National Education Policy-2020

Common Minimum Syllabus for Uttarakhand State Universities and Colleges

Subject: Statistics

FINAL STRUCTURE OF STATISTICS SYLLABUS

Effective from academic year 2025-2026

DEPARTMENT OF STATISTICS

EXPERT/SYLLABUS PREPARATION COMMITTEE

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1.	Dr. M.C Joshi	Professor & Head	D. S. B. Campus, Kumaun University, Nainital
2.	Dr. Niraj Tiwari	Professor & Head	S.S.J Campus, S.S.J University, Almora
3.	Dr. Seema Joshi	Associate Professor	RLAC, University of Delhi
4.	Dr. Pushpa Panwar	Assistant Professor and Head	Govt PG College, New Tehri
5.	Dr. Spersh Bhatt	Assistant Professor	D. S. B. Campus, Kumaun University, Nainital
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Contents

List of Papers (DSC, DSE) with Semester-wise Titles (Major Course)					
Year	**Sem.**	**Course Code**	**Paper Title**	**Theory/Practical**	**Credits (L+P+T)**
Bachelor (Research) of Science (Statistics)					
4	VII	DSC	Advanced Probability Theory	Theory	3
		DSE-1	Distribution Theory	Theory	3
		DSE-2	Advanced Analysis	Theory	3
		DSE-3	Matrix Theory And Non Parametric Methods	Theory	3
			Practical	Practical	4
			Dissertation	-	6
		DSE-4 /GE-1	Biostatistics	-	4
	VIII	DSC	Advanced Statistical Inference	Theory	3
		DSE-1	Linear Estimation And Regression Analysis	Theory	3
		DSE-2	Advanced Theory of Design	Theory	3
		DSE-3	Stochastic Processes	Theory	3
			Practical	Practical	4
			Dissertation	-	6
		DSE-4 /GE-1	Economic Statistics And Demography	-	4

Purpose of the Program

The Importance of Statistics is well known. Statistical ideas not only help students to understand the theory of several disciplines of Basic as well as Social sciences but also to enhance their decision-making skills so that they can handle critical situation in a better way. The purpose of the postgraduate program in Statistics at the university and college level is to prepare our students for all those fields where advanced Statistical and Analytical skill is required for careers as well as professionals in various industries and research institutions.

Program Outcomes

1. **PO1: Knowledge and Understanding**
   Demonstrate advanced knowledge of statistical theory, methods, and applications across a range of contexts.
2. **PO2: Problem Solving and Analysis**
   Analyze complex real-world problems using statistical models and techniques; design and interpret appropriate statistical solutions.
3. **PO3: Research Competency**
   Develop independent research skills in statistical methodologies, data collection, modeling, analysis, and interpretation.
4. **PO4: Data Handling and Technological Skills**
   Apply modern statistical software (e.g., R, Python, SAS, SPSS) for data analysis, simulations, and visualization.
5. **PO5: Communication Skills**
   Present statistical findings effectively through written reports, graphical displays, and oral presentations to both technical and non-technical audiences.
6. **PO6: Ethics and Professionalism**
   Apply ethical principles and maintain integrity in research, data handling, and professional statistical practices.
7. **PO7: Life-long Learning**
   Demonstrate a commitment to continuous learning and professional development in the evolving field of data science and statistics.
8. **PO8: Interdisciplinary Integration**
   Integrate statistical knowledge with other disciplines (e.g., economics, biology, computer science, social sciences) for collaborative research and decision-making.
9. **PO9: Teamwork and Leadership**
   Work effectively in teams and exhibit leadership in academic and industry research settings.
10. **PO10: Global and Societal Relevance**
    Understand the societal impact of statistical research and contribute meaningfully to data-driven policy making and social innovation.

Progarmme Specific Outcomes (PSOs)

1. **PSO1: Statistical Modelling Expertise**
   Develop and apply a variety of models including linear, nonlinear, multivariate, and time series models to real-world data.

