for connectedness, balance and orthogonality, intrablock analysis (Estimability). Optimality criteria, Robustness of Design against loss of data, Concept of Rotatable Design.

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), Fractional replications,Regular and irregular fractions , Confounding-Total and Partial in factorial experiments, Split plot Design, Strip plot design.

Unit-III

Balanced incomplete block designs, partially balanced incomplete block design,m-associate PBIB design, methods of constructions and their analysis, Nested Block Design ,Lattice design and Youden Square Design, Geberalized Youden Design,Pseudo-Youden Design.

Unit-IV

Response Surface Design-symmetrical and asymmetrical factorials,Response Optimization and slope estimation, 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(s).

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC301
Credit Hours: 04
Duration of examination: 3 hours

Title: Advanced Design of Experiments
Maximum Marks: 100
Minor Test-I: 20
Minor Test-II:20
Major Test: 60

Books Recommended:

1.	Aloke Dey (1987)	Theory of Block Designs, Wiley-Blackwell
2.	Anderson, V.L. & McLean, R.A. (2019)	Design of Experiments: A Realistic Approach, CRC Press
3.	Angela, D., Voss D. & Draguljić, D. (2017)	Design and Analysis of Experiments, Springer
4.	Chakrabarty, M.C.(1962)	Mathematics of Design and analysis of experiments
5.	Cochran, W.G.& Cox, G.M.	Design of Experiments, John Wiley & Sons
6.	Das, M.N. & Giri N.C.(2024)	Design and Analysis of Experiment, New Age Publishers
7.	Joshi, D.D. (2003)	Linear Estimation and Design of Experiments, New Age International Publishers
8.	Kempthorne, O. (2008)	Design and Analysis of Experiments, Wiley
9.	Montgomery,C.D. (2019)	Design and Analysis of Experiments, Wiley, New York
10.	Nigam, A. K., Puri, P.D. & Gupta, V.K. (1988)	Characterizations and Analysis of Block Designs, Wiley– Blackwell
11.	Searle, S.R., Casella, G. & Culloch, C.E. (1992)	Variance Components, Wiley

SCHEME OF EXAMINATIONS

	Syllabus to be covered in the examination	**Time allotted for the examination**	**%Weightage (Marks)**
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC301
Credit Hours: 04
Duration of examination: 3 hours

Title: Advanced Design of Experiments
Maximum Marks: 100
Minor Test-I: 20
Minor Test-II:20
Major Test: 60

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of 10 **compulsory MCQ** of one mark each and THREE **subjective type questions** (05 marks each). Students are required to answer any **TWO** questions out of three asked questions. **No preparatory holidays shall be provided for the Test I and Test II.**

Those candidates who have appeared in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of **two sections,** Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC302 **Title: Artificial Intelligence and Machine Learning**

Credits Hour:04

Duration of exination: 3 hours **Maximum Marks: 100**

Minor Test-I :20

Minor Test-II :20

Major Test :60

Course Outcomes:

- **CO1**: Understand the foundation, history, and applications of artificial intelligence, along with key search techniques such as depth-first and breadth-first search.
- **CO2**: Apply heuristic search methods, including generate-and-test, hill climbing, constraint satisfaction, and simulated annealing, for problem-solving in AI.
- **CO3**: Develop knowledge of machine learning fundamentals, differentiating between AI and ML, and utilizing key concepts like training, validation, and data preprocessing.
- **CO4**: Implement supervised learning algorithms, including decision trees, Naïve Bayesian classifiers, neural networks, support vector machines, and k-nearest neighbour methods for classification tasks.
- **CO5**: Utilize advanced machine learning techniques such as case-based reasoning, random forest algorithms, and optimization methods for AI-driven decision-making.

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

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.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC302 **Title: Artificial Intelligence and Machine Learning**

Credits Hour:04 **Maximum Marks: 100**

Duration of exination: 3 hours **Minor Test-I :20**

Minor Test-II :20

Major Test :60

Books Recommended:

1.	Alpaydin, E. (2014)	Introduction to Machine Learning, third edition, MIT Press
2.	Ela Kumar (2008)	Artificial Intelligence, I.K. International Publishing House Pvt. Ltd., New Delhi
3.	Dinesh Kumar, U. and Pradhan, M. (2019)	Machine learning using Python, Wiley
4.	Hastie,T.,Tibshirani R. and Friedman J. 2017	The Elements of Statistical Learning: Data Mining, Inference, and Prediction,2nd Edition Springer
5.	Motwani, B (2020)	Data Analytics using Python, Wiley
7.	Rich,E. and Knight K. (2010)	Artificial Intelligence, 3rd Edition, Tata McGraw-Hill
8.	Srinivasaraghavan, A. & Joseph, V. (2019)	Machine Learning, Wiley

SCHEME OF EXAMINATIONS

	Syllabus to be covered in the examination	**Time allotted for the examination**	**%Weightage (Marks)**
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC302 **Title: Artificial Intelligence and Machine Learning**

