Department of Statistics

H.N.B. Garhwal University, Srinagar Garhwal (Uttarakhand)
(A Central University)

Fourth Year (7th and 8th Semester) Bachelors Honours/ Honours with Research Programs along with P G Syllabus Under NEP Framework

STATISTICS SYLLABUS
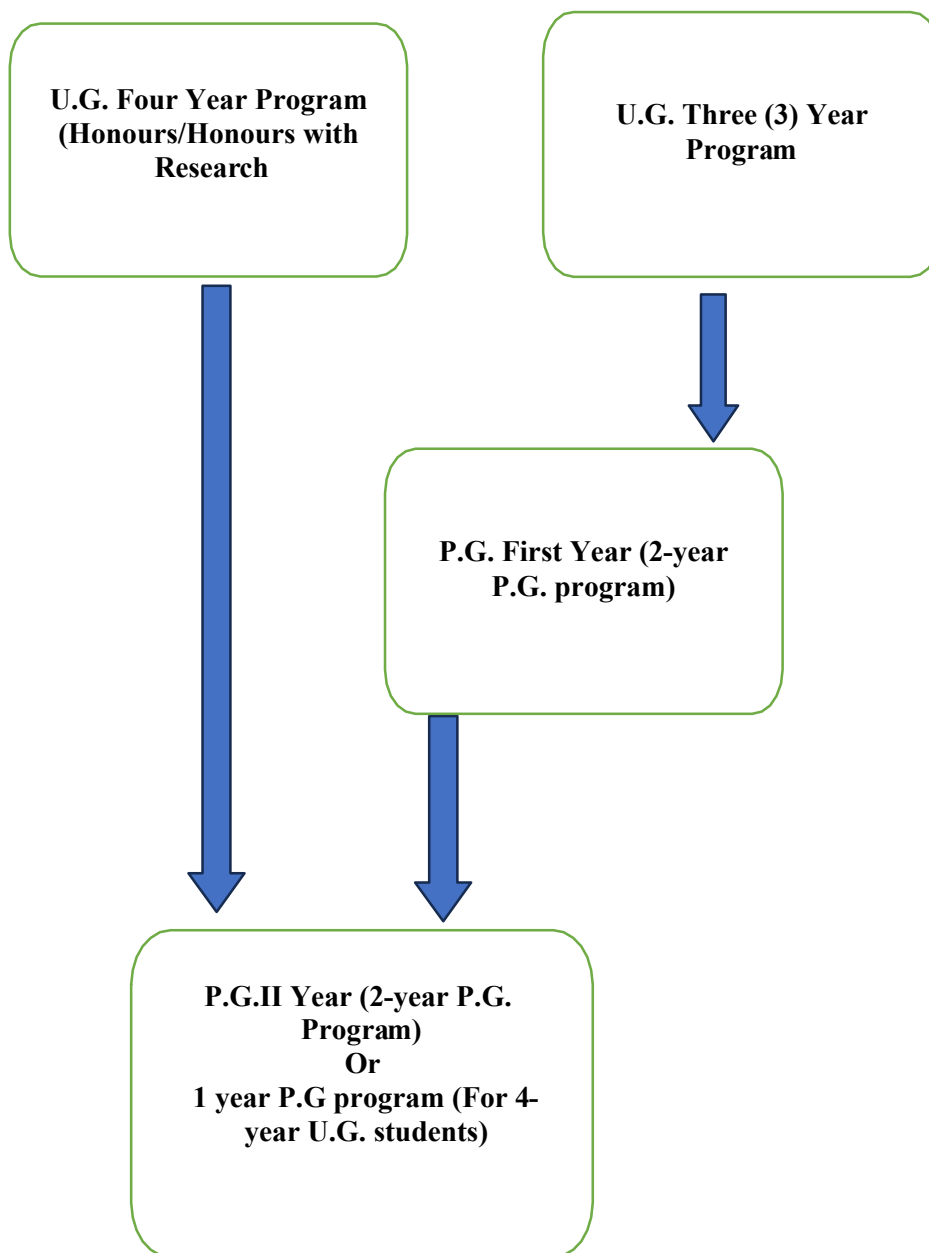

Academic Session 2025-26 Onwards

Fourth Year-(U.G. with Honours)

Entry requirement	(After completing requirements of a 3-year bachelor's degree (120 credits) and 2 additional credits under SSD, will be allowed to continue studies in the fourth year Of the under graduate programme leading to the four years bachelor's degree (with Honours).							
Course Type	**Semester-VII**				**Semester-VIII**			
	Subject/Title	No. of paper	Credits		Subject /Title	No. of paper	Credits	
			T	P			T	P
Core Major Subject (One)	Core Major -I *Measure Theory and Probability*	1	2	2	Core Major-I *Sample Surveys*	1	2	2
	Core Major –II *Statistical Inference*	1	2	2	Core Major–II *Advanced Operation Research*	1	2	2
	Core Major Elective–I *Numerical Analysis and Operations Research* *OR* *Matrices*	1	2	2	Core Major Elective–I *Block Designs and Their Analysis* *OR* *Official Statistics*	1	2	2
Core (Research based)	Basic Research Methods *Research Methodology*	1	2	-				
Core Minor Subject (One)	Core Minor –I *Measure Theory and Probability*	1	2	1	Core Minor–I *Sample Surveys*	1	3	1
	Core Minor Elective–I *Numerical Analysis* *OR* *Matrices*	1	2	1	Core Minor Elective–I *Block Designs and Their Analysis* *OR* *Official Statistics*	1	3	1
Total		5	12	8		5	12	8
Student on exit after successfully completing four years (i.e., securing minimum required 160 credits along with securing additional 2 credits under SSD course work) will be awarded "Four Years Bachelor's Degree (Honours)", in related field/ discipline/subject								

Fourth year (U.G. Honours with Research)

Entry requirement	(After completing requirements of a 3-year bachelor's degree (120 credits) and 2 additional credits under SSD, candidates who meet a minimum CGPA of 7.5 will be allowed to continue studies in the fourth year of the under graduate programme Leading to the four years bachelor's degree (Honours with Research).							

Course Type	Semester-VII				Semester-VIII			
	Subject/Title	No. of paper	Credits		Subject /Title	No. of paper	Credits	
			T	P			T	P
Core	**Core-I** *Measure Theory and Probability*	1	2	2	**Core-I** *Sample Surveys*	1	2	2
Subject (One)	**Core-II** *Statistical Inference*	1	2	2				
	Core Elective-I *Numerical Analysis and Operations Research* **OR** *Matrices*	1	2	2	**Core Elective-I** *Advanced Operation Research* **OR** *Block Designs and Their Analysis* **OR** *Official Statistics*	1	2	2
Core Course (Research Based)	*Research Methodology*	1	6		*Dissertation*	1	12	--
	Research Writing & Ethics	1	2		--	--	--	--
Total		5	14	6		3	16	4

Student on exit after successfully completing four years (i.e., securing minimum required 160 Credits along with securing additional 2 credits under SSD coursework) will be awarded "Four years Bachelor's Degree "Honours with Research", in related field/discipline/subject

Post Graduate Program

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┌────────────────────────────┐        ┌────────────────────────────┐
│   U.G. Four Year Program   │        │   U.G. Three (3) Year      │
│  (Honours/Honours with     │        │        Program             │
│        Research            │        │                            │
└────────────┬───────────────┘        └─────────────┬──────────────┘
             │                                       │
             │                                       ▼
             │                        ┌────────────────────────────┐
             │                        │   P.G. First Year (2-year  │
             │                        │        P.G. program)       │
             │                        └─────────────┬──────────────┘
             │                                      │
             ▼                                      ▼
        ┌──────────────────────────────────────────────┐
        │     P.G.II Year (2-year P.G. Program)         │
        │                   Or                          │
        │   1 year P.G program (For 4-year U.G.         │
        │              students)                        │
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In the following pages the P.G. program framework is enclosed

P.G. First Year- First Semester (for Two-year P.G. program)

