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

S.N.	Name	Designation	Affiliation
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
6.	Dr. Bharat Ratna	Assistant Professor	D. S. B. Campus, Kumaun University, Nainital

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
Master of Science (Statistics)					
5	IX	DSC	Multivariate Analysis	Theory	3
		DSE-1	Reliability Theory	Theory	3
		DSE-2	Bayesian Inference	Theory	3
		DSE-3	Time Series Analysis	Theory	3
			Practical	Practical	4
			Dissertation	-	6
		DSE-4 /GE-1	Bioinformatics	-	4
	X	DSC	Advanced Sampling Theory	Theory	3
		DSE-1	Statistical Computing	Theory	3
		DSE-2	Econometrics	Theory	3
		DSE-3	Operation Research	Theory	3
			Practical	Practical	4
			Dissertation	-	6
		DSE-4 /GE-1	Actuarial Statistics	-	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 passed B.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, inversion 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 square and 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 – Levy and Liapounov's form, Borel-Cantelli Lemma, Borelzero-onelaw.	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 and Statistics. 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 passed B. 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 Sampling distributions. ✓ Ability to understand the Distribution of quadratic forms.		
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, exponential distributions Extreme value distributions· Truncated distribution. Compound distributions. Properties of these distributions. Probability distributions of functions of random variables.	15-20
III	Sampling distributions of sample mean and sample variance from Normal Population, Non- central Chi-Square. t and F distributions, their properties and interrelationship.	13-18
IV	Distribution of quadratic forms, sampling distribution of correlation coefficient, 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. Probability Theory and Mathematical Statistics. John Wiley.
7. HuberP.J.1981.RobustStatistics.John Wiley.
8. Johnson NI., Kotz S & Balakrishnan N. 2000. Discrete Univariate Distributions. JohnWilcy.
9. Johnson NI., Kotz S & Balakrishnan N. 2000. Continuous Univariate Distributions. JohnWiley.

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-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 passed B. 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, Linear continuity of function of two 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 of real Analysis. John Wiley
6. ChatterjeeSK.1970.MathematicalAnalysis.Oxford&IBH.
7. Priestley HA. 1985. Complex Analysis. Clarenton Press
8. RudinW.1985.PrinciplesofMathematicalAnalysis.McGrawHill.

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-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 passed B. 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	Inverse of a matrix, Characteristic roots and vectors, vector spaces, orthonormal basis of sub-spaces. generalized Inverse, solutions of non Homogenous equations, quadratic forms (real field).	12-18
II	Non-parametric methods, Sign test, Run test, Mann-Whitney U-statistics, Kruskal Wallis test, test for Randomness, Test for 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. Narayan Shanti. 1994. A Text book of Matrices. 9th Ed.
9. S.Chand &Company
10. Gibbons. Non Parametric Statistical Inference.
11. SiegelS, JohanN &CasellanJr.1956.NonParametricTestforBehavioralSciences. John Wiley.

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-10/GE-1)–Bio-statistics

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: Bio-statistics	**4**	**3**		**1**	To study this course, a student must have passed B. 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 data with numerical examples. Non-parametric methods: Actuarial and Kaplan-Meier methods for estimating survival function and variance of the Estimator.	12-18
II	Competing Risk Theory: Indices for measurement of probability of death under competing risks 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	Stochastic Epidemic Models: Simple epidemic models, general epidemic model definition 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, Random mating, Gametic Array .relation between genotypicarray and gametic 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):Survival Analysis, Springer.
4. Chiang, C.L.(1968):Introduction to Stochastic Processes in Bio Statistics, John Wiley and Sons.
5. Indrayan,A.(2008):MedicalBiostatistics,2ndEditionChapmanandHall/CRC

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).

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 kruskal wallis 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.

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 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 and Regression Analysis	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VII	**Nil**

					semester.	