2. **PSO2: Advanced Statistical Inference**
   Use principles of estimation, hypothesis testing, and Bayesian inference to draw conclusions from complex data sets.
3. **PSO3: Computational Statistics and Data Science**
   Gain hands-on experience in computational techniques including resampling methods, machine learning, and data mining.
4. **PSO4: Survey and Experimental Design**
   Design, conduct, and analyze data from surveys and experiments using advanced sampling and design of experiments methods.
5. **PSO5: Specialized Domain Application**
   Apply statistical methods to specialized domains such as biostatistics, econometrics, psychometrics, demography, actuarial science, or environmental statistics.
6. **PSO6: Project-Based Learning and Dissertation**
   Execute a full-cycle statistical research project or dissertation, involving formulation of problems, data analysis, interpretation, and presentation of results.

Pattern of examination theory papers

A. Theory

*Each theory paper shall consist two sections **A** and **B**.*

***Section A**: (Short answers type); 30 marks, eight questions of six marks each, any five have to be attempted).*

***Section B**: (Long answers type); 45 marks, five questions of fifteen marks each. Any three have to be attempted.*

B. Internal assessment

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25. The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.

C. Practical

The laboratory work of the students has to be evaluated periodically. The internal assessment in the form of lab test, lab record, internal evaluation and attendance of total 25 marks for each semester shall be conducted during the semester. A minimum of 10 experiments covering all kinds of exercises have to be conducted during a semester. In each semester practical examination of 75 marks has to be conducted by two examiners (External and internal) having duration of 3 hours for each Semester. The total number of students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital.

Semester-VII

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC COURSE (DSC-7)–Advanced Probability Theory

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Advanced Probability Theory	**4**	**3**		**1**	To study this course, a student must have passedB.Sc. with Statistics as a major Subject	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)		
Programme/Class: Bachelor (Research) of Science (Statistics)	**Year: IV**	**Semester: VII Paper: DSC-7**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-	**Course Title: Advanced Probability Theory**	
Course outcomes: After completing this course a student will have: ✓ Ability to understand the probability theory. ✓ Ability to understand the Characteristic function and its elementary properties. ✓ Ability to understand the Convergence of sequence of random variables. ✓ Ability to understand the different probability function.		
Credits: 5	**Compulsory**	
Max. Marks: 25+75	Minimum Passing Marks: ….	

Unit	**Topic**	**No. of Hours**

I	Sets, Fields —Fields and Measurable functions, Definition of Measure and probability, Notion of Random Variable, Definition of Integral and expectation of Random variable, Distribution function of a Random variable and Decomposition Theorem	18-20
II	Characteristic function and its elementary properties. Uniqueness, lnversion and continuity theorems, *C*.F. Kolmogorov's inequality. Chebyshev's Inequality. Law of large numbers, Central limit theorem.	15-20
III	Convergence of sequence of random variables. Convergence in Probability, in mean squareand almost sure. The weak law of large numbers, The strong law of large numbers	12-18
IV	Bernoulli's, Kintchin's theorems, Central limit theorem Lindberg – Levyand Liapounov's form, Borel-Cantelli Lemma, Borelzero-one law.	13-18

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. Roliatgi VK & Saleh AK Md. E. 2005. An introduction to Probability andStatistics. 2nd Ed.John Wiley.
6. FellerW.1972.AnIntroductiontoProbabilityTheory&Applications (Vol1andII). John Wiley.
7. Marek F. 1963. Probability Theory and Mathematical Statistics. John Wiley.
8. BhattBR.1999.ModerenProbabilityTheory.3rdEd.NewAgeInternational Pub.

Suggested Online Links/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have Bachelor of Science (Statistics as one of the major Subject).