Entry requirement	3-year bachelor's degree (120 credits), and candidates who have met the entrance requirements, including specified levels of attainment, in the programme admission regulations.				
Semester	**Course category**	**Course title**	**Credits**		**Total Credit**
			T	**P**	
I	**Core**	Core-1 *Measure Theory and Probability*	4	-	4
		Core-2 *Numerical Analysis and O R*	-	4	4
		Core-3 *Statistical Inference*	4	-	4
		Core-4 *Matrices*	-	4	4
	Elective (Any 2 outofMinimum 5 electives)	Elective-1 1. *Real Analysis and Complex Analysis* 2. *Linear Algebra* 3. *Distribution Theory* 4. *Decision Theory and Bayesian Analysis* 5. *Actuarial Statistics*	2	2	4
Total			**10**	**10**	**20**

P.G. (First Year)- Second Semester (for Two-year P.G. program)

Semester	Course category	Course title	Credits		Total Credit
			T	**P**	
II	**Core**	Core-1 *Sample Surveys*	4	-	4
		Core-2 *Block Designs and Their Analysis*	-	4	4
		Core-3 *Official Statistics*	4	-	4
		Core-4 *Advanced Operations Research*	-	4	4
	Elective (Any 2 outofMinimum 5 electives)	Elective-1 1. *Linear Models and Regression Analysis* 2. *Reliability Theory* 3. *Statistical Methodology and Data Mining* 4. *Bio Statistics* 5. *Statistical Quality Control and Educational Statistics*	2	2	4
Total			**10**	**10**	**20**

P.G. Second Year (for Two year P.G. program) And

1 year P.G. program for (4 year U.G. passed students)

P.G. (Second Year)-

➢ **Third semester (For two year program-** *P.G. first year passed students)*
➢ **First semester (For one year program-** *U.G. 4 years passed students)*

Entry requirement	4-year bachelor's degree (160credits), and candidates who have met the entrance requirements, including specified levels of attainment, in the programme admission regulations Or P.G. First year with 40credits				
Semester	**Course category**	**Course title**	**Credits**		**Total Credit**
			T	**P**	
III/I	**Core**	Core-1 *Multivariate Analysis and Curve Fitting*	4	-	4
		Core-2 *Non parametric and Semi parametric Methods*	4	-	4
		Core-3 *Advanced Statistical Analysis Using SPSS*	-	4	4
	Elective* (Any 2 outofMinimum6 electives)	Elective-1 1. *Factorial Experiments and Response Surfaces* 2. *Survival Analysis* 3. *Applied Regression Analysis*	4	-	4
		Elective-2 1. *Demography* 2. *Time Series Analysis* 3. *Computer Intensive Statistical Methods*	-	4	4
Total			**12**	**8**	**20**

Note: * Students not opting Electives (02) in 3rd semester will have to pursue 8 credits research-based study / Dissertation.

P.G. (Second Year)-

- ➢ **Fourth Semester (For two-year program)**
- ➢ **Second Semester(For one year program)**

Semester	Course category	Course title	Credits		Total Credit
			T	P	
IV/II	**Core**	**Core-1** *Econometrics*	4	-	4
		Core-2 *Stochastic Processes*	4	-	4
		Core-3 *Data Analysis Using R*	-	4	4
	Elective (Any 2 outofMinimum5 electives)	Elective-1 1. *Financial Statistics* 2. *Ethics, Integrity and Aptitude*	4	-	4
		Elective-2 1. *Data Analysis Using STATA* 2. *Qualitative Data Analysis* 3. *Project Work*	-	4	4
Total			12	8	20

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The course contents (The Detailed Syllabus) of different papers are as follows:

Fourth Year- (U.G. With Honours) - VII Semester

Programme/Class: U.G. with Honours		Year: Fourth	Semester: VII
Subject: STATISTICS			
Course Title: **Measure Theory and Probability**			
Credits:	T- 2	P-2	Core: **Core Major I**

Course Outcome:
The aim of the course is to pay a special attention to applicantions of measure theory in the probability theory and the Central Limit Theorem with their applications. To understand the concepts of random variables, sigma-fields generated by random variables, probability distributions and independence of random variables related to measurable functions. To gain the ability to understand the concepts of measurable functions, sequence of random variables, convergence, modes of convergence. To learn the concepts of weak and strong laws of large numbers and central limit theorem.

Syllabus

Measure and integration: Classes of sets, field, sigma fields, minimal sigma fields, Borel sigma fields, Limsup and liminf of a sets, Measure, Probability measure, properties of a measure, Lebesgue and Lebesgue- Steljes measures, measurable functions.

Probability: Baye's theorem. Random variable. Marginal and conditional distributions, Expectation. Tehebycheffs inequality and improvements on it, convergence in probability. The weak law of large numbers Bernoulli's theorem. Convergence in distribution continuity theorem. Khinchin's theorem. Strong law of large numbers Kologorov's theorem, Borel zero-one law, Borel-Cantelli lemma.

Central limit theorem-Lindberg Levy's and Liapouneff forms.

Books Recommended:

1. Goon Gupta and Das Gupta: An outline of Statistical theory, World Press Calcutta, Vol. 1. 6
2. Rohtagi, V.K. and Saleh A.K. (2005): Probability Theory, John Wiley.
3. B.R. Bhat(1985): Modern Probability Theory.
4. Basu, A.K. (2001): Probability and Measure theory, Narosa Pub.

Programme/Class: U.G. with Honours			Year: Fourth	Semester: VII
Subject: STATISTICS				
Course Title: **Statistical Inference**				
Credits:	T- 2	P-2	Core: **Core Major II**	
Course Outcome: To make aware the students about parametric, non-parametric and sequential estimation (point, as well as, interval) and testing (simple, as well as, composite hypotheses) procedures. To apply various estimation techniques and testing procedures to deal with real life problems. To understand consistency, CAN estimator, MLE. Understand UMPU tests UMVU estimators.				
Syllabus				
Problem of point estimation: Unbiasedness, Consistency, Sufficiency, Efficiency, Complete statistics, Complete Sufficient statistics. Factorization theorem, Exponential family of distributions and its properties, Minimum-variance unbiased estimators, Rao Blackwell theorem. Lehmann Schefe'stheorm, Cramer-Rao Inequality. Method of estimation- Method of Maximum Likelihood and its properties. Interval estimation, Interval Estimation: Confidence Region, shortest confidence intervals, General method of finding confidence interval. Method of obtaining confidence intervals based on small and large samples, Relationship with the testing of hypothesis. Testing of hypothesis: Basic concept, Simple and composite hypothesis, Two types of error, power of the test , Neyman-Pearson lemma and its generalization, Types A, A1 critical regions, Construction of most powerful test, Uniformly most powerful tests, Uniformly most powerful Unbiased test using N P lemma, likelihood ratio test and its properties. General decision problem: Basic concept of loss function, risk function, Minimax and Bays rule.				
Books Recommended:				
1. Lehmann, E.L.(1986): Theory of Point Estimation, Student Edition. 2. Zacks, S. (1971): Theory of Statistical Inference, Wiley, New York. 3. Rao, C.R. (1973): Linear Statistical Inference and its applications, 2nd edition, John wiley and sons. 4. Kale, B.K. (1999): A First course on Parametric Inference, Narosa Publishing House. 5. Goon, A.M., M.K. Gupta, & B. Das Gupta: Outline of Statistics, Vol-II.				

Programme/Class: U.G. with Honours			Year: Fourth	Semester: VII

Subject: STATISTICS

Course Title: **Numerical Analysis and Operation Research**

Credits:	T- 2	P-2	Core: **Core Major Elective I**

Course Outcome:

To acquire the knowledge of Numerical Integration, Knowledge of interpolation and extrapolation, An idea about the historical background and need of Operations research, Ability to identify and develop operational research models from the verbal description of the real life problems, Knowledge of the mathematical tools that are needed to solve optimization problems, Ability of solving Linear programming problem, Transportation and Assignment problems etc.

Syllabus

Calculus of finite differences, operators, separation of symbols, examples and problems. Interpolation formulas with remainder term. Newton's forward and backward formulae. Central difference formulae, Newton's divided difference formulae for interpolation. Lagrange's interpolation formulae.