Credits Hour:04 **Maximum Marks: 100**

Duration of exination: 3 hours

Minor Test-I :20

Minor Test-II :20

Major Test :60

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of 10 **compulsory MCQ** of one mark each and THREE **subjective type questions** (05 marks each). Students are required to answer any **TWO** questions out of three asked questions. **No preparatory holidays shall be provided for the Test I and Test II.**

Those candidates who have appeared in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of **two sections**, Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC303 **Title: Statistical Modelling and Computing**

Credits Hour:04 **Maximum Marks: 100**

Duration of examination: 3 hours **Minor Test-I : 20**

Minor Test-II : 20

Major Test : 60

Course Outcomes:

- **CO1**: Understand the fundamentals of simulation, including discrete and continuous systems, event scheduling, and real-world applications in problem-solving.
- **CO2**: Apply random number generation techniques, analyse queuing models, and assess performance measures for different stochastic processes.
- **CO3**: Utilize advanced sampling techniques such as importance sampling, Monte Carlo methods, bootstrap, jackknife, and permutation tests for statistical inference.
- **CO4**: Implement missing value imputation techniques, including single and multiple imputation methods, for handling incomplete datasets.
- **CO5**: Apply the EM algorithm in various contexts, including mixture models and stochastic processes, for efficient data estimation and analysis

Unit-I

Simulation: Definition, areas of application, System: discrete and continuous Systems, Model of System, Steps in a simulation study. General principles of discrete event–Simulation, Event scheduling/time advance algorithms, World views, Simulation examples: single channel queues newspaper selling problem, reliability problem, Lead-time demand.

Unit-II

Random number generation, Properties of random numbers, Techniques of generation of pseudo–random numbers, Test for random numbers, Random variate generation: Inverse transform technique, Convolution method, Acceptance–rejection technique. Queuing Models, Long run measures of performance of models M/M/1/N/∞, M/M/C/∞/∞, M/M/C/K/K, M/G/1.

Unit-III

Accept-Rejection Sampling, Importance Sampling, Markov Chain and Monte Carlo, Metropolis-Hastings, Hamiltonial Monte Carlo. esampling Techniques: Re sampling paradigms, bias-variance trade-off. Bootstrap methods, estimation of sampling distribution, confidence interval, variance stabilizing transformation. Jackknife and cross-validation. Jackknife in sample surveys. Jackknife in regression under heteroscedasticity. Permutation tests.

Unit-IV

Missing Values and Imputations Techniques: Missing values and types of missingness, imputations methods for missing values, single and multiple imputations. EM Algorithm and Applications: EM algorithm for incomplete data, EM algorithm for mixture models, EM algorithm for missing values, stochastic EM algorithm.

40 20

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC303 **Title: Statistical Modelling and Computing**

Credits Hour:04 **Maximum Marks: 100**

Duration of examination: 3 hours **Minor Test-I : 20**

Minor Test-II : 20

Major Test : 60

Books Recommended:

1.	Good, P. I. (2005)	Resampling Methods: A Practical Guide to Data Analysis. BirkhauserBosel.
2.	Law A. M. (2015)	Simulation Modeling and Analysis, Fifth edition, McGraw Hill New York
3.	McLachlan, G.J. and Krishnan, T. (2008)	The EM Algorithms and Extensions. Wiley.
4.	Robinson S (2014)	Simulation, The Practice of Model Development and Use, Red Globe Press; Second edition
5.	Shao J. and Tu, D. (1995)	The Jackknife and the Bootstrap. Springer Verlag.

SCHEME OF EXAMINATIONS

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Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTC303

Title: Statistical Modelling and Computing

Credits Hour:04

Duration of examination: 3 hours

Maximum Marks: 100

Minor Test-I : 20

Minor Test-II : 20

Major Test : 60

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In major test there should not be a gap of more than two days in between two tests.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STRC304 **Title: Internship/Survey/Industrial training**
Credit Hours :01 **Maximum Marks: 25**

Course Outcomes:

It shall be a short-term internship/Project of 15 days duration at the end of Semester 2nd during the summer vacations. Students 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 labs with faculty or researchers in their field or other HEIs/research institutions during the summer break. 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 will 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 will be a summer term internship cum 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 duly signed by the internship supervisor and Head of the department.

The Board of Examiners consisting of Head of the Department, one teacher of concerned department, and internship supervisor shall evaluate/assess performance of the students.

The work will be assessed on the following components:

Contents of the Report	Seminar Presentation	Domain Knowledge	Total
10	05	10	25

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

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STPC305
Credit Hours: 04
Duration of examination: 4 hours

Title: Computing with R
Maximum Marks: 100
Internal :50
External :50

Course Outcomes: To make students acquaint with the software R and to do practicals using this software. There shall be at least twenty computing exercises on the computation work and Statistical Analysis.