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 and Regression 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 homoscedasticity and normality of errors, Durbin Wats on test, Use of R^2 in examining goodness of fit, other measures of goodness of fit. Cook statistic, M-estimation.	12-18
III	Concepts of Least median of squares and its applications, Concept of Multi collinearity, Analysis of Multiple Regression Models, estimation and testing of regression parameters, sub hypothesis testing, restricted estimation.	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, Backward elimination, Stepwise and Stage wise 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. Balsley DA, Kuh E & Walsch RE. 2004. Regression Diagnostics -- Identifying Influential Data and Sources Of Collinearity. John Wiley.
9. ChatterjeeS, HadiA, & Price B.1999. Regression Analysis by Examples. John Wiley.
10. Montgomery DC, Peck EA & Vining GG.2003.Introductionto Linear Regression Analysis. 3rdEd.JohnWiley.
11. Draper & Smith.2005. Applied Regression Analysis, John Wiley

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 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	**4**	**3**		**1**	To study this	**Nil**

Experiment					course, a student must have passed all Theory papers up to VII semester.	

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 the Missing 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.

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 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	**Nil**

					student must have passed all Theory papers up to VII semester.	

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

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 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	**4**	**3**		**1**	To study this course, a student	**Nil**

Demography					must have passed all Theory papers up to VII semester.	

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	15-20

	demographic parameters, method of inter-censal and post-censal estimation.	
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

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 passed all Theory papers up to VII semester.

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

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.		
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 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.	**60**
Suggested Readings: As suggested for Theory papers.		
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-IX

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC COURSE (DSC-9)–Multivariate 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		
DSC: Multivariate Analysis	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VIII semester.	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: IX** **Paper: DSC-9**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-	**Course Title: Multivariate Analysis**	

Course outcomes:

After completing this course a student will have:

✓ Ability to understand the Non Singular and Singular Multivariate Normal distributions.

✓ Ability to understand the Hotelling's T2 statistic andit's distribution and applications.

✓ Ability to understand the Principal Components and Canonical Correlations analysis.

Ability to understand the Discriminant Analysis, Discriminant function.

Credits: 5	Compulsory
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Non Singular and Singular Multivariate Normal distributions, Marginal and Conditional distributions, Characteristic Function and Moment Generating Functions, Maximum Likelihood Estimation of Mean and Co-Variance matrix,	15-20
II	Hotelling's T2 statistic as a function of the Likelihood Ratio criterion, It's distribution and applications, Mahalanob is D2 statistic and it's distribution	13-18
III	Principal Components and Canonical Correlations Analysis, Factor Analysis, Cluster Analysis	14-20
IV	Discriminant Analysis, Discriminant function (for two variables), Path Analysis, MANOVA	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. Anderson,TW.1958. An introduction to Multivariate Statistical Analysis. John Wiley.
6. DillonWR&GoldsteinM.1984.MultivariateAnalysis-Methodsand Applications. John Wiley.
7. MorrisonDF.1976.MultivariateStatisticalMethods.McGrawHill.
8. GillNC. Multivariate Statistical Inference

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 passed all Theory papers up to VIII semester.

Semester-IX

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-17)–Reliability 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: Reliability Theory	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VIII semester.	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: IX** **Paper: DSE-17**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-	**Course Title: Reliability Theory**	
Course outcomes: After completing this course a student will have: ✓ Ability to understand the reliability theory. ✓ Ability to understand the system reliability.		
Credits: 5	**Compulsory**	
Max. Marks: 25+75	Minimum Passing Marks: ….	