Numerical Integration: Derivation of general quadrature formula for equidistant ordinates. Derivation of trapezoidal, Simpson's 1\3 rd and 3\8 th rules. Weddle's rule.

General linear programming problems and their formulations, Method for solving LPP: Graphical Method, Simplex method, Big – M method, Two phase Method, Duality in LPP (introduction only).

Transportation problem, Methods for obtaining IBFS: North-west corner rule, Least cost method, Vogel's approximation method, Methods for determining optimum solution: Stepping stone method, Method of Multipliers (MODI Method). Assignment Problem, Hungarian Algorithm.

Books Recommended:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.

2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata

3. Swarup, K., Gupta P.K. and Man Mohan (2007). Operations Research (13th ed.), Sultan Chand & Sons.

4. Taha, H.A. (2007). Operations Research: An Introduction, 8 thed., Prentice Hall of India.

5. Hadley, G: (2002) : Linear Programming, Narosa Publications

6. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, 9th Edition, Tata McGraw Hill.

Programme/Class: U.G. with Honours			Year: Fourth	Semester: VII
Subject: STATISTICS				
Course Title: **Matrices**				
Credits:	T- 2	P-2	Core: **Core Major Elective I**	
Course Outcome: To acquire the knowledge of Matrices, determinants and their operations and their properties, solutions and applications.				
Syllabus				

Different type of matrices, algebra of matrices, row and column spaces of a matrix, elementary matrices,

Determinant, singular and non-singular matrices, adjoint of matrix,

Rank and inverse of matrix,

Portioned matrices and Kroneker product,

Canonical form, Hermit canonical form, diagonal form, triangular form, Jordan form, quadratic form,

Generalized inverse, Moore-Penrose generalized inverse, idempotent matrices.

Characteristic roots and vectors, algebraic multiplicity of characteristic roots,

Caley Hamilton theorem, spectral decomposition of real symmetric matrix,

Positive, semi positive, negative and semi negative definite matrices, similar matrices,

Derivative of determinant

Books Recommended:

1. Biswas, S, (1984): Topics in Algebra of matrices, Academic Publications.
2. Shanti Narain: A text books of matrices, S. Chand and Company (Pvt) Ltd.
3. Frank Ayres , JR: Schaum's outline series Theory and problems.
4. A.I. Kostrikin, Introduction to Algebra, Springer Verlag, 1984.
5. S. H. Friedberg, A. L. Insel and L. E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
6. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.

Programme/Class: U.G. with Honours	Year: Fourth	Semester: VII

Subject: STATISTICS		
Course Title: **Research Methodology**		
Credits:	T- 2	Core: **Core Research Based**

Course Outcome:

A solid foundation in Statistical Theory and Methodology, will be able to communicate the major tenets of statistics, explain their work orally and identify areas of future research areas.

Syllabus

Foundations of Research: Meaning, Objectives, Motivation, Utility. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Analysis of Literature review – Primary and Secondary Sources, Web sources –critical Literature Review. Development of Working Hypothesis, Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, Deductive Inductive, pattern of Deductive –Inductive logical process – Different types of inductive logical methods. Research methods vs. Methodology.

Research design: Meaning, Need, Features of Good Design and Concepts. Research Design types. Selection of appropriate method for data collection, Case Study, Focus Group Discussion, Techniques of developing research tools, viz. Questionnaire and rating scales etc. Reliability and validity of Research tools. Sample size determination.

Preparation of Project Proposal, Title, Abstract, Introduction, Rationale, Objectives, Methodology, Time frame and work plan, Budget and Justification, References. Ethical Issues, Ethical Committees, Commercialization, copy right, royalty, Intellectual Property rights and patent law, Track Related aspects of intellectual property Rights, Reproduction of published material, Plagiarism, Citation and Acknowledgement, Reproducibility and accountability.

Meaning of Interpretation, Technique of Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation. Writing Research Project Report: Format and style. Review of related literature its implications at various stages of research. (Formulation of research problem, hypothesis, interpretation and discussion of results). Major findings, Conclusions and suggestions. Citation of references and Bibliography.

Books Recommended:

1. Garg. B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Vol 2, Ess Publication.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

Programme/Class: U.G. with Honours	Year: Fourth	Semester: VII
Subject: STATISTICS		
Course Title: **Measure Theory and Probability**		
Credits:	T- 2	P-1	Core: **Core Minor I**

Course Outcome:

The aim of the course is to pay a special attention to applications of measure theory in the probability theory and the Central Limit Theorem with their applications. To understand the concepts of random variables, sigma-fields generated by random variables, probability distributions and independence of random variables related to measurable functions. To gain the ability to understand the concepts of measurable functions, sequence of random variables, convergence, modes of convergence. To learn the concepts of weak and strong laws of large numbers and central limit theorem.

Syllabus

Measure and integration: Classes of sets, field, sigma fields, minimal sigma fields, Borel sigma fields, Limsup and liminf of a sets, Measure, Probability measure, properties of a measure, Lebesgue and Lebesgue- Steljes measures, measurable functions.

Probability: Baye's theorem. Random variable. Marginal and conditional distributions, Expectation. Tehebycheffs inequality and improvements on it, convergence in probability. The weak law of large numbers Bernoulli's theorem. Convergence in distribution continuity theorem. Khinchin's theorem. Strong law of large numbers Kologorov's theorem, Borel zero-one law, Borel-Cantelli lemma.

Central limit theorem-Lindberg Levy's and Liapouneff forms (Without Proofs)

Books Recommended:

1. Goon Gupta and Das Gupta: An outline of Statistical theory, World Press Calcutta, Vol. 1. 6
2. Rohtagi, V.K. and Saleh A.K. (2005): Probability Theory, John Wiley.
3. B.R. Bhat(1985): Modern Probability Theory.
4. Basu, A.K. (2001): Probability and Measure theory, Narosa Pub.

Programme/Class: U.G. with Honours		Year: Fourth	Semester: VII
Subject: STATISTICS			
Course Title: **Numerical Analysis and Operation Research**			
Credits:	T- 2	P-1	Core: **Core Minor Elective I**

Course Outcome:

To acquire the knowledge of Numerical Integration, Knowledge of interpolation and extrapolation, An idea about the historical background and need of Operations research, Ability to identify and develop operational research models from the verbal description of the real life problems, Knowledge of the mathematical tools that are needed to solve optimization problems, Ability of solving Linear programming problem, Transportation and Assignment problems etc.

Syllabus

Calculus of finite differences, operators, separation of symbols, examples and problems. Interpolation formulas with remainder term. Newton's forward and backward formulae. Central difference formulae, Newton's divided difference formulae for interpolation. Lagrange's interpolation formulae.

Numerical Integration: Derivation of general quadrature formula for equidistant ordinates. Derivation of trapezoidal, Simpson's 1\3 rd and 3\8 th rules. Weddle's rule.

General linear programming problems and their formulations, Method for solving LPP: Graphical Method, Simplex method, Big – M method, Two phase Method, Duality in LPP (introduction only).

Transportation problem, Methods for obtaining IBFS: North-west corner rule, Least cost method, Vogel's approximation method, Methods for determining optimum solution. Assignment Problem.

Books Recommended:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata
3. Swarup, K., Gupta P.K. and Man Mohan (2007). Operations Research (13th ed.), Sultan Chand & Sons.
4. Taha, H.A. (2007). Operations Research: An Introduction, 8 thed., Prentice Hall of India.
5. Hadley, G: (2002) : Linear Programming, Narosa Publications
6. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, 9th Edition, Tata McGraw Hill.

Programme/Class: U.G. with Honours	Year: Fourth	Semester: VII
Subject: STATISTICS		
Course Title: **Matrices**		
Credits:	T- 2	P-1	Core: **Core Minor Elective I**		

Course Outcome: To acquire the knowledge of Matrices, determinants and their operations and their properties, solutions and applications.

Syllabus

Different type of matrices, algebra of matrices, row and column spaces of a matrix,

Elementary matrices,

Determinant,

Singular and non-singular matrices, adjoint of matrix,

Rank and inverse of matrix, portioned matrices and Kroneker product.