Semester-VII

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-5)–Statistical Methods

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Statistical Methods	**4**	**3**		**1**	To study this course, a student must have passedB. Sc. with Statistics as a major Subjects	**Nil**

BACHELOR (RESEARCH) OF SCIENCE		
Programme/Class: Bachelor (Research) of Science	**Year: IV**	**Semester: VII Paper: DSE-5**
Subject: STATISTICS		**Credits:3+ 1+0**
Course Code:-DSE-5	**Course Title: Distribution Theory**	

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of discrete distributions. Discuss appropriate distribution negative binomial, Geometric, etc. with their properties and application of discrete distribution models to solve problems.
- ✓ Knowledge of continuous distributions. Discuss the appropriate distribution (i.e. Lognormal,Logistic,Pareto etc.) with their properties and application of continuous distribution models to solve problems.
- ✓ Ability to understand the Samplingdistributions.
- ✓ Ability to understand theDistributionofquadraticforms.

Credits: **05**	Core: **Compulsory**
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	**Topic**	**No. of Hours**

I	Negative Binomial, Geometric and Hyper Geometric, Uniform, Multinomial - properties of these distributions and real life examples	10-15
II	Cauchy, Gamma, Beta of two kinds, Weibull, Lognormal, Logistic, Pareto, Inverse Gaussian, Eexponentialdistributions Extreme value distributions· Truncateddistribution.Compound distributions. Properties of these distributions. Probability distributions of functions of randomvariables.	15-20
I I I	Samplingdistributionsofsamplemeanandsample variance from Normal Population, Non- central Chi-Square. t and F distributions, their properties and interrelationship.	13-18
IV	Distributionofquadraticforms,samplingdistributionofcorrelationcoefficient, regression coefficient, correlation ratio, Intra class correlation coefficient.	15-18

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. RaoCR.1965.LinearStatisticalInferenceanditsapplication.JohnWiley
6. DudewiczEJ&AMishraSN.1988.ModernMathematicalStatistics.JohnWiley. Murek F. 1963. Piobability Theory and Mathematical Statistics. John Wiley.
7. HuberP.J.1981.RobustStatistics.John Wiley.
8. Johnson NI., Kotz S & Balakrishnan N. 2000. DiscreteUnivariateDistributions. JohnWilcy.
9. Johnson NI., Kotz S & Balakrishnan N. 2000. Continuous Univariate Distributions. JohnWiley.

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have Bachelor of Science (Statistics as one of the major Subject).

Semester-VII

BACHELOR (RESEARCH) OF SCIENCE(STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-6)–Advanced Analysis

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Advanced Analysis	**4**	**3**		**1**	To study this course, a student must have passedB. Sc. with Statistics as a major Subjects	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)		
Programme/Class: Bachelor (Research) of Science	**Year: IV**	**Semester: VII Paper: DSE-6**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-DSE-6	**Course Title: Advanced Analysis**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the Functions of several variables.
- ✓ Ability to understand the Partial derivatives.
- ✓ Ability to understand the Linear transformations.
- ✓ Ability to understand the Conformal representation.

Credits: **05**	Core: **Compulsory**
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Functions of several variables, Concept of functions of two variables, Single valued and multiple valued functions, Simultaneous limits and iterated limits in functions of two variables,.	13-18

II	Partial derivatives, interchange of order of differentiation, Composite functions,Linearcontinuityoffunctionoftwo variables, Partial Derivatives, definition, existence and continuity, interchange of order of differentiation.	15-20
III	Linear transformations, vector valued function, Differentiation of vector valued function.	13-18
IV	Conformal representation, Analytic continuation. The maximum modulus theorem, Schwartz's theorem. Hadmard's three circle theorem, Integral functions, Fourier series and transforms.	15-20

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. Bartle RG. 1976. Elements ofreal Analysis. John Wiley
6. ChatterjeeSK.1970.MathematicalAnalysis.Oxford&IBH.
7. Priestley HA. 1985. Complex Analysis. Clarenton Press
8. RudinW.1985.PrinciplesofMathematicalAnalysis.McGrawHill.

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have Bachelor of Science (Statistics as one of the major Subject).