Module-1

a) **Tests of significance based on t-distribution.**
   (i) Testing the significance of the mean of a random sample from a normal population.
   (ii) Testing the significance of difference between two sample means,
   (iii) Testing the significance of an observed correlation coefficient.
   (iv) Testing the significance of an observed partial correlation coefficient.
   (v) Testing the significance of an observed regression coefficient.

b) **Tests based on F-distribution.**
   (i) Testing the significance of the ratio of two independent estimates of the population variance.
   (ii) Testing the homogeneity of means (Analysis of variance).

c) **Testing the significance of the difference between two independent correlation coefficients.**

d) **Testing the significance for**
   (i) a single proportion
   (ii) difference of proportions for large samples.

e) **Testing the significance of the difference between means of two large samples.**

f) **Testing the significance of difference between standard deviations of two large samples.**

g) **Data Visualization tools through R packages**

h) **Linear and Multiple Regression analysis**

i) **Logistics ,Probit Regression Analysis**

Module-2

j) **Understanding Bayesian Inference:**
   (i) Prior, Likelihood, and Posterior
   (ii) MCMC Sampling
   (iii) Hierarchical Models, Regression Models, Model Comparison, Posterior Predictive
   (iv) Checks and Convergence Diagnostics

k) **Numerical algorithms such as direct search, grid search, interpolation search, gradient search, Bisection and Newton-Raphson methods**

l) **Case Studies and Real-world Applications**
   Direct Marketing /Research related Case Studies

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STPC305
Credit Hours: 04
Duration of examination: 4 hours

Title: Computing with R
Maximum Marks: 100
Internal :50
External :50

Books Recommended

1.	Braun, W. J. and Murdoch, D. J. (2007)	A First Course on Statistical Programming with R, Cambridge University Press.
2.	Gardener M. (2010)	Beginning R : The Statistical Programming Language, Wiley India Pvt. Ltd., New Delhi.
3.	Jared P. Lander(2018)	R for Everyone. Advanced Analytics and Graphics
4.	Mailund, T. (2017)	Beginning Data Science in R: Data Analysis, Visualization, and Modelling for the Data Scientist..
5.	Schmuller, J. (2017)	Statistical Analysis with R For Dummies John Wiley & Sons.
6.	Teetor, Paul (2011)	R Cookbook, O'Really.

SCHEME OF EXAMINATION

Each practical Internal and External paper shall carry **50 marks** and will be of **04 hours** and distribution of marks shall be as under:

Component	Marks	Remarks
Internal	25	After 60 days on completion of 50 % of syllabus **Written Exam: 20 Marks (Attempt two Practical of 10 Marks Each out of three Practicals)** **Viva Voce :05 Marks**
External	75	On completion of entire syllabus **Written Exam: 40 Marks (two Practicals each of 20 Marks out of three Practicals)** **Case study report: 10** **Viva Voce: 25 Marks**
Total	100	

External Practical examination shall be conducted by Board of Examiners consisting of Head of the Department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance of the students.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STPC306 | **Title: Advanced Data Analytics with SPSS**
Credit Hours :04 | **Maximum Marks: 100**
Duration of examination: 4 hours | **Internal : 50**
External : 50

Course Outcomes:

- **CO1**: Develop proficiency in data management, organization, cleaning, and visualization techniques for effective statistical analysis.
- **CO2**: Apply ANOVA and experimental design principles, including Latin Square Design, factorial experiments, and randomized block designs, for analysing data structures.
- **CO3**: Utilize advanced regression models, non-parametric statistical methods, and predictive analytics to enhance data-driven decision-making.
- **CO4**: Explore time series analysis, forecasting techniques, and survival models such as Cox regression and Kalman filters for practical applications.
- **CO5**: Implement statistical techniques in real-world scenarios, including direct marketing case studies, ensuring practical proficiency in analytical methodologies.

Module 1: Data Management, Presentation, and Statistical Analyses

1. **Data Management and Presentation**
   - Problems based on data organization, cleaning, and visualization techniques.
2. **Analysis of Variance (ANOVA)**
   - One-way ANOVA
   - Two-way ANOVA (multiple but equal, multiple but unequal)
   - Randomized Block Design (RBD)
3. **Experimental Designs**
   - Latin Square Design
   - Factorial Experiments
   - Missing and Mixed-up plot in RBD
4. **Non-parametric Statistical Methods**

- Kruskal-Wallis one-way analysis of variance by ranks
- Kolmogorov-Smirnov one-sample and two-sample tests

Module 2: Advanced Statistical Methods and Applications

1. **Advanced Regression and Models**
   - Loglinear Models
   - Repeated Measures ANOVA
   - Non-linear Regression
   - Optimal Scaling
2. **Classification and Predictive Analytics**
   - Hierarchical Cluster Classification
   - Cluster Silhouettes
   - Receiver Operating Characteristic (ROC) Curve Analysis
3. **Time Series and Forecasting Techniques**
   - Seasonal Decomposition
   - Spectral Analysis
   - Sequence Charts