Unit	Topic	No. of Hours
I	**RELIABILITY THEORY:** Definition of Reliability, Maintainability and Availability ,Basic functions of Reliability and their relationships-Reliability Function, Cumulative failure distribution function, failure density function, hazard rate, Relationship between functions R(t),F(t), f(t) and λ(t), Mean time to system failure and mean time between failure, Bath Tub Curve, Estimation of Reliability from failure data	15-20
II	System Reliability- Definition of a simple system, Reliability Evaluation of a system, Reliability of a Series system, Reliability of a Parallel System, Reliability of a mixed system	13-18
III	Definition of Redundancy, Fully Redundant system and partially Redundant system, Active Redundancy and standby Redundancy, Reliability of k out of n system, Reliability of Standby systems, Standby system with perfect switching, Standby system with imperfect switching	14-20
IV	Definition of a complex system, Decomposition Method, Minimal path set and cut set method, cut set method, Tie set method, Life distributions, exponential, Gamma, Weibull and Log Normal models, Linearly increasing Hazard model	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. Ravichandran N 1990. Stochastic Methods in Reliability Theory. New Age.
6. Sinha SK. 1986. Reliability and Life Testing. Wiley Eastern Ltd.

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 passed all Theory papers up to VIII semester.

Semester-IX

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-18)–Bayesian 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: Bayesian Inference	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VIII semester.	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: IX** **Paper: DSE-18**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-	**Course Title: Bayesian Inference**	

Course outcomes:

After completing this course a student will have:

- ✓ Treat "evidence'' as value of observations and prescribe methods to deal rationally with it.
- ✓ Equip students with skills to carry out and interpret posterior and preposterior data based modeling and analyses.
- ✓ Compute probability that the theory in question could produce the observed data.
- ✓ Examine some simple Bayesian models and linear regression in a Bayesian framework.

Credits: 5		Compulsory
Max. Marks: 25+75		Minimum Passing Marks: ….
Unit	**Topic**	**No. of Hours**
I	Review of Basic Probability Concepts. Comparing Likelihood and Bayesian Approaches, Concept of Inverse Probability and Bayes Theorem. Classes of Prior Distributions. Conjugate Families for One Parameter Exponential Family Models, Models admitting sufficient statistics of fixed dimension.	15-20
II	Generalized Maximum Likelihood Estimate. Type of Loss Functions. Bayes estimation under various loss functions. Posterior Risk. Bayesian interval estimation: Credible intervals, HPD intervals, Comparison with classical confidence intervals. Situation specific case studies to conduct posterior analysis.	13-18
III	Prior and posterior odds. Bayes factor. Lindley's Paradox. Various types of testing hypothesis problems.	15-18
IV	Predictive density function, Regression Models	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. **Sinha Sk 1998**. Bayesian Estimation. New Age International.
6. **Winkler.** Introduction To Bayesian Inference
7. **Lee, P.** M. (1997). Bayesian Statistics: An Introduction, Arnold Press.
8. **Robert, C.**P. (2001) . The bayesian Choice: A Decision Theoretic Motivation, 2nd ed Springer Verlag.

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 passed all Theory papers up to VIII semester.

Semester-IX

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-19)–Time Series 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		
DSC: Time Series Analysis	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VIII semester.	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: IX** **Paper: DSE-19**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-	**Course Title: Time Series Analysis**	
Course outcomes: After completing this course a student will have: ✓ Ability to understand the Linear Stationary models. ✓ Ability to understand the Moving Average and mixed processes. ✓ Ability to understand the Forecasting. ✓ Ability to understand the Model identification techniques.		

Credits: 5	Compulsory
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Definition of Time series and its components, Measurement of Irregular component- Variate difference method, Harmonic Analysis, Autocorrelation and partial autocorrelation functions, Periodogram and Correlogram Analysis.	15-20
II	Linear Stationary models: Auto regressive, Moving Average and mixed processes, Linear non Stationary models, Auto regressive integrated moving average processes	13-18
III	Forecasting: Minimum mean square forecast and their properties, calculating and updating forecast.	15-18
IV	Model identification: techniques and objectives, initial estimates, Model estimation: Likelihood function, sum of squares function, Least square estimates, Seasonal models, Intervention analysis models and Out lierdetection	15-20

Suggested Readings:

1. Fundamentals of Applied 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. BarnettV&Lewis'1'.1984.OutliersinStatisticalData.JohnWiley.
6. Box GEP, Jenkins GM & Reinsel GC. 2007. Time Series Analysis: ForecastingandControl.3"1Ed.PearsonEdu
7. Douglas Montgomery. 2003. Introduction to Time Series Analysis and Forecasting. Wiley
8. RobertHShumway.2000.TimeSeriesAnalysisandit'sApplications.Springer

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 passed all Theory papers up to VIII th semester.