Semester-VII

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-7)–Matrix Theory and Non Parametric Inference

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Matrix Theory and Non Parametric Inference	**4**	**3**		**1**	To study this course, a student must have passedB. Sc. with Statistics as a major Subjects	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)		
Programme/Class: Bachelor (Research) of Science	**Year: IV**	**Semester: VII Paper: DSE-7**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-DSE-7	**Course Title: Matrix Theory and Non Parametric Inference**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the Inverse of a matrix.
- ✓ Ability to understand the Non-parametric methods.
- ✓ Ability to understand the Linear rank statistic and general two way sample problem.
- ✓ Ability to understand the Multivariate non parametric test.

Credits: **05**	Core: **Compulsory**
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Inverseofamatrix,Characteristicrootsandvectors,vector spaces,orthonormalbasis of sub-spaces. generalized Inverse, solutions of non Homogenous equations, quadratic forms (real field).	12-18
II	Non-parametricmethods,Signtest,Runtest,Mann-WhitneyU-statistics, KruskalWallistest,testforRandomness,Testfor normality	15-20

III	Linear rank statistic and general two way sample problem, Linear rank tests for location and scale problems, rank test for one way and two way classified data	13-18
IV	Multivariate non parametric test for one sample location problems, Asymptotic relative efficiency, examples of ARE tests.	15-20

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. SearleSr.1982.MatrixAlgebra.MatrixAlgebrausefulforStatistics.JohnWiley.
6. Hohn FE. 973. Elementry Matrix Algebra. Macmillan.
7. VatssaBS.l994.TheoryofMatrices.2ndEd.WileyEastern
8. NarayanShanti. 1994. A Text book of Matrices. 9th Ed.
9. S.Chand&Company
10. Gibbons.NonParametricStatistical Inference.
11. SiegelS,JohanN&CasellanJr.1956.NonParametricTestforBehavioralSciences. John Wiley.

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have Bachelor of Science (Statistics as one of the major Subject).

Semester-VII

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-10/GE-1)–Bio-statistics

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course	Credits	Credit distribution of the Course	Eligibility	Pre-

Title		Lecture	Tutorial	Practical/Practice	criteria	requisite of the course (if any)
DSE: Bio-statistics	**4**	**3**		**1**	To study this course, a student must have passedB. Sc. with Statistics as a major Subjects	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)		
Programme/Class: Bachelor (Research) of Science	**Year: IV**	**Semester: VII Paper: DSE-10 /GE-1**
Subject: STATISTICS		**Credits:3+ 1+0**
Course Code:- DSE-10/GE-1	**Course Title: Bio-statistics**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the Survival Analysis
- ✓ Ability to understand the Censoring Schemes
- ✓ Ability to understand the Competing Risk Theory
- ✓ Ability to understand the Stochastic Epidemic Models
- ✓ Ability to understand the Statistical Genetics

Credits: **05**	Core: **Compulsory**
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Survival Analysis: Functions of survival times, survival distributions and their applications- exponential, gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shaped hazard function. Censoring Schemes: 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	12-18

	data with numerical examples. Non-parametric methods: Actuarial and Kaplan-Meier methods for estimating survival function and variance of the Estimator.	
II	Competing Risk Theory: Indices for measurement of probability of death under competingrisks and their inter-relations. Estimation of probabilities of death using maximum likelihood principle and modified minimum Chi-square methods. Theory of independent and dependent risks. Bivariate normal dependent risk model.	15-20
III	StochasticEpidemicModels:Simpleepidemicmodels,generalepidemicmodeldefinition and concept (without derivation). Duration of an epidemic.	13-18
IV	Statistical Genetics: Introduction, concepts-Genotype, Phenotype, Dominance, Recessiveness, Linkage and Recombination, Coupling and Repulsion. Mendelian laws of Heredity, Randommating, Gametic Array .relation between genotypicarrayandgametic array under random mating. Distribution of genotypes under random mating. Clinical Trials: Planning and design of clinical trials, Phase I, II and III trials. Single Blinding.	15-20

Suggested Readings:

1. Lee, E.T. and Wang, J.W. (2003): Statistical Methods for Survival data Analysis, 3rdEdition, John Wiley and Sons.
2. Biswas,S.(2007):AppliedStochasticProcesses:ABiostatisticalandPopulation Oriented Approach, Reprinted 2ndCentral Edition, New Central Book Agency.
3. Kleinbaum,D.G.(1996):SurvivalAnalysis,Springer.
4. Chiang,C.L.(1968):IntroductiontoStochasticProcessesinBioStatistics,John Wiley and Sons.
5. Indrayan,A.(2008):MedicalBiostatistics,2ndEditionChapmanandHall/CRC

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have Bachelor of Science (Statistics as one of the major Subject).