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STPC306 | **Title: Advanced Data Analytics with SPSS**
Credit Hours :04 | **Maximum Marks: 100**
Duration of examination: 4 hours | **Internal : 50**
External : 50

4. **Survival Analysis and Specialized Methods**
   - Life Tables
   - Cox Regression
   - Kalman Filter
5. **Case Studies and Real-world Applications**
   - Direct Marketing Case Studies

Books Recommended :

1.	Carver RH. and Nash JG. (2024)	Doing Data Analysis in SPSS: Version 29, Cengage Learning.
2.	Cleophas TJ and Zwinderman AH (2012)	SPSS for Starters and Second Levelers (Second Edition), Springer, Singapore.
3.	Field A. (2023)	Discovering Statistics Using SPSS, Sage Publications.
4.	Ho, Robert (2006)	Handbook of Univariate and Multivariate Data Analysis and Interpretation with SPSS, Chapman and Hall/CRC Press, London.
5.	Landu, S. and Everitt, BS. (2004)	A Handbook of Statistical Analysis in SPSS, Chapman and Hall/CRC Press, London.
6.	Schmidt W (2019)	IBM SPSS: Comprehensive Beginners Guide to Learn Statistics Using IBM SPSS from A to Z, Independently Published.

SCHEME OF EXAMINATION

Each practical Internal and External paper shall carry **50 marks** and will be of **04 hours** and distribution of marks shall be as under:

Component	Marks	Remarks
Internal	25	After 60 days on completion of 50 % of syllabus **Written Exam: 20 Marks (Attempt two Practical of 10 Marks Each out of three Practicals)** **Viva Voce :05 Marks**
External	75	On completion of entire syllabus **Written Exam: 40 Marks (two Practicals each of 20 Marks out of three Practicals)** **Case study report: 10** **Viva Voce: 25 Marks**
Total	100	

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STPC306
Credit Hours :04
Duration of examination: 4 hours

Title: Advanced Data Analytics with SPSS
Maximum Marks: 100
Internal : 50
External : 50

External Practical examination shall be conducted by Board of Examiners consisting of Head of the Department, concerned teacher and outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess final practical performance of the students.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No.: P2STPC307
Credit Hours :01
Duration of Examination: 1 Hour

Title: Seminar
Maximum Marks:25

Course Learning Outcomes (CLO)

After completing this course, the learner will be able to:

1: To enhance the critical thinking and communication skills of students, enabling them to effectively evaluate, synthesize, and apply information in academic and professional contexts for decision making.

2: To enhance the research acumen and statistical as well as interpretation skills of students, enabling them to effectively apply statistical tools in academic and professional contexts.

SCHEME OF EXAMINATIONS

The seminar presentation shall carry 25 marks and distribution of marks shall be as under:

Presentation	Contents	Domain Knowledge	Total
05	10	**10**	**25**

Evaluation Criteria: Each student will be allotted a mentor under whose guidance student will prepare the Seminar.

Each Seminar presentation will be of **duration 45-60 minutes**. Evaluation of the seminar will be done by the DAC members on the above parameters. There will be no external examination/viva-voce examination. The schedule of the Seminar will be issued by the Head of the Department.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020
for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE308 **Title: Advanced Statistical Inference-II**

Credits Hour: 04 **Maximum Marks: 100**
Duration of examination: 3 hours **Minor Test-I: 20**
Minor Test-II :20
Major Test : 60

Course Outcomes:

- **CO1**: Understand the fundamentals of non-parametric and distribution-free methods, including key single-sample and two-sample tests for statistical inference.
- **CO2**: Apply general linear rank statistics, various distributional properties, and advanced non-parametric test procedures for effective data analysis.
- **CO3**: Assess efficiency and asymptotic properties of statistical tests, explore U-statistics, and analyse measures of association such as Kendall's Tau and Spearman's Rank Correlation.
- **CO4**: Perform statistical tests for multiple-sample problems, including Kruskal-Wallis and Jonckheere-Terpstra tests, enhancing non-parametric inference capabilities.
- **CO5**: Utilize advanced statistical techniques such as jack knifing, bootstrapping, and bias reduction methods for robust data-driven decision-making.

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 Kolmogorov Smirnov test.

Unit-II

General linear rank statistic, Its Distributional Properties, Statement and applications of Terry Hoefling, 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 Hoefling'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), Kendall's 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.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE308 **Title: Advanced Statistical Inference-II**

Credits Hour: 04 **Maximum Marks: 100**
Duration of examination: 3 hours **Minor Test-I: 20**
Minor Test-II :20
Major Test : 60

Books Recommended:

1.	Conover, W.J. (2017)	Practical Nonparametric Statistics, Wiley
2.	David, H.A. & Nagaraja, H.N. (2003)	Order Statistics, John Wiley & sons
3.	Davison, A. C. & Hinkley, D.V. (1997)	Bootstrap Methods and their application, Cambridge University Press
4.	Fraser, D.A.S. (1996)	Non-parametric Methods in Statistics, Wiley
5.	George Casella & Roger Berger (2024)	Statistical Inference (2nd Edition), Chapman & Hall/CRC
6.	Ghosh, J.K. (2003)	Bayesian Non-parametric, Springer
7.	Gibbons, J.D. (2020)	Non-parametric Statistical Inference, Chapman and Hall/CRC Press
8.	Govindarajulu Z. (2007)	Nonparametric Inference, World Scientific
9.	Hajek, J. & Sidak, Z. (1967)	Theory of Rank Tests, Academic Press.
10.	Puri, M.L. (2007)	Nonparametric Techniques in Statistical Inference, Cambridge University Press
11.	Rohatgi, V. K. (1998)	An Introduction to Probability Theory & Mathematical Statistics, John Wiley & Sons
12.	Tiku, M. L.,Tan W.Y. & Balakrishnan, N.(1986)	Robust Inference, Marcel and Dekker

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE308

Title: Advanced Statistical Inference-II

Credits Hour: 04
Duration of examination: 3 hours

Maximum Marks: 100
Minor Test-I: 20
Minor Test-II :20
Major Test : 60

SCHEME OF EXAMINATIONS

	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of 10 **compulsory MCQ** of one mark each and THREE **subjective type questions** (05 marks each). Students are required to answer any **TWO** questions out of three asked questions. **No preparatory holidays shall be provided for the Test I and Test II.**

Those candidates who have appeared in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of **two sections**, Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE309
Credits Hour:04
Duration of Examination: 3 Hrs.

Title: Information Theory
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

Course Outcomes:

- **CO1**: Understand the Bayesian framework, including Bayes' theorem, types of priors, and methods for obtaining prior distributions in statistical inference.
- **CO2**: Apply Bayesian interval estimation techniques, including credible intervals and highest posterior density regions, while comparing classical confidence intervals.
- **CO3**: Perform Bayesian hypothesis testing using prior and posterior odds, Bayes factor, Bayesian Information Criterion (BIC), and computational methods.
- **CO4**: Explore concepts of censoring, truncation, and sequential tests, including Wald's SPRT, optimality properties, and large sample properties of estimators.
- **CO5**: Utilize likelihood ratio tests, Rao's score test, and asymptotic efficiency methods for hypothesis testing and statistical decision-making.

Unit I

Foundations of Information Theory, Concept of Entropy and Information Measures, Formal Requirements of Average Uncertainty, Shannon's Measure of Information and Its Properties, Joint and Conditional Entropy, Relative Entropy and Mutual Information, Uniqueness of the Entropy Function Modern Additions: Rényi Entropy and its Applications, Quantum Entropy in Quantum Information Theory, Differential Privacy and Information Theoretic Security.

Unit II

Data Encoding and Compression Techniques, Elements of Encoding, Redundancy, and Efficiency,Binary Codes and Shannon-Fano Encoding, Necessary and Sufficient Conditions for Noiseless Coding,Average Length of Encoded Messages, Kraft Inequality, McMillan Inequality, Optimal Codes and Huffman Code,Modern Additions: Arithmetic Coding for Efficient Data Compression, Adaptive Huffman Coding for Dynamic Encoding, Deep Learning-Based Compression Methods.

Unit III

Advanced Entropy and Optimization Principles, Differential Entropy, Joint and Conditional Differential Entropy, Properties of Differential and Relative Entropy, Relationship of Differential Entropy to Discrete Entropy, Entropy Bound on Discrete Entropy.

Modern Additions: Entropy Optimization in Machine Learning and Neural Networks, Maximum Entropy Principle and MaxEnt Formalism in AI Models, Entropy in Reinforcement Learning for Policy Optimization.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE309
Credits Hour:04
Duration of Examination: 3 Hrs.

Title: Information Theory
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

Unit IV

Information Transmission and Coding Theory, Channel Capacity and Symmetric Channels, Binary Symmetric Channel and 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

Modern Additions' (Low-Density Parity Check) and Turbo Codes, Error-Correcting Codes in Quantum Computing, Network Coding and Distributed Storage Systems.

Books Recommended:

1.	Dehmer, M. and Frank E. S. (2009)	Information Theory and Statistical Learning, Springer
2.	Gray, R.M. (2011)	Entropy and Information Theory 2nd edition. Springer
3.	Kapur,J.N. and Kesavan .K(1992)	Entropy Optimization Principles with Applications, Academic Press, New York.
4.	Reza, F.M. (2007)	An Introduction to Information Theory, Dover Publications.
5.	Robert Ash (1965)	Information Theory, Dover Publications
6.	Shannon, C.E. (1948)	The mathematical theory of communication. Bell Syst.Tech. J, Vol. 27, pp. 379-423 and pp 623-656.
7.	Thomas T. M. and Cover (2006)	Elements of Information Theory. Wiley, New York.
8.	Vander, L. (1997)	Information Theory, Cambridge University Press.
9.	Yury Polyanskiy & Yihong Wu (2024)	Information Theory

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE309
Credits Hour:04
Duration of Examination: 3 Hrs.