Canonical form, Hermit canonical form, diagonal form, triangular form, Jordan form, quadratic form,

Generalized inverse, Moore-Penrose generalized inverse, idempotent matrices.

Characteristic roots and vectors, algebraic multiplicity of characteristic roots, Caley Hamilton theorem.

Books Recommended:

1. Biswas, S, (1984): Topics in Algebra of matrices, Academic Publications.
2. Shanti Narain: A text books of matrices, S. Chand and Company (Pvt) Ltd.
3. Frank Ayres , JR: Schaum's outline series Theory and problems.
4. A.I. Kostrikin, Introduction to Algebra, Springer Verlag, 1984.
5. S. H. Friedberg, A. L. Insel and L. E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
6. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.

Fourth Year- (U.G. With Honours) - VIII Semester

Programme/Class: U.G. with Honours			Year: Fourth	Semester: VIII
Subject: STATISTICS				
Course Title: **Sample Surveys**				
Credits:	T- 2	P-2	Core: **Core Major I**	
Course Outcome: The main objective of this course is to learn techniques in survey sampling with practical applications in daily life which would be beneficial for the students to their further research.				
Syllabus				
Basic Principles: Census and sample surveys, advantages and disadvantages of sample surveys. Basic principles in sampling, survey enquiries, choice of sampling units, problems of sample size, Bias in selection and estimation, simple random sampling, sampling from finite populations with and without replacement, sampling of attributes, unbiased estimates of population total, mean and estimation of their variances. Stratified Sampling: Reason for stratification, choice of strata, choice of sampling unit, stratified random sampling, estimation of population mean and its variance, choice of sample sizes in different strata, variances of estimates with different allocation, effects of deviation from optimum allocation, estimation of the gain in precision due to stratification, cost function, construction of strata. Systematic Sampling: Estimation of sample mean and its variance, comparison of systematic sampling with simple random and stratified sampling. Ratio and Regression Estimation: Ratio and regression methods of estimation, variances of the estimates, optimum property of ratio estimates, comparison among ratio and regression and simple and biased estimates. Cluster Sampling: Estimates of mean and its variance for equal and unequal clusters, efficiency in terms of intra-class correlation, optimum unit of sampling, sampling with replacement, estimation of mean and variance. Double Sampling: Multistage sampling with special reference to two stage design, Nonsampling errors, problems of non response, errors of measurements, Interpenetrating sub sampling. Randomized response techniques. Pilot survey. PPS Sampling schemes, sampling techniques with varying probabilities for simple random sampling. Herwits Thompson Estimators, Mid Zuno Sen Sampling Scheme.				
Books Recommended:				
1. Cochran W.G.: Sampling Techniques, Wiley Eastern Ltd., New Delhi. 2. Des Raj and Chandhok (1998): Sampling Theory, Narosa Publishing House. 3. Mukhopadhayay Parimal: Theory and Methods of Survey Sampling-Prentice Hall of India Ltd. 4. Kish L: Survey Sampling.				

Programme/Class: U.G. with Honours		Year: Fourth	Semester: VIII
Subject: STATISTICS			
Course Title: **Advanced Operation Research**			
Credits:	T- 2	P-2	Core: **Core Major II**
Course Outcome: To acquire the knowledge of Advanced Operations research, Dynamic Programming, Queuing Models, Non-Linear Programming, Inventory Control, Integer Programming, Sequencing and scheduling problems, Sensitivity analysis. Parametric programming and Replacement problems etc.			
Syllabus			
Dynamic Programming: Bellman's principle of optimality; general formulation of dynamic programming; computational methods and applications of dynamic programming. Queuing Models: Steady-state solutions of (M/M/1) and (M/M/C) models with associated distributions of queue length and waiting time; M/G/1. Non-Linear Programming: Kuhn-Tucker conditions; Wolfe's and Beale's algorithms for solving quadratic programming problems. Inventory Control- Economic lot Size, Formulae of Harris for known demand and its extension allowing shortage, Random demand: Discrete and Continuous case, Integer Programming: Branch and bound algorithm and cutting plane algorithm, Multicriterion and goal programming, Stochastic Programming; quantile rules, Two-stage programming; use of fractional programming, Sequencing and scheduling problems: 2 machines n-job and 3-machines n-job problems with identical machine sequence for all jobs; 2-job n-machine problem with different routing; branch and bound method for solving travelling-salesman problems, Sensitivity analysis. Parametric programming, Project management: CPM and PERT; probability of project completion; PERT-crashing, Replacement problems: block and age replacement policies; dynamic programming approach for maintenance problems; replacement of items with long life, Transient solution of M/M/1 queue; bulk queues(bulk arrival and bulk service); finite queues; queues in tandem; GI/G/1 queue and its solutions; simulation of queues.			
Books Recommended:			
1. Sharma, S.D.: Operation Research, Pragati Prakashan, Meerut. 2. Taha, H.A. (1982): Operations Research: An Introduction; MacMillan Publishing Company, New York. 3. Kanti Swaroop, Gupta, P.K. and Singh, M.M. (1985): Operations Research; Sultan Chand and Sons. 4. Hadley, G and Whitin, T.M. (1963): Analysis of Inventory System; Prentice Hall. 5. Shamblin, J.E. and Stevens, G.T. (1974): Operations Research: A Fundamental Approach; McGraw Hill 6. Kleinrock, L. (1975): Queuing Systems, Vol. I; John Wiley. 7. Starr, M.K. and Miller, D.W. (1962): Inventory Control-Theory and Practice; Prentice Hall.			

Programme/Class: U.G. with Honours		Year: Fourth	Semester: VIII
Subject: STATISTICS			
Course Title: **Block Design and Their Analysis**			
Credits:	T- 2	P-2	Core: **Core Major Elective I**
Course Outcome:			
This course provides the students the ability to understand the design and conduct experiments, as well as to analyze data and interpret the results.			
Syllabus			
Fixed, mixed and random effects models; Variance components estimation: study of various methods, Tests for variance components. General block design and its information matrix (C), criteria for connectedness, balance design and orthogonality: Intrablock analysis (estimability, best point estimates/Interval estimates of estimable linear parametric functions and testing of linear hypotheses). BIBD - recovery of interblock information, Youden design - intrablock analysis, Lattice Design, Split plot design. Analysis of covariance in a general Gauss-Markov model and its applications to standard designs, Missing plot technique - general theory and applications Finite group and finite field, Finite geometry: projective and Euclidean, Construction of complete set of mutually orthogonal latin square (mols), Construction of BIBD's using mols and finite geometries, Symmetrically repeated differences, Steiner Triples and their use in construction of BIBD.			
Books Recommended:			

1. Raghava Rao D. (1971) : Construction and Combinatorial problems in Design of experiment. Wiley
2. Aloke Dey (1986) : Theory of Block Designs, Wiley Eastern.
3. Das, M.N. & Giri, N.(1979): Design and Analysis of experiments, Wiley Eastern.
4. Giri, N. (1986) : Analysis of Variance, South Asian Publishers.
5. Rao, C.R. and Kleffe, J.(1988) : Estimation of Variance Components and applications, North Holland.
6. Searle, S.R., Casella, G. and McCulloch, C.E. (1992) : Variance Components, Wiley.
7. Nigam, Puri & Gupta (1987-88) : Characterisation and Analysis of Block Design, Wiley Eastern.
8. V.K. Gupta & A.K. Nigam (1978-79) : Handbook an analysis of Agriculture Experiment, IASRI Publication.

Programme/Class: U.G. with Honours	Year: Fourth	Semester: VIII
Subject: STATISTICS		
Course Title: **Official Statistics**		
Credits:	T- 2	P-2	Core: **Core Major Elective I**
Course Outcome:		

Course Outcome:

This paper will help to know about different dimensions and issues related to our country through data and images such as graphs and visuals. It will help to provide basic information for decision making, evaluation related to administrative issues and policy making.