Programme/Class: **Bachelor (Research) of Science**	Year:**IV**	Semester:**VII**
Subject: **STATISTICS (Practical)**		
Course Code:-	Course Title: **Practical**	

Course outcomes:

After completing this course a student will have knowledge to:

- ❖ Find the rank of matrix.
- ❖ Find the inverse of the matrix.
- ❖ Find the eigen values and eigen vectors of the matrix.
- ❖ Find the generalised inverse of the matrix.
- ❖ Find the moorepenrose inverse of the matrix.
- ❖ Perform kruskalwallis test.
- ❖ Perform Friedman test.
- ❖ Fitting of various theoretical distributions.

Credits:**01**	Core: **Compulsory**
Max. Marks: As per Univ. rule	**Min. Passing Marks:As per Univ. rule**

	Topic	**No. of Hours**
	** Practical papers based on the above Theory papers for Post Graduate course. ❖ Find the rank of matrix. ❖ Find the inverse of the matrix. ❖ Find the eigen values and eigen vectors of the matrix. ❖ Find the generalised inverse of the matrix. ❖ Find the moorepenrose inverse of the matrix. ❖ Perform kruskalwallis test. ❖ Perform Friedman test. ❖ Fitting of various theoretical distributions.	**60**

Suggested Readings:As suggested for paper I & II

Suggested Continuous Evaluation Methods(25 marks):

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:

Practical File/Record	**(10 marks)**
Class Interaction	**(05 marks)**
Report Preparation/Presentation	**(10 marks)**

Suggested Practical Examination Evaluation Methods:(75 Marks)

Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major) 03x15Marks	**45 Marks**
Viva-voce	**15 Marks**
Practical Record and Attendance	**15 marks**

Further Suggestions:

Semester-VIII

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC COURSE (DSC-8)–Advanced Statistical Inference

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Advanced Statistical Inference	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VII semester.	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)		
Programme/Class: Bachelor (Research) of Science	**Year: IV**	**Semester: VIII** **Paper: DSC-8**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:- DSC-8	**Course Title: Advanced Statistical Inference**	
Course outcomes: After completing this course a student will have: ✓ Ability to understand the Elements of Decision Theory ✓ Ability to understand the Method of Estimation ✓ Ability to understand the Testing of Hypothesis ✓ Ability to understand the Sequential Analysis		
Credits: 5	**Compulsory**	
Max. Marks: 25+75	Minimum Passing Marks: ….	

Unit	Topic	No. of Hours
I	**Elements of Decision Theory**: Admissibility, Properties of good estimators, Unbiasedness, Efficiency, Sufficiency and completeness, Cramer —Rao inequality and its generalization, Bhattacharya's Bounds, Characteristics of distribution admitting sufficient statistic, Rao-Blackwell Theorem and Lehmann - Scheffe theorem.	16-20
II	**Method of Estimation**, Method of Maximum Likelihood, Method of Moments, Method of Chi-Square, Properties of M.L.E, existence of best asymptotic normal estimate under regularity conditions,. Interval Estimation: Confidence Regions, Shortest Confidence Interval	12-18
III	**Testing of Hypothesis-** Neyman Pearson Lemma and its generalization, UMP Tests, Unbiased Tests, UMPU Tests, Tests with Neyman structure and UMP similar tests, Likelihood Ratio tests and their large sample properties along with simple applications.	14-18
IV	**Sequential Analysis-** Need of Sequential Probability Ratio tests and it's properties, Wald's fundamental identity, OC and ASN function, Optimality of SPRT, Applications to Normal, Binomial and Poisson Distributions, Sequential estimation- Basic idea, Stein's two stage procedure.	14-20