Title: Information Theory
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

SCHEME OF EXAMINATIONS

	Syllabus to be covered in the examination	Time allotted for the examination	%Weightage (Marks)
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of 10 **compulsory MCQ** of one mark each and THREE **subjective type questions** (05 marks each). Students are required to answer any **TWO** questions out of three asked questions. **No preparatory holidays shall be provided for the Test I and Test II.**

Those candidates who have appeared in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of **two sections,** Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE310
Credit Hours :04
Duration of Examination: 3 Hrs

Title: Advanced Sampling Techniques
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

Course Outcomes:

- **CO1**: Understand optimal stratification techniques, including dynamic and data-driven methods, post-stratification refinements, and Bayesian approaches for improved sampling strategies.
- **CO2**: Apply advanced systematic sampling methods, including variance estimation refinements, probability proportional to size (PPS) techniques, and specialized estimators for survey sampling.
- **CO3**: Utilize regression and ratio estimators, calibration methods, and hierarchical models for small area estimation, incorporating machine learning techniques for enhanced statistical inference.
- **CO4**: Develop expertise in cluster and two-stage sampling optimization, efficiency improvements, and variance estimation refinements for real-world applications.
- **CO5**: Implement adaptive and responsive sampling techniques, successive sampling strategies, and real-time data collection methods to enhance data-driven decision-making.

Unit I

Optimal stratification techniques: dynamic stratification, data-driven methods, post-stratification refinements: handling missing data, nonresponse adjustments, Controlled sampling: adaptive and real-time sampling strategies, Bayesian approaches to stratified sampling.

Unit II

Systematic sampling: variance estimation refinements, efficiency improvements, Probability proportional to size (PPS) sampling: enhanced selection methods, PPS WOR refinements, Advanced estimators: Horvitz-Thompson estimator, Des Raj strategy, Murthy estimator, Sen-Midzuno method: modifications for real-world applications.

Unit III

Ratio and regression estimators: bias reduction techniques, robust variance estimation, Calibration estimators: applications in survey sampling, Small area estimation: hierarchical models, empirical Bayes methods, Machine learning approaches to sampling and estimation.

Unit IV

Cluster sampling: optimization techniques, handling unequal cluster sizes, Two-stage sampling: efficiency improvements, variance estimation refinements, Successive sampling: multi-occasion sampling strategies , Adaptive and responsive sampling: real-time data collection methods.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020
for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE310
Credit Hours :04
Duration of Examination: 3 Hrs

Title: Advanced Sampling Techniques
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

Books Recommended:

1.	Chaudhuri , Arijit (2014)	Modern Survey Sampling, CRC Press
2.	Cochran, W.G. (2013)	Sampling techniques, Wiley & Sons
3.	Des Raj (1999)	Sampling Theory, Create Space Publishers, USA.
4.	Mukhopadhayay, P. (2014)	Theory and methods of survey sampling, PHI Learning.
5.	Murthy, M.N. (1967)	Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
6.	Pfeffermann, D., Rao, C.R. (2009)	Handbook of Statistics: Sample Surveys ,Vol 29B, Elsevier (North Holland)
7.	Sampath, S. (2005)	Sampling Theory & Methods, Alpha Science India Ltd.
8.	Särndal, C.E., Swensson, B., Wretman, J.H (1992)	Model Assisted Survey Sampling, Springer-Verlag
9.	Singh, S (2003)	Advanced Sampling Theory with Applications: How Michael' selected' Amy Volume I, Springer
10.	Thompson, S.K. (2012)	Sampling, John Wiley & Sons

SCHEME OF EXAMINATIONS

	Syllabus to be covered in the examination	**Time allotted for the examination**	**%Weightage (Marks)**
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE310
Credit Hours :04
Duration of Examination: 3 Hrs

Title: Advanced Sampling Techniques
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of 10 **compulsory MCQ** of one mark each and THREE **subjective type questions** (05 marks each). Students are required to answer any **TWO** questions out of three asked questions. **No preparatory holidays shall be provided for the Test I and Test II.**

Those candidates who have appeared in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of **two sections**, Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE311
Credits Hour :04
Duration of Examination: 3 Hrs.

Title: Advanced Biostatistics
Maximum Marks:100
Minor Test -I : 20
Minor Test -II : 20
Major Test: 60

Course Outcomes:

- **CO1:** Understand fundamental genetic concepts, including Mendel's laws, Hardy-Weinberg equilibrium, allele frequency distribution, and evolutionary forces such as natural selection and genetic drift.
- **CO2**: Apply principles of clinical trial design, including various phases, comparative trial methodologies, and sample size determination for effective biomedical research.
- **CO3**: Analyse survival distributions, hazard functions, and goodness-of-fit tests for modelling biological data related to survival time and failure rates.
- **CO4**: Develop expertise in censoring techniques, survival time estimation, and stochastic epidemic models for analysing real-world biological datasets.
- **CO5**: Utilize statistical techniques for biomedical applications, improving data-driven decision-making in genetics, clinical trials, and epidemiology.