Syllabus

Introduction to Indian and International Statistical systems.
Present Official Statistical System in India, role, functions and activates of central and state organization.
Organization of large scale sample surveys methods of collection of official statistics,
Role of National Sample Survey Organization.
General and special data dissemination systems,
Population growth in developed and developing countries,
Evaluation of performance of family welfare programs projection of labor force and manpower ,
Scope and content of population of census of India,
System of collection of agriculture Statistics,
Crop forecasting and estimation.
Support prices buffer stock, impact of irrigation projects,
Statistics related to industries,
Balance of payment, cost of living,
Educational and other Social Statistics.

Books Recommended:

1. Basic Statistics relating to Indian Economy (CSO) 1990.
2. Statistical system in India (CSO) 1975.
3. Guide to Official Statistics (CSO) 1999.
4. Principles and accommodation of National Populations Census. UNESCO.

Programme/Class: U.G. with Honours			Year: Fourth	Semester: VIII
Subject: STATISTICS				
Course Title: **Sample Surveys**				
Credits:	T- 3	P-1	Core: **Core Minor I**	
Course Outcome: The main objective of this course is to learn techniques in survey sampling with practical applications in daily life which would be beneficial for the students to their further research.				
Syllabus				
Basic Principles: Census and sample surveys, advantages and disadvantages of sample surveys. Basic principles in sampling, survey enquiries, choice of sampling units, problems of sample size, Bias in selection and estimation, simple random sampling, sampling from finite populations with and without replacement, sampling of attributes, unbiased estimates of population total, mean and estimation of their variances. Stratified Sampling: Reason for stratification, choice of strata, choice of sampling unit, stratified random sampling, estimation of population mean and its variance, choice of sample sizes in different strata, variances of estimates with different allocation, effects of deviation from optimum allocation, estimation of the gain in precision due to stratification, cost function, construction of strata. Systematic Sampling: Estimation of sample mean and its variance, comparison of systematic sampling with simple random and stratified sampling. Ratio and Regression Estimation: Ratio and regression methods of estimation, variances of the estimates, optimum property of ratio estimates, comparison among ratio and regression and simple and biased estimates. Cluster Sampling: Estimates of mean and its variance for equal and unequal clusters, efficiency in terms of intra-class correlation, optimum unit of sampling, sampling with replacement, estimation of mean and variance. Double Sampling: Multistage sampling with special reference to two stage design, Nonsampling errors,				
Books Recommended:				
1. Cochran W.G.: Sampling Techniques, Wiley Eastern Ltd., New Delhi. 2. Des Raj and Chandhok (1998): Sampling Theory, Narosa Publishing House. 3. Mukhopadhayay Parimal: Theory and Methods of Survey Sampling-Prentice Hall of India Ltd. 4. Kish L: Survey Sampling.				

Programme/Class: U.G. with Honours	Year: Fourth	Semester: VIII
Subject: STATISTICS		
Course Title: **Block Design and Their Analysis**		
Credits:	T- 3	P-1	Core: **Core Minor Elective I**
Course Outcome: This course provides the students the ability to understand the design and conduct experiments, as well as to analyze data and interpret the results.		
Syllabus		
Fixed, mixed and random effects models; Variance components estimation: study of various methods, Tests for variance components. General block design and its information matrix (C), criteria for connectedness, balance design and orthogonality: Intrablock analysis (estimability, best point estimates/Interval estimates of estimable linear parametric functions and testing of linear hypotheses). BIBD - recovery of interblock information, Youden design - intrablock analysis, Lattice Design, Split plot design. Analysis of covariance in a general Gauss-Markov model and its applications to standard designs, Missing plot technique, Construction of BIBD's, Steiner Triples and their use in construction of BIBD.		
Books Recommended:		

1. Raghava Rao D. (1971) : Construction and Combinatorial problems in Design of experiment. Wiley
2. Aloke Dey (1986) : Theory of Block Designs, Wiley Eastern.
3. Das, M.N. & Giri, N.(1979): Design and Analysis of experiments, Wiley Eastern.
4. Giri, N. (1986) : Analysis of Variance, South Asian Publishers.
5. Rao, C.R. and Kleffe, J.(1988) : Estimation of Variance Components and applications, North Holland.
6. Searle, S.R., Casella, G. and McCulloch, C.E. (1992) : Variance Components, Wiley.
7. Nigam, Puri & Gupta (1987-88) : Characterisation and Analysis of Block Design, Wiley Eastern.
8. V.K. Gupta & A.K. Nigam (1978-79) : Handbook an analysis of Agriculture Experiment, IASRI Publication.

Programme/Class: U.G. with Honours		Year: Fourth	Semester: VIII
Subject: STATISTICS			
Course Title: **Official Statistics**			
Credits:	T- 3	P-1	Core: **Core Minor Elective I**
Course Outcome: This paper will help to know about different dimensions and issues related to our country through data and images such as graphs and visuals. It will help to provide basic information for decision making, evaluation related to administrative issues and policy making.			
Syllabus			
Introduction to Indian and International Statistical systems. Present Official Statistical System in India, role, functions and activates of central and state organization. Organization of large scale sample surveys methods of collection of official statistics, Role of National Sample Survey Organization. General and special data dissemination systems, Population growth in developed and developing countries. Evaluation of performance of family welfare programs projection of labor force and manpower. Scope and content of population of census of India. System of collection of agriculture Statistics, Crop forecasting and estimation. Statistics related to industries, educational and other Social Statistics.			
Books Recommended:			
1. Basic Statistics relating to Indian Economy (CSO) 1990. 2. Statistical system in India (CSO) 1975. 3. Guide to Official Statistics (CSO) 1999. 4. Principles and accommodation of National Populations Census. UNESCO.			

Fourth Year- (U.G. Honours With Research) -VII Semester

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VII
Subject: STATISTICS		
Course Title: **Measure Theory and Probability**		
Credits:	T- 2	P-2	Core: **Core I**
Course Outcome: The aim of the course is to pay a special attention to applicant ions of measure theory in the probability theory and the Central Limit Theorem with their applications. To understand the concepts of random variables, sigma-fields generated by random variables, probability distributions and independence of random variables related to measurable functions. To gain the ability to understand the concepts of measurable functions, sequence of random variables, convergence, modes of convergence. To learn the concepts of weak and strong laws of large numbers and central limit theorem.			
Syllabus			
Measure and integration: Classes of sets, field, sigma fields, minimal sigma fields, Borel sigma fields, Limsup and liminf of a sets, Measure, Probability measure, properties of a measure, Lebesgue and Lebesgue- Steljes measures, measurable functions. Probability: Baye's theorem. Random variable. Marginal and conditional distributions, Expectation. Tehebycheffs inequality and improvements on it, convergence in probability. The weak law of large numbers Bernoulli's theorem. Convergence in distribution continuity theorem. Khinchin's theorem. Strong law of large numbers Kologorov's theorem, Borel zero-one law, Borel-Cantelli lemma. Central limit theorem-Lindberg Levy's and Liapouneff forms.			
Books Recommended:			
1. Goon Gupta and Das Gupta: An outline of Statistical theory, World Press Calcutta, Vol. 1. 6 2. Rohtagi, V.K. and Saleh A.K. (2005): Probability Theory, John Wiley. 3. B.R. Bhat(1985): Modern Probability Theory. 4. Basu, A.K. (2001): Probability and Measure theory, Narosa Pub.			

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VII
Subject: STATISTICS		

Course Title: **Statistical Inference**			

Credits:	T- 2	P-2	Core: **Core II**

Course Outcome:

To make aware the students of parametric, non-parametric and sequential estimation (point, as well as, interval) and testing (simple, as well as, composite hypotheses) procedures. To apply various estimation techniques and testing procedures to deal with real life problems. To understand consistency, CAN estimator, MLE. Understand UMPU tests UMVU estimators.

Syllabus

Problem of point estimation: Unbiasedness, Consistency, Sufficiency, Efficiency, Complete statistics, Complete Sufficient statistics. Factorization theorem, Exponential family of distributions and its properties, Minimum-variance unbiased estimators, Rao Blackwell theorem. Lehmann Schefe'stheorm, Cramer-Rao Inequality.

Method of estimation- Method of Maximum Likelihood and its properties.

Interval estimation, Interval Estimation: Confidence Region, shortest confidence intervals, General method of finding confidence interval. Method of obtaining confidence intervals based on small and large samples, Relationship with the testing of hypothesis.