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. Rohatgi VK. 1984. Statistical Inference. John Wiley
6. Rohatgi VK & Sala AK. Md. E. 2005. An Introduction to Probability and Statistics. 2I'd Ed. John Wiley
7. Joshi DD. 1990. Linear Estimation and Design of Experiment. First reprint. Wiley Eastern
8. Rao CR. 1973. Linear Statistical Inference and Its Applications. 2nd Ed. Wiley Eastern
9. E. L Lehman. 1990.Testing of Hypothesis. John Wiley
10. Wald A. 2004. Sequential Analysis. Dover Publ.

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics

- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have passed all Theory papers up to VII semester.

Semester-VIII

BACHELOR (RESEARCH) OF SCIENCE(STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-11)–Linear Estimation and Regression Analysis

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Linear Estimation andRegression Analysis	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VII semester.	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)		
Programme/Class: Bachelor (Research) of Science	**Year: IV**	**Semester: VIII** **Paper: DSE-11**
Subject: STATISTICS		**Credits: 3+1+0**
Course Code:-DSE-11	**Course Title: Linear Estimation andRegression Analysis**	
Course outcomes: After completing this course a student will have: ✓ Ability to understand the Simple and multiple Linear regression		

✓ Ability to understand the Assumptions of regression ✓ Ability to understand the Concepts of Least median of squares and its applications ✓ Ability to understand the Weighted Least squares method		
Credits: **05**	Core: **Compulsory**	
Max. Marks: 25+75	Minimum Passing Marks: ….	

Unit	Topic	No. of Hours
I	Simple and multiple Linear regression, Least squares fit- Properties and example, Polynomial Regression, Use of orthogonal polynomials	16-20
II	Assumptionsofregression,diagnosticsandtransformations,ExaminationofResiduals, - Studentized residuals, applications of residuals in detecting outliers, identification of influential observations, Lack of fit, pure error, Testing homoscedasticityandnormalityoferrors,DurbinWatsontest,UseofR^2 inexamining goodness of fit, other measures of goodness of fit. Cook statistic, M- estimation.	12-18
III	ConceptsofLeastmedianofsquaresanditsapplications,ConceptofMulticollinearity, Analysis of Multiple Regression Models, estimation and testing of regressionparameters,subhypothesistesting,restrictedestimation.	14-18
IV	Weighted Least squares method: Properties and it's examples, Box-Cox family of transformation, Using of Dummy variables, Selection of variables, Forward Selection, Backwardelimination,StepwiseandStagewise regression. Introduction to non linear models, Non linear estimation: Least squares for non linear models.	14-20

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. Rohatgi VK. 1984. Statistical Inference. John Wiley
6. Rohatgi VK & Sala AK. Md. E. 2005. An Introduction to Probability and Statistics. 2I'd Ed. John Wiley
7. Joshi DD. 1990. Linear Estimation and Design of Experiment. First reprint. Wiley Eastern
8. BalsleyDA, Kuh E & WalschRE. 2004. Regression Diagnostics -- Identifying Influential Data and Sources Of Collinearity. John Wiley.
9. ChatterjeeS,HadiA,&PriceB.1999.RegressionAnalysisbyExamples. John Wiley.
10. MontgomeryDC,PeckEA&ViningGG.2003.IntroductiontoLinearRegressionAnalysis. 3rdEd.JohnWiley.
11. Draper&Smith.2005.AppliedRegressionAnalysis,JohnWiley

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have passed all Theory papers up to VII semester.