Semester-IX

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-21/GE-3)–Bio Informatics

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: Bio Informatics	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to VIII semester.	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: IX Paper: DSE-21/ GE-3**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:- DSE-21/GE-3	**Course Title: Bio Informatics**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the Basic Biology.
- ✓ Ability to understand the Computing techniques.
- ✓ Ability to understand the Tools for Bioinformatics.
- ✓ Ability to understand the Multiple alignment and data base search using motif models.

Credits: 5	Compulsory
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Basic Biology: Cell, genes , gene structure, gene expression and regulation, Molecular tools, nucleotides, nucleic acid, markers , proteins and enzymes, bioenergetics, single nucleotide polymorphism, expressed sequence tag, Structural and functional Genomics, Organization and structure of genomes, assembling of physical maps, strategies and techniques for genome sequencing and analysis	15-20
II	Computing techniques: OS and programming languages, - Linux, pert, biioperl, cgi, My SQL, php My Admin: Coding for browsing Biological tables on the web, parsing and annotation of genomic sequences, Data base designing, Computer Networks: Internet, World wide Web, Web, browsers EMB net, NCBI, Database on public domain pertaining to Nucleic acid sequences, protein sequences, SNP setc, Searching sequence databases, Structural databases.	12-18
III	**Tools for Bioinformatics:** DNA Sequence Analysis- Features of DNA Sequence Analysis, Approaches to EST analysis, Pair wise alignment techniques, Comparing two sequences, PAM and BLOSUM, Global Alignment (The Needleman and Wunsch algorithms)Local alignment(The Smith-Waterman Algorithm), Dynamic Programming, Pair wise database searching, Sequence Analysis- BLAST and other related tools	15-20
IV	Multiple alignment and database search using motif models, ClustalW,Phylogeny,DatabasesonSNPs,EMalgorithmsandothermethodsto discover common motifs in bio sequences, Gene production based on Neural Networks, Genetic Algorithms, Hidden Markov models, Computational analysis of protein sequences, structure and function, Design and Analysis of microarray experiments.	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. BaldiP&BrunakS.2001.Bioinformatics:The Machine Learning Approach.
6. 201Ed.(Adaptive Computation and Machine Learning). MIT Press.
7. Baxevanis AD & Francis BF. (Eds.). 2004.

8. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley.
9. BergeronBP.2002.BioInformaticsComputing.PrenticeHall.
10. EwensWJ&GrantGR.2001.StatisticalMethodsinBioinformatics:An Introduction(Statistics for Biology and Health). Springer.
11. JonesNC&PevznerPA.2004.AnIntroductiontoBioinformaticsAlgorithms. MIT Press.
12. Krane DE & Raymer ML. 2002. Fundamental Concepts of Bioinformatics. Benjamin /Cummings. Tisdall JD. 2003. Beginning Perl for Bioinformatics. O'Reilly & Associates.
13. Wunschiers R. 2004. Computational Biology Unix/Linux, Data Processing and Programming. Springer.

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 passed all Theory papers up to VIII semester.

Programme/Class: **Master of Science**	Year: **V**	Semester: **IX**
Subject: **STATISTICS (Practical)**		
Course Code:-	Course Title: **Practical**	

Course outcomes:
After completing this course a student will have:

- ❖ Perform PCA.
- ❖ Perform factor analysis.
- ❖ Perform discriminant analysis.
- ❖ Perform T^2 test and MANOVA.
- ❖ Perform MANOVA.
- ❖ Perform Canonical correlation analysis.
- ❖ Find the different Reliability functions of failure data.
- ❖ Finding the Reliability of series and parallel systems.
- ❖ Finding the Reliability of complex system.
- ❖ Corellogram analysis.
- ❖ Periodogram analysis.