Testing of hypothesis: Basic concept, Simple and composite hypothesis, Two types of error, power of the test , Neyman-Pearson lemma and its generalization, Types A, A1 critical regions, Construction of most powerful test, Uniformly most powerful tests, Uniformly most powerful Unbiased test using N P lemma, likelihood ratio test and its properties.

General decision problem: Basic concept of loss function, risk function, Minimax and Bays rule.

Books Recommended:

1. Lehmann, E.L.(1986): Theory of Point Estimation, Student Edition.
2. Zacks, S. (1971): Theory of Statistical Inference, Wiley, New York.
3. Rao, C.R. (1973): Linear Statistical Inference and its applications, 2nd edition, John wiley and sons.
4. Kale, B.K. (1999): A First course on Parametric Inference, Narosa Publishing House.
5. Goon, A.M., M.K. Gupta, & B. Das Gupta: Outline of Statistics, Vol-II.

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VII

Subject: STATISTICS

Course Title: **Numerical Analysis and Operation Research**

Credits:	T- 2	P-2	Core: **Core Elective I**

Course Outcome:

To acquire the knowledge of Numerical Integration, Knowledge of interpolation and extrapolation, An idea about the historical background and need of Operations research, Ability to identify and develop operational research models from the verbal description of the real life problems, Knowledge of the mathematical tools that are needed to solve optimization problems, Ability of solving Linear programming problem, Transportation and Assignment problems etc.

Syllabus

Calculus of finite differences, operators, separation of symbols, examples and problems. Interpolation formulas with remainder term. Newton's forward and backward formulae. Central difference formulae, Newton's divided difference formulae for interpolation. Lagrange's interpolation formulae.

Numerical Integration: Derivation of general quadrature formula for equidistant ordinates. Derivation of trapezoidal, Simpson's 1\3 rd and 3\8 th rules. Weddle's rule.

General linear programming problems and their formulations, Method for solving LPP: Graphical Method, Simplex method, Big – M method, Two phase Method, Duality in LPP (introduction only).

Transportation problem, Methods for obtaining IBFS: North-west corner rule, Least cost method, Vogel's approximation method, Methods for determining optimum solution: Stepping stone method, Method of Multipliers (MODI Method). Assignment Problem, Hungarian Algorithm.

Books Recommended:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata
3. Swarup, K., Gupta P.K. and Man Mohan (2007). Operations Research (13th ed.), Sultan Chand & Sons.
4. Taha, H.A. (2007). Operations Research: An Introduction, 8 thed., Prentice Hall of India.
5. Hadley, G: (2002) : Linear Programming, Narosa Publications
6. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research-Concepts and cases, 9th Edition, Tata McGraw Hill.

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VII

Subject: STATISTICS

Course Title: **Matrices**

Credits:	T- 2	P-2	Core: **Core Elective I**

Course Outcome:

To acquire the knowledge of Matrices, determinants and their operations and their properties, solutions and applications.

Syllabus

Different type of matrices, algebra of matrices, row and column spaces of a matrix,

Elementary matrices, determinant, singular and non-singular matrices, adjoint of matrix,

Rank and inverse of matrix,

Portioned matrices and Kroneker product.

Canonical form, Hermit canonical form, diagonal form, triangular form, Jordan form,

Quadratic form,

Generalized inverse, Moore-Penrose generalized inverse, idempotent matrices.

Characteristic roots and vectors, algebraic multiplicity of characteristic roots,

Caley Hamilton theorem, spectral decomposition of real symmetric matrix.

Positive, semi positive, negative and semi negative definite matrices, similar matrices,

Derivative of determinant

Books Recommended:

1. Biswas, S, (1984): Topics in Algebra of matrices, Academic Publications.
2. Shanti Narain: A text books of matrices, S. Chand and Company (Pvt) Ltd.
3. Frank Ayres , JR: Schaum's outline series Theory and problems.

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VII
Subject: STATISTICS		
Course Title: **Research Methodology**		
Credits:	T- 6	Core: **Core Course Research Based**

Course Outcome:

A solid foundation in Statistical Theory and Methodology, will be able to communicate the major tenets of statistics, explain their work orally and identify areas of future research areas.

Syllabus

Foundations of Research: Meaning, Objectives, Motivation, Utility. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Analysis of Literature review – Primary and Secondary Sources, Web sources –critical Literature Review. Development of Working Hypothesis, Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, DeductiveInductive, pattern of Deductive –Inductive logical process – Different types of inductive logical methods. Research methods vs. Methodology.

Research design: Meaning, Need, Features of Good Design and Concepts. Research Design types. Selection of appropriate method for data collection, Case Study, Focus Group Discussion, Techniques of developing research tools, viz. Questionnaire and rating scales etc. Reliability and validity of Research tools. Sample size determination.

Preparation of Project Proposal, Title, Abstract, Introduction, Rationale, Objectives, Methodology, Time frame and work plan, Budget and Justification, References. Ethical Issues, Ethical Committees, Commercialization, copy right, royalty, Intellectual Property rights and patent law, Track Related aspects of intellectual property Rights, Reproduction of published material, Plagiarism, Citation and Acknowledgement, Reproducibility and accountability.

Meaning of Interpretation, Technique of Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation. Writing Research Project Report: Format and style. Review of related literature its implications at various stages of research. (Formulation of research problem, hypothesis, interpretation and discussion of results). Major findings, Conclusions and suggestions. Citationof references and Bibliography.

Books Recommended:

1. Garg. B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Vol 2, Ess Publication.
3. Wadehra, B.L.2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

Programme/Class: U.G. Honours With Research		Year: Fourth	Semester: VII
Subject: STATISTICS			
Course Title: **Research Writing and Ethics**			
Credits:	T- 2		

Course Outcome:

The purpose of this course is to engage student researchers in reading and understanding the responsible code of conduct of scientific research. Research ethics include- knowing rules, issues, options, and resources for research ethics, to familiarize with various institutional ethics and to have a positive disposition towards continued learning about research ethics.

Syllabus

Scientific Research Writing and Conduct:

Elements of Research Ethics & Types of Research, Mixed Methods in Applied & Action Research, Authenticated Internet search, deep web search , Fake information , Research Integrity & Academic Honesty, Redundant Publications; Duplicate & Overlapping Publications, Selective Reporting and Misrepresentation of Data.

Publication Ethics & Best Practices:

Publication Ethics: Introduction, Definition, & Importance, Scientific Research Misconduct; Falsification, Fabrication & Plagiarism/Self-plagiarism, Kinds & Remedies iii. Intellectual Property; Reasonable & Fair Use; Copyright and related IPR Issues, Violation of Publication Ethics; Authorship/Co-authorship, Joint research/ Contributorship & Patentable Inventions- Extent of Rights & Claims, Best Practices/Standards Setting Initiatives and guidelines; COPE, WAME, UGC-CARE list etc., Publication Misconduct; Concept; Definition & Kinds of Problems & Unethical Behaviour, Identification of Publication Misconduct, Complaints & Appeal Provisions.

Books Recommended:

1. The Handbook of Social Research Ethics, Donna M. Mertens, Pauline E. Ginsberg, SAGE (2009).
2. What are Qualitative Research Ethics? Rose Wiles, Bloomsbury (2013).
3. Research Ethics: Cases and Materials, Robin Levin Penslar, eds, Indiana University Press (1995).
4. Research Ethics: A Philosophical Guide to the Responsible Conduct of Research, Gary Comstock, Cambridge University Press (2013)
5. Scientific Integrity and Research Ethics: An Approach from the Ethos of Science, David Koepsell, Springer (2017)
6. An Introduction to Ethical, Safety and Intellectual Property Rights Issues, Padma Nambisan, Elsvier (2017).