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).

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE311
Credits Hour :04
Duration of Examination: 3 Hrs.

Title: Advanced Biostatistics
Maximum Marks:100
Minor Test -I : 20
Minor Test -II : 20
Major Test: 60

Books Recommended:

1.	B. Santhosh Kumar (2024)	Recent Advances in Biostatistics.
2.	Biswas, S. (1995)	Applied Stochastic Processes. A Biostatistical and Population Oriented Approach, Wiley Eastern Ltd.
3.	Cox, D.R. & Oakes, D. 1984)	Analysis of Survival Data, Chapman and Hall.
4.	Ewens, & Grant, (2010)	Statistical methods in Bio informatics.: An Introduction, Springer.
5.	Ewens, W. J. (1979)	Mathematics of Population Genetics, Springer Verlag.
6.	Friedman, L. M., David L., & Christobher G. (2015)	Fundamentals of Clinical Trials, Springer
7.	Lee, Elisa, T. (1992)	Statistical Methods for Survival Data Analysis, John Wiley

SCHEME OF EXAMINATIONS

	Syllabus to be covered in the examination	**Time allotted for the examination**	**%Weightage (Marks)**
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE311
Credits Hour :04
Duration of Examination: 3 Hrs.

Title: Advanced Biostatistics
Maximum Marks:100
Minor Test -I : 20
Minor Test -II : 20
Major Test: 60

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of 10 **compulsory MCQ** of one mark each and THREE **subjective type questions** (05 marks each). Students are required to answer any **TWO** questions out of three asked questions. **No preparatory holidays shall be provided for the Test I and Test II.**

Those candidates who have appeared in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of **two sections**, Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE312
Credits Hour:04
Duration of Examination: 3 Hrs.

Title: Advanced Reliability Theory
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

Course Outcomes:

- **CO1**: Understand reliability functions, failure time distributions, and system structures, including series, parallel, and k-out-of-n configurations for reliability assessment.
- **CO2**: Apply Laplace transforms and Markov models to derive reliability and availability measures, optimizing system performance through redundancy and preventive maintenance.
- **CO3**: Analyse stochastic processes, including Markov chains, Poisson processes, birth-death processes, and renewal models, for probabilistic system modelling.
- **CO4**: Develop expertise in queuing models for reliability analysis, including M/M/1 and M/M/S models, loss systems, bulk arrival/service systems, and Poisson input models.
- **CO5**: Utilize advanced statistical and probabilistic techniques for system reliability evaluation, predictive modelling, and real-world applications.

UNIT-I

Reliability functions, Pointwise and steady state Availability, Interval Reliability, Mean Time to System Failure, Mean sojourn time, Failure, Typos of Failure, Failure rate and Various failure time distribution such as Exponential, Gamma, Rayliegh, Lognormal, Weibull; Various System structures such as series, parallel, k out of n system structure, structure function.

UNIT-II

Laplace and Laplace Steiljes transform their important properties and applications. Derivation of reliability and availability using Markov Models, Methods of improving reliability, redundancy, optimization, preventive maintenance, Reliability estimation in case of exponential, Gamma and Weibull distribution.

UNIT-III

Stochastic Process, Classification of SP, Markov Chain, Markov Process, Poisson Process, Its postulates and properties, Birth process, Death process, Birth and Death Process. Markov process with continuous state space, renewal process, age and block replacement policies.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE312
Credits Hour:04
Duration of Examination: 3 Hrs.

Title: Advanced Reliability Theory
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

UNIT-IV

Stochastic Process in queuing and reliability, M/M/1 model, Steady state and transient behavior, Queues with limited waiting space i.e. M/M/S model, loss system model, Bulk arrival system and bulk service system, Queues with Poisson input WG/I model.

Books Recommended:

1.	R. E. Barlow and F. Proschan, John Wiley & Sons, New York	Mathematical theory of Reliability (1965)
2.	Reliability k. E Barlow and F. Proschan, Holt, and Life Testing: Rinehard and Winston, Inc, New York.	Statistical theory of Reliability and Life (1975)
3.	B. V. Gnedenko, Belyayvev and Solovyev, Academic Press.	Mathematical Models of Reliability (1977)
4.	L J Bain, Marcell Dekker, New York.	Statistical analysis of Reliability and Life testing models (1978)
5.	J Medhi, New Age International Private Ltd., New Delhi., SM Ross, Wiley, New York, NU Prabhu, McMillan	Stochastic Process (1982)
6.	Balagurusamy Tata McGraw Hill	Reliability Engineering (1984)
7.	SK Sinha Wiley Eastern Ltd.	Reliability and Life Testing (1986)
8.	Recent Advances in Reliability and Maintenance Modeling	Hiroyuki Okamura, Shinji Inoue, Xiao Xiao (2024)

SCHEME OF EXAMINATIONS

	Syllabus to be covered in the examination	**Time allotted for the examination**	**%Weightage (Marks)**
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE312
Credits Hour:04
Duration of Examination: 3 Hrs.