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. ❖ Perform PCA. ❖ Perform factor analysis. ❖ Perform discriminant analysis.	**60**

	❖ Perform T^2 test and MANOVA. ❖ Perform MANOVA. ❖ Perform Canonical correlation analysis. ❖ Find the different Reliability functions of failure data. ❖ Finding the Reliability of series and parallel systems. ❖ Finding the Reliability of complex system. ❖ Corellogram analysis. ❖ Periodogram analysis.	
Suggested Readings: As suggested for Theory papers.		
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		**(10marks)**
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-X

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC COURSE (DSC-10)–Advanced Sampling Theory

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)
DSC: Advanced Sampling Theory	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to IX semester.	**Nil**

MASTER OF SCIENCE			
Programme/Class: Master of Science		**Year: V**	**Semester: X** **Paper: DSC-10**
Subject: STATISTICS			**Credits:3+1+0**
Course Code:-	**Course Title: Advanced Sampling Theory**		
Course outcomes: After completing this course a student will have: ✓ Ability to understand the sampling methods. ✓ Ability to understand the Probability sampling. ✓ Ability to understand the Stratified sampling and proportional and optimum allocation. ✓ Ability to understand the Ratio and regression method of estimation.			
Credits: 5		**Compulsory**	
Max. Marks: 25+75		Minimum Passing Marks: ….	

Unit	Topic	No. of Hours
I	Fundamentals of survey sampling, Probability sampling, purposive sampling. Advantages of sample survey over complete survey. Simple random sampling, with and without replacement.	15-20
II	Stratified sampling, proportional and optimum allocation. Systematic sampling, comparison with simple random sampling, linear trend, periodicity, circular systematic sampling.	13-18
III	Ratio and regression method of estimation. sampling with replacement and unequal probabilities, Estimation of mean and it's variance, Cluster Sampling: Estimates of mean and Variance for	14-20

	equal and unequal clusters, Efficiency in terms of Intra class correlation, Optimum unit of sampling.	
IV	Double sampling, Multistage sampling with special reference to two stage design, Non Sampling errors, problems of Non Response, errors of measurement, Interpenetrating sub-sampling, Sampling with varying probabilities with and without replacement, PPS sampling, Cumulative method and Lahiri's method of selection, Horvitz-Thompson estimator, Ordered and unordered estimators, Sampling strategies due to Midzuno-Sen, Sampford and Rao-Hartley-Cochran, inclusion probability proportional to size sampling, PPS systematic sampling, Multistage sampling with unequal probabilities.	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. Cochran WG. 1977. Sampling Techniques. John Wiley.
5. Murthy MN. 1977. Sampling Theory and Methods. 2nd Ed. Statistical Publ. Soc., Calcutta.
6. Mukhopadhyay P. 1998. Theory and Methods of Survey Sampling. Prentice Hall of India Pvt. Ltd., New Delhi.
7. Des Raj & Chandhok P. 1988. Sample Survey Theory. Narosa Publ. House.
8. Sukhatme PV, Sukhatme BV, Sukhatme S & Asok C. 1984. Sampling Theory of Surveys with Applications. Sampling Theory of Surveys with Applications. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.
9. Thompson SK. 2000. Sampling. John Wiley.

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 passed all Theory papers up to IX semester.