Fourth Year- (U.G. Honours With Research) -VIII Semester

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VIII
Subject: STATISTICS		
Course Title: **Sample Surveys**		
Credits:	T- 2	P-2	Core: **Core I**
Course Outcome: The main objective of this course is to learn techniques in survey sampling with practical applications in daily life which would be beneficial for the students to their further research.		
Syllabus		
Basic Principles: Census and sample surveys, advantages and disadvantages of sample surveys. Basic principles in sampling, survey enquiries, choice of sampling units, problems of sample size, Bias in selection and estimation, simple random sampling, sampling from finite populations with and without replacement, sampling of attributes, unbiased estimates of population total, mean and estimation of their variances. Stratified Sampling: Reason for stratification, choice of strata, choice of sampling unit, stratified random sampling, estimation of population mean and its variance, choice of sample sizes in different strata, variances of estimates with different allocation, effects of deviation from optimum allocation, estimation of the gain in precision due to stratification, cost function, construction of strata. Systematic Sampling: Estimation of sample mean and its variance, comparison of systematic sampling with simple random and stratified sampling. Ratio and Regression Estimation: Ratio and regression methods of estimation, variances of the estimates, optimum property of ratio estimates, comparison among ratio and regression and simple and biased estimates. Cluster Sampling: Estimates of mean and its variance for equal and unequal clusters, efficiency in terms of intra-class correlation, optimum unit of sampling, sampling with replacement, estimation of mean and variance. Double Sampling: Multistage sampling with special reference to two stage design, Nonsampling errors, problems of non response, errors of measurements, Interpenetrating sub sampling. Randomized response techniques. Pilot survey. PPS Sampling schemes, sampling techniques with varying probabilities for simple random sampling. Herwits Thompson Estimators, Mid Zuno Sen Sampling Scheme.		
Books Recommended:		
1. Cochran W.G.: Sampling Techniques, Wiley Eastern Ltd., New Delhi. 2. Des Raj and Chandhok (1998): Sampling Theory, Narosa Publishing House. 3. Mukhopadhayay Parimal: Theory and Methods of Survey Sampling-Prentice Hall of India Ltd. 4. Kish L: Survey Sampling.		

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VIII

Subject: STATISTICS		
Course Title: **Advanced Operation Research**		
Credits:	T- 2	P-2	Core: **Core Elective I**
Course Outcome: To acquire the knowledge of Advanced Operations research, Dynamic Programming, Queuing Models, Non-Linear Programming, Inventory Control, Integer Programming, Sequencing and scheduling problems, Sensitivity analysis. Parametric programming and Replacement problems etc.			
Syllabus			
Dynamic Programming: Bellman's principle of optimality; general formulation of dynamic programming; computational methods and applications of dynamic programming, Queuing Models: Steady-state solutions of (M/M/1) and (M/M/C) models with associated distributions of queue length and waiting time; M/G/1, Non-Linear Programming: Kuhn-Tucker conditions; Wolfe's and Beale's algorithms for solving quadratic programming problems, Inventory Control-Economic lot Size, Formulae of Harris for known demand and its extension allowing shortage, Random demand: Discrete and Continuous case, Integer Programming: Branch and bound algorithm and cutting plane algorithm. Multicriterion and goal programming, Stochastic Programming; quantile rules, Two-stage programming; use of fractional programming, Sequencing and scheduling problems: 2 machines n-job and 3-machines n-job problems with identical machine sequence for all jobs; 2-job n-machine problem with different routing; branch and bound method for solving travelling-salesman problems, Sensitivity analysis. Parametric programming, Project management: CPM and PERT; probability of project completion; PERT-crashing, Replacement problems: block and age replacement policies; dynamic programming approach for maintenance problems; replacement of items with long life,Transient solution of M/M/1 queue; bulk queues(bulk arrival and bulk service); finite queues; queues in tandem; GI/G/1 queue and its solutions; simulation of queues.			
Books Recommended:			
1. Sharma, S.D.: Operation Research, Pragati Prakashan, Meerut. 2. Taha, H.A. (1982): Operations Research: An Introduction; MacMillan Publishing Company, New York. 3. Kanti Swaroop, Gupta, P.K. and Singh, M.M. (1985): Operations Research; Sultan Chand and Sons. 4. Hadley, G and Whitin, T.M. (1963): Analysis of Inventory System; Prentice Hall. 5. Shamblin, J.E. and Stevens, G.T. (1974): Operations Research: A Fundamental Approach; McGraw Hill 6. Kleinrock, L. (1975): Queuing Systems, Vol. I; John Wiley. 7. Starr, M.K. and Miller, D.W. (1962): Inventory Control-Theory and Practice; Prentice Hall.			

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VIII
Subject: STATISTICS		
Course Title: **Block Design and Their Analysis**		
Credits:	T- 2	P-2	Core: **Core Elective I**		

Course Outcome:

This course provides to the students the ability to understand the design and conduct experiments, as well as to analyze data and interpret the results.

Syllabus

Fixed, mixed and random effects models; Variance components estimation: study of various methods, Tests for variance components.

General block design and its information matrix (C), criteria for connectedness, balance design and orthogonality: Intrablock analysis (estimability, best point estimates/Interval estimates of estimable linear parametric functions and testing of linear hypotheses).

BIBD - recovery of interblock information, Youden design - intrablock analysis, Lattice Design, Split plot design.

Analysis of covariance in a general Gauss-Markov model and its applications to standard designs, Missing plot technique - general theory and applications

Finite group and finite field, Finite geometry: projective and Euclidean, Construction of complete set of mutually orthogonal latin square (mols), Construction of BIBD's using mols and finite geometries, Symmetrically repeated differences, Steiner Triples and their use in construction of BIBD.

Books Recommended:

9. Raghava Rao D. (1971) : Construction and Combinatorial problems in Design of experiment. Wiley
10. Aloke Dey (1986) : Theory of Block Designs, Wiley Eastern.
11. Das, M.N. & Giri, N.(1979): Design and Analysis of experiments, Wiley Eastern.
12. Giri, N. (1986) : Analysis of Variance, South Asian Publishers.
13. Rao, C.R. and Kleffe, J.(1988) : Estimation of Variance Components and applications, North Holland.
14. Searle, S.R., Casella, G. and McCulloch, C.E. (1992) : Variance Components, Wiley.
15. Nigam, Puri & Gupta (1987-88) : Characterisation and Analysis of Block Design, Wiley Eastern.
16. V.K. Gupta & A.K. Nigam (1978-79) : Handbook an analysis of Agriculture Experiment, IASRI Publication.

Programme/Class: U.G. Honours With Research	Year: Fourth	Semester: VIII
Subject: STATISTICS		
Course Title: **Official Statistics**		
Credits:	T- 2	P-2	Core: **Core Elective I**
Course Outcome:		
This paper will help to know about different dimensions and issues related to our country through data and images such as graphs and visuals. It will help to provide basic information for decision making, evaluation related to administrative issues and policy making.		
Syllabus		
Introduction to Indian and International Statistical systems. Present Official Statistical System in India, role, functions and activates of central and state organization. Organization of large scale sample surveys methods of collection of official statistics, Role of National Sample Survey Organization, General and special data dissemination systems, Population growth in developed and developing countries. Evaluation of performance of family welfare programs projection of labor force and manpower. Scope and content of population of census of India. System of collection of agriculture Statistics, Crop forecasting and estimation. Support prices buffer stock, impact of irrigation projects. Statistics related to industries, Balance of payment, cost of living, Educational and other Social Statistics.		
Books Recommended:		
1. Basic Statistics relating to Indian Economy (CSO) 1990. 2. Statistical system in India (CSO) 1975. 3. Guide to Official Statistics (CSO) 1999. 4. Principles and accommodation of National Populations Census. UNESCO.		

Programme/Class: U.G. Honours With Research		Year: Fourth	Semester: VIII
Subject: STATISTICS			
Course Title: **Dissertation**			
Credits:	**T- 12**		

Course Outcome: A dissertation showcases a student's research skills and expertise in a specific field of study. It demonstrates their ability to identify research gaps, develop research questions, analyse data, and draw meaningful conclusions.

Syllabus

The topic for the dissertation should be a theme or a problem in an area of your choice within the framework of the contents of the courses studied. You are free to work on any topic or theme of any discipline.