Title: Advanced Reliability Theory
Maximum Marks:100
Minor Test -I: 20
Minor Test -II: 20
Major Test: 60

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of **THREE questions** (05 marks each). Students are required to answer **TWO** questions. **No preparatory holidays shall be provided for the Test I and Test II.**

*Those candidates who have **appeared** in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.*

Major Test

The Major test will comprise of **two sections**, Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE313 **Title: Advanced Bayesian and Sequential Inference**

Credit Hours :04
Duration of examination: 3 hours

Maximum Marks: 100
Minor Test-I : 20
Minor Test-II : 20
Major Test : 60

Course Outcomes:

- **CO1**: Understand the Bayesian framework, including Bayes' theorem, types of priors, and methods for obtaining prior distributions in statistical inference.
- **CO2**: Apply Bayesian interval estimation techniques, including credible intervals and highest posterior density regions, while comparing classical confidence intervals.
- **CO3**: Perform Bayesian hypothesis testing using prior and posterior odds, Bayes factor, Bayesian Information Criterion (BIC), and computational methods.
- **CO4**: Explore concepts of censoring, truncation, and sequential tests, including Wald's SPRT, optimality properties, and large sample properties of estimators.
- **CO5**: Utilize likelihood ratio tests, Rao's score test, and asymptotic efficiency methods for hypothesis testing and statistical decision-making.

Unit-I

An outline of Bayesian framework, Bayes Theorem, Types of priors, Conjugate prior, proper and improper prior, subjective prior etc., Methods of obtaining priors. Types of loss functions, Squared error loss function, Absolute error loss, 0-1 loss, Asymmetric loss functions such as LINEX and Entropy loss functions, Mixture of loss functions.

Unit-II

Bayesian Interval Estimation: Credible Intervals, Highest Posterior Density Regions, Interpretation of the Confidence Coefficient of an Interval & its Comparison with the Coefficient of Classical Confidence Intervals.

Unit-III

Bayesian Hypothesis testing: Specification of the Appropriate Form of the Prior Distribution for a Bayesian Testing of Hypothesis Problem, Prior Odds, Posterior Odds, Bayes Factor, Bayesian Information Criterion(BIC).

Bayesian computations: Analytic approximation, convergence and diagnostic issues. Concept of Censoring, types of censoring, Type-I censoring, Type-II censoring, Progressive censoring, Concept of Truncation.

Unit-IV

Stopping variables, Sequential Tests, Wald's equation for ASN, Walds SPRT and its properties – fundamental identity, OC and ASN Functions, Optimality of SPRT (under usual approximation). Consistency and Asymptotic Efficiency of Estimators, Maximum Likelihood estimators and their Large sample properties. Asymptotic distributions and properties of Likelihood ratio tests, Rao's score test and Wald's tests in the simple hypothesis case. Introduction to Sequential Tests for Composite Hypothesis.

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE313 **Title: Advanced Bayesian and Sequential Inference**

Credit Hours :04
Duration of examination: 3 hours

Maximum Marks: 100
Minor Test-I : 20
Minor Test-II : 20
Major Test : 60

Books Recommended:

1.	A. Wald(2017)	Sequential Analysis
2.	Albert, J. (2009)	Bayesian Computation with R, Springer
3.	B.K.Ghosh(1971)	Sequential Tests of Statistical Hypotheses
4.	Berger, J. O.(1985)	Statistical Decision Theory and Bayesian Analysis, Springer Verlag
5.	Box, G.P. and Tiao, G. C.(1992)	Bayesian Inference in Statistical Analysis, Addison-Wesley.
6.	Gelman, A., Carlin, J.B., and Rubin, D.B. (2021)	Bayesian Data Analysis, Electronic Edition.
7.	Gemerman, D.(2006)	Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, Chapman Hall.
8.	Robert, C.P. and Casella, G.(2004)	Monte Carlo Statistical Methods, Springer Verlag.
9.	Turkman, M. A. A., Paulino, C. D. and Muller, P. (2019)	Computational Bayesian Statistics: An Introduction, CUP

SCHEME OF EXAMINATIONS

	Syllabus to be covered in the examination	**Time allotted for the examination**	**%Weightage (Marks)**
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

Syllabus for Two Years PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-3 examinations to be held in Dec-2026,2027 and 2028

Course No: P2STTE313 **Title: Advanced Bayesian and Sequential Inference**

Credit Hours :04
Duration of examination: 3 hours

Maximum Marks: 100
Minor Test-I :20
Minor Test-II :20
Major Test :60

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of 10 **compulsory MCQ** of one mark each and THREE **subjective type questions** (05 marks each). Students are required to answer any **TWO** questions out of three asked questions. **No preparatory holidays shall be provided for the Test I and Test II.**

Those candidates who have appeared in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of **two sections,** Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.