Semester-VIII

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-12)–Design of Experiment

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Design of Experiment	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VII semester.	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)		
Programme/Class: Bachelor (Research) of Science	**Year: IV**	**Semester: VIII Paper: DSE-12**
Subject: STATISTICS		**Credits: 3+1+0**
Course Code:-DSE-12	**Course Title: Design of Experiment**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the Fundamentals of experimental designs
- ✓ Ability to understand the block design
- ✓ Ability to understand the Factorial Experiments
- ✓ Ability to understand theMissing Plot technique

Credits: **05**	Core: **Compulsory**
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Fundamentals of experimental designs, one way and two way classifications, heterogeneity settings, connectedness, balance, orthogonal structures, contrasts,.	15-20
II	Balanced incomplete block design and Lattice design, Recovery of intra-block information, Latin square, mutually orthogonal latin squares, Youden squares,	12-18
III	Factorial Experiments- 2^2 ,2^3 and 3^2 designs, confounding in factorial experiments,	15-20
IV	Missing Plot technique. Plot sampling, Uniformity Trials. Split Plot and Strip plot Design	13-18

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. **Joshi DD. 1990.** Linear Estimation and Design of Experiment. First reprint. Wiley Eastern
6. Ltd. **Cochran WG & Cox GM. 1957.** Experimental Designs. 2nd Ed. John Wiley.
7. **Federer WT. 1985.** Experimental Designs. MacMillan
8. **Nigam AK & Gupta VK. 1979**. Handbook on Analysis of Experiments. IASRI Publ.
9. **Dean AM & Voss D. 1999.** Design and Analysis of Experiments. Springer.
10. **Fisher RA. 1953**. Design and Analysis of Experiments. Oliver & Boyd.

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have passed all Theory papers up to VII semester.

Semester-VIII

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-13)–Stochastic Process

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Stochastic Process	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VII semester.	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)			
Programme/Class: Bachelor (Research) of Science		**Year: IV**	**Semester: VIII** **Paper: DSE-13**
Subject: STATISTICS			**Credits: 3+1+0**
Course Code:-DSE-13	**Course Title: Stochastic Process**		
Course outcomes: After completing this course a student will have: ✓ Ability to understand the Stochastic processes ✓ Ability to understand the Markov Process			
Credits: **05**		Core: **Compulsory**	
Max. Marks: 25+75		Minimum Passing Marks: ….	

Unit	Topic	No. of Hours
I	Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.	15-18
II	Markov Chains: Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains, stability of Markov system, graph theoretic approach.	14-16
III	Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, pure birth process, Yule Furry process, birth and death process, pure death process.	15-20
IV	Queuing System: General concept, steady state distribution, queuing model, M/M/1with finite and infinite system capacity, waiting time distribution (without proof). Gambler's Ruin Problem: Classical ruin problem, expected duration of the game.	15-20

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. Medhi J. 2001. Stochastic Processes. 2nd Ed. Wiley Eastern.
6. Parzen E. 1962. Stochastic Processes. Holden-Day.
7. Bhatt BR. 2000. Stochastic Models; Analysis and Applications. New Age

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have passed all Theory papers up to VII semester.

Semester-VIII

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-16/GE-2)–Economic Statistics and Demography

Total Number of Hours = 70-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Economic Statistics and Demography	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VII semester.	**Nil**

BACHELOR (RESEARCH) OF SCIENCE (STATISTICS)		
Programme/Class: Bachelor (Research) of Science	**Year: IV**	**Semester: VIII Paper: DSE-16/GE-2**
Subject: STATISTICS		**Credits: 3+1+0**
Course Code:-DSE-16/GE-2	**Course Title: Economic Statistics and Demography**	
Course outcomes: After completing this course a student will have: ✓ Ability to understand the Tests of Randomness ✓ Ability to understand the Demand Analysis ✓ Ability to understand the Demography		

✓ Ability to understand the Vital rates and Ratios		
Credits: **05**		Core: **Compulsory**
Max. Marks: 25+75		Minimum Passing Marks: ….
Unit	**Topic**	**No. of Hours**
I	Objects decomposition, Tests of Randomness, Trend Component, Polynomial Logistic, Gompertz, Log Normal trend functions, smoothing of moving average, Spencer's formula and effects, Slutzky-Yule effect, variate difference method, measurement of seasonal and cyclic fluctuations, periodogram and Harmonic analysis, Stationary Time Series: Concepts, Autocorrelation and Correlogram analysis.	15-18
II	Demand Analysis: Distribution of income, income and demand elasticities, Method of estimation of elasticities using family budget data and time series data, Engel's curve and Engel's law.	14-16
III	Demography: Sources of Demographic data, limitations and uses of demographic data, Theory of Demographic transition, stationary and stable population theory, uses of Lothka's stable population theory in the estimation of demographic parameters, method of inter-censal and post-censal estimation.	15-20
IV	Vital rates and Ratios, definition and construction of life tables from Vital Statistics, census returns, uses of life table, logistic and other population growth curves, measure of fertility gross net reproduction rates,	15-20