Format of the Dissertation: The dissertation should be around 20,000 words in length (including the title page, acknowledgements and bibliographic references). Essential statistical and documentary appendices such as questionnaires, surveys, interview schedules or other data collection materials may be added to the total, but these should be kept to an absolutely relevant minimum. Dissertation should be typed or word-processed on A-4 size paper.

All material in the main part of the dissertation, excluding the bibliographic references, should have 1.5- line spacing and printed on one side of the paper with one-inch margins. Notes and references should be in the prescribed format. Pages should be numbered sequentially at bottom-centre.

The final dissertation should be bound. The sequence of the material in the dissertation should be in the following order:

1) The Cover Page of the dissertation should state the title of the dissertation, the name and enrolment number of the student, the name of the Academic supervisor, the degree programme for which it is prepared, the name of the university/college and the month and year of submission.

2) Title Page should give the same information as on the cover, together with the statement: "This dissertation is submitted in partial fulfilment of the requirements for the degree of …", followed by the date (month and year) of submission.

3) Certificate issued by the Academic Supervisor that the dissertation submitted by the candidate is his/ her own work and that the same be placed before the examiner.

4) Table of Contents should list the contents of the dissertation by chapters, with sections where appropriate, and the page number for each, together with the page number for the bibliographic references and figures, tables and maps, if any.

5) Acknowledgements: You may wish to acknowledge any help that you have received in the preparation of the dissertation.

6) Main Text comprises of the chapters (usually three, four or five, including the Introduction and Conclusion) bibliographic references and appendices, if any. Each main heading (chapters, bibliographic references and appendices) should start on a new page; sections within main headings may continue on the same page. Numbering of the main text of the dissertation should be sequential. Bibliographic references should list all works cited in the chapters and other valuable sources used in the preparation of the dissertation.

P.G First Year- First Semester (For Two Year P.G. Programme)

Programme/Class: P.G.	Year: First	Semester: I (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Measure Theory and Probability**		
Credits:	T- 4	Core: **Core I**

Course Outcome: The aim of the course is to pay a special attention to applicant ions of measure theory in the probability theory and the Central Limit Theorem with their applications. To understand the concepts of random variables, sigma-fields generated by random variables, probability distributions and independence of random variables related to measurable functions. To gain the ability to understand the concepts of measurable functions, sequence of random variables, convergence, modes of convergence. To learn the concepts of weak and strong laws of large numbers and central limit theorem.

Syllabus

Measure and integration: Classes of sets, field, sigma fields, minimal sigma fields, Borel sigma fields, Limsup and liminf of a sets, Measure, Probability measure, properties of a measure, Lebesgue and Lebesgue- Steljes measures, measurable functions.

Probability: Baye's theorem. Random variable. Marginal and conditional distributions, Expectation. Tehebycheffs inequality and improvements on it, convergence in probability. The weak law of large numbers Bernoulli's theorem. Convergence in distribution continuity theorem. Khinchin's theorem. Strong law of large numbers Kologorov's theorem, Borel zero-one law, Borel-Cantelli lemma.

Central limit theorem-Lindberg Levy's and Liapouneff forms.

Books Recommended:

1. Goon Gupta and Das Gupta: An outline of Statistical theory, World Press Calcutta, Vol. 1. 6
2. Rohtagi, V.K. and Saleh A.K. (2005): Probability Theory, John Wiley.
3. B.R. Bhat(1985): Modern Probability Theory.
4. Basu, A.K. (2001): Probability and Measure theory, Narosa Pub.

Programme/Class: P.G.	Year: First	Semester: I (for 2 year PG Programme)

Subject: STATISTICS

Course Title: **Numerical Analysis and Operation Research**

Credits:	P- 4	Core: **Core II**

Course Outcome:

To acquire the knowledge of Numerical Integration, Knowledge of interpolation and extrapolation, An idea about the historical background and need of Operations research, Ability to identify and develop operational research models from the verbal description of the real life problems, Knowledge of the mathematical tools that are needed to solve optimization problems, Ability of solving Linear programming problem, Transportation and Assignment problems etc.

Syllabus

Calculus of finite differences, operators, separation of symbols, examples and problems. Interpolation formulas with remainder term. Newton's forward and backward formulae. Central difference formulae, Newton's divided difference formulae for interpolation. Lagrange's interpolation formulae.

Numerical Integration: Derivation of general quadrature formula for equidistant ordinates. Derivation of trapezoidal, Simpson's 1\3 rd and 3\8 th rules. Weddle's rule.

General linear programming problems and their formulations, Method for solving LPP: Graphical Method, Simplex method, Big – M method, Two phase Method, Duality in LPP (introduction only).

Transportation problem, Methods for obtaining IBFS: North-west corner rule, Least cost method, Vogel's approximation method, Methods for determining optimum solution: Stepping stone method, Method of Multipliers (MODI Method). Assignment Problem, Hungarian Algorithm.

Books Recommended:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I, World Press, Kolkata.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata
3. Swarup, K., Gupta P.K. and Man Mohan (2007). Operations Research (13th ed.), Sultan Chand & Sons.
4. Taha, H.A. (2007). Operations Research: An Introduction, 8 thed., Prentice Hall of India.
5. Hadley, G: (2002) : Linear Programming, Narosa Publications
6. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, 9th Edition, Tata McGraw Hill.

Programme/Class: P.G.	Year: First	Semester: I (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Statistical Inference**		
Credits:	T- 4	Core: **Core III**

Course Outcome:
To make aware the students about parametric, non-parametric and sequential estimation (point, as well as, interval) and testing (simple, as well as, composite hypotheses) procedures. To apply various estimation techniques and testing procedures to deal with real life problems. To understand consistency, CAN estimator, MLE. Understand UMPU tests UMVU estimators.

Syllabus

Problem of point estimation: Unbiasedness, Consistency, Sufficiency, Efficiency, Complete statistics, Complete Sufficient statistics. Factorization theorem, Exponential family of distributions and its properties, Minimum-variance unbiased estimators, Rao Blackwell theorem. Lehmann Schefe'stheorm, Cramer-Rao Inequality.

Method of estimation- Method of Maximum Likelihood and its properties.

Interval estimation, Interval Estimation: Confidence Region, shortest confidence intervals, General method of finding confidence interval. Method of obtaining confidence intervals based on small and large samples, Relationship with the testing of hypothesis.

Testing of hypothesis: Basic concept, Simple and composite hypothesis, Two types of error, power of the test , Neyman-Pearson lemma and its generalization, Types A, A1 critical regions, Construction of most powerful test, Uniformly most powerful tests, Uniformly most powerful Unbiased test using N P lemma, likelihood ratio test and its properties.

General decision problem: Basic concept of loss function, risk function, Minimax and Bays rule.

Books Recommended:

1. Lehmann, E.L.(1986): Theory of Point Estimation, Student Edition.
2. Zacks, S. (1971): Theory of Statistical Inference, Wiley, New York.
3. Rao, C.R. (1973): Linear Statistical Inference and its applications, 2nd edition, John wiley and sons.
4. Kale, B.K. (1999): A First course on Parametric Inference, Narosa Publishing House.
5. Goon, A.M., M.K. Gupta, & B. Das Gupta: Outline of Statistics, Vol-II.

Programme/Class: P.G.	Year: First	Semester: I (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Matrices**		
Credits:	P- 4	Core: **Core IV**

Course Outcome:
To acquire the knowledge of Matrices, determinants and their operations and their properties, solutions and applications.

Syllabus

Different type of matrices, algebra of matrices, row and column spaces of a matrix,
Elementary matrices,
Determinant,
Singular and non-singular matrices,
Adjoint of matrix,
Rank and inverse of matrix,
Portioned matrices and Kroneker product.
Canonical form,
Hermit canonical form, diagonal form, triangular form, Jordan form,
Quadratic form,
Generalized inverse, Moore-Penrose generalized inverse,
Idempotent matrices.
Characteristic roots and vectors,
Algebraic multiplicity of characteristic roots,
Caley Hamilton theorem, spectral decomposition of real symmetric matrix.
Positive, semi positive, negative and semi negative definite matrices,
Similar matrices
Derivative of determinant

Books Recommended:

1. Biswas, S, (1984): Topics in Algebra of matrices, Academic