Semester-X

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-23)–Statistical Computing

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: Statistical Computing	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to IX semester.	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: X** **Paper: DSE-23**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-	**Course Title: Statistical Computing**	
Course outcomes: After completing this course a student will have: ✓ Ability to understand the Introduction to Statistical packages and computing. ✓ Ability to understand the Matrix computations in linear models. ✓ Ability to understand the Spatial Statistics. ✓ Ability to understand the Regression Analysis.		
Credits: 5	**Compulsory**	

Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Introduction to Statistical packages and computing, data types and structures, pattern recognition, classification, association rules, graphical methods, Data analysis principles and practice.	15-20
II	Matrix computations in linear models, Analysis of discrete data, Numerical linear algebra, Numerical optimization, graphical techniques, numerical approximations, numerical integration and Monte Carlo Methods.	15-18
III	Spatial Statistics, spatial sampling, hierarchical modeling. Analysis of cohort studies, case controlled studies and randomized clinical trials, techniques in the survival data and longitudinal studies, Approaches to handle missing data and meta analysis.	15-20
IV	Random number generators, Regression Analysis (both linear and non linear), ANOVA and ANCOVA, EML Algorithm, Gibbs Sampling, Some advanced statistical computing	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. Agresti A. 2002. Categorical Data Analysis. 2nd Ed. John Wiley.
6. 'Misted RA. 1998. Elements of Statistical Computing. Chapman & Hall.
7. Ross S. 2000. Introduction to Probability Models. Academic Press.
8. Rajaraman V. 1993. Computer Oriented Numerical Methods. Prentice-Hall.
9. Ilan J & Kamber M. 2000. Data Mining: Concepts and Techniques. Morgan. Packages: SPSS/R/Statistica/SYSTAT

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 passed all Theory papers up to IX th semester.

Semester-X

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-24)–Econometrics

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: Econometrics	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to IX semester.	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: X** **Paper: DSE-24**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-	**Course Title: Econometrics**	
Course outcomes: After completing this course a student will have:		

✓ Ability to understand the econometrics. ✓ Ability to understand the models and identification. ✓ Ability to understand the Simultaneous equations. ✓ Ability to understand the Identification Problems.	
Credits: 5	**Compulsory**
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Models and identification, meaning of Econometrics, formulation of economic phenomenon with specification analysis, Endogenous and Exogenous Variables.	15-20
II	Simultaneous equations, meaning of structure and model problems involved in construction of economic models, concept of Multicollinearity.	15-20
III	Identification Problems, rank and order condition of Identify ability, identification under bilinear restrictions, identify ability everywhere in the parametric space, WALA'S criterion of identification.	15-18
IV	Estimation: method of estimation, two stage and three stage least squares, K- class estimates with properties (Bias and Moment matrix), Maximum Likelihood estimators, full information and limited information maximum likelihood estimators ,Monte Carlo Studies.	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. Koop G. 2007. Introduction to Econometrics. John Wiley.
6. Maddala GS. 2001. Introduction to Econometrics. 3rd Ed. John Wiley.
7. Pindyck RS & Rubinfeld DL. 1998. Econometric Models and Economic Forecasts. 4`11 Ed. McGraw Hill.
8. Verbeek M. 2008. A Guide to modern Econometrics. 3rd Ed. John Wiley.
9. G. M. K Madnani. 2008. Introduction to Econometrics.8th Ed. Oxford and IBH

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 passed all Theory papers up to IX semester.

Semester-X

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-25)–Operation Research

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: Operation Research	**4**	**3**		**1**	To study this course, a student must have passed all Theory	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: X Paper: DSE-25**
Subject: STATISTICS		**Credits:3+1+0**
Course Code:-	**Course Title: Operation Research**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the operation research.
- ✓ Ability to understand the application operation research.
- ✓ Ability to understand the inventory control.
- ✓ Ability to understand the quelling theory.

Credits: 5	**Compulsory**
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	**Topic**	**No. of Hours**
I	Introduction, definition and scope of O.R., different types of Models, Simulation techniques and Monte-Carlo Methods, Linear programming: Mathematical formulation and Simplex Method of solutions.	15-20
II	Application to the allocation of resources and industry, Transportation and Assignment Techniques.	15-20
III	Inventory Control: Economic Lot Size formula of Harris in case of known Demand and its extension allowing shortages, the case of random demand, Discrete and continuous cases, Newspaper boy problems, Replacement of items that depreciate , that fail according to a probability law, Stuffing Problems.	15-18
IV	Quelling theory: The case of Poisson and exponential input, Erlangian general and regular service items, Queuing formulas and their use in determining the optimum service rate and number of channels, Machine repair problems.	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. Rustagi JS. 1994. Optimization Techniques in Statistics. Academic Press.
6. Taha HA. 2007. Operations Research: Introduction with CD. 811' Ed. Pearson Edu.