Suggested Readings:

1. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor.
2. Fundamentals of Statistics Vol- I: A. M. Goon, M. K. Gupta and B. Dasgupta.
3. Fundamentals of Statistics Vol-II: A. M. Goon, M. K. Gupta and B. Dasgupta
4. An Outline of Statistical Theory Vol-I & II, A. M. Goon, M. K. Gupta and B. Dasgupta
5. Cox DR. 1957. Demography. Cambridge Univ. Press.
6. Rowland Di'. 2004. Demographic Methods and Concepts. Oxford Press.
7. Sigel JS & Swanson DA. 2004. The Methods and Material of Demography. 2"d Ed. Elsevier.
8. Woolson FR. 1987. Statistical Methods for the Analysis of Biomedical Data. John Wiley.
9. Wald H. Demand Analysis
10. Kendall MG. Advanced Theory of Statistics Vol-11

SuggestedOnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx

- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Course Prerequisites: To study this course, a student must have passed all Theory papers up to VII semester.

<table>
<tr><td colspan="2">Programme/Class: Bachelor (Research) of Science</td><td>Year:IV</td><td>Semester:VIII</td></tr>
<tr><td colspan="4">Subject: STATISTICS (Practical)</td></tr>
<tr><td colspan="2">Course Code:-</td><td colspan="2">Course Title: Practical</td></tr>
<tr><td colspan="4">Course outcomes:
After completing this course a student will have:
❖ Find the least square estimator of a multiple regression model.
❖ Find $R^2$and check significance of the regression model.
❖ Analysis of BIBD.
❖ Analysis of 2^2 and 2^3 factorial experiment.
❖ Analysis of 3^2 factorial experiment.
❖ Analysis of split plot design.
❖ Analysis of strip plot design.
❖ Constructing transition graphs from TPM.
❖ Finding various probabilities from TPM.
❖ Queuing problem.</td></tr>
<tr><td colspan="2">Credits:01</td><td colspan="2">Core: Compulsory</td></tr>
<tr><td colspan="2">Max. Marks: As per Univ. rule</td><td colspan="2">Min. Passing Marks:As per Univ. rule</td></tr>
<tr><td></td><td colspan="2">Topic</td><td>No. of Hours</td></tr>
<tr><td></td><td colspan="2">** Practical papers based on the above Theory papers for Post Graduate course.
❖ Find the least square estimator of a multiple regression model.
❖ Find $R^2$and check significance of the regression model.
❖ Analysis of BIBD.
❖ Analysis of $2^2$and 2^3factorial experiment.
❖ Analysis of 3^2factorial experiment.
❖ Analysis of split plot design.
❖ Analysis of strip plot design.
❖ Constructing transition graphs from TPM.
❖ Finding various probabilities from TPM.
❖ Queuing problem.</td><td>60</td></tr>
<tr><td colspan="4">Suggested Readings: As suggested for Theory papers.</td></tr>
<tr><td colspan="4">Suggested Continuous Evaluation Methods(25 marks):

Continuous Internal Evaluation shall be based on Practical File/Record, Class Activities and Overall performance. The marks shall be as follows:</td></tr>
</table>

Practical File/Record	**(10 marks)**
Class Interaction	**(05 marks)**
Report Preparation/Presentation	**(10 marks)**
Suggested Practical Examination Evaluation Methods:(75 Marks) Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:	
Practical Exercise (Major) 03x15Marks	**45 Marks**
Viva-voce	**15 Marks**
Practical Record and Attendance	**15 marks**
Further Suggestions:	