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 passed all Theory papers up to IX semester.

Semester-X

MASTER OF SCIENCE (STATISTICS)

DISCIPLINE SPECIFIC ELECTIVES (DSE-28/GE-4)–Actuarial Statistics

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: Actuarial Statistics	**4**	**3**		**1**	To study this course, a student must have passed all Theory papers up to IX semester.	**Nil**

MASTER OF SCIENCE		
Programme/Class: Master of Science	**Year: V**	**Semester: X Paper: DSE-28/ GE-4**

Subject: STATISTICS		Credits:3+1+0
Course Code:-	**Course Title: Actuarial Statistics**	

Course outcomes:

After completing this course a student will have:

- ✓ Ability to understand the Life tables and it's relation with survival function.
- ✓ Ability to understand the multiple life functions.
- ✓ Ability to understand the Insurance payable at the moment of death and at the end of the year of death-level benefits insurance.
- ✓ Ability to understand the Net premiums.

Credits: 5	Compulsory
Max. Marks: 25+75	Minimum Passing Marks: ….

Unit	Topic	No. of Hours
I	Insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality Life tables and it's relation with survival function, examples, assumptions for fractional ages, some analytical laws of morality, select and ultimate tables.	15-20
II	Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple numerical evaluation, central rate of multiple decrement Distribution of aggregate claims, compound Poisson Distribution and it's applications, Principles of compound interest, Nominal and effective rates of interest and discount, compound interest, accumulation factor, continuous compounding	15-20
III	Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions, Life annuities, single payment, continuous life annuities, discrete life annuities, life annuities with monthly payment, commutation functions, varying annuities, recursions , complete annuities-intermediate and apportionable annuities-due.	15-18
IV	Net premiums: Continuous and discrete premiums, true monthly payment premiums, accumulation type benefits, Net premium reserves, Continuous and discrete net premium reserve, reserves	15-20

	on a semi continuous basis, reserves based on true monthly premium, reserves on an apportionable or discounted continuous basis, reserves at fractional durations, allocation of loss to policy years, recursive formulas and differential equations for reserves, commutation functions.	

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

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 passed all Theory papers up to IX semester.

Programme/Class: **Master of Science**	Year: **V**	Semester: **X**
Subject: **STATISTICS (Practical)**		
Course Code:-	Course Title: **Practical**	

Course outcomes:

After completing this course a student will have:

- Find the estimate of mean and variance for Cluster sampling.
- Find the estimate of mean and variance for two stage sampling.
- Find the estimate of mean and variance for double sampling.
- Cumulative and Lahiri method of selecting varying probability sampling.
- Find the estimate of mean and variance for various varying probability sampling schemes.
- 2 SLS method.
- 3SLS method.
- Graphical method for LPP problems.
- Simplex method for LPP problems.
- Transportation problem.
- Assignment problem.

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 estimate of mean and variance for Cluster sampling. ❖ Find the estimate of mean and variance for two stage sampling. ❖ Find the estimate of mean and variance for double sampling. ❖ Cumulative and Lahiri method of selecting varying probability sampling. ❖ Find the estimate of mean and variance for various varying probability sampling schemes. ❖ 2 SLS method. ❖ 3SLS method. ❖ Graphical method for LPP problems. ❖ Simplex method for LPP problems. ❖ Transportation problem. ❖ Assignment problem.	**60**
Suggested Readings: As suggested for Theory papers.		
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:(40Marks) 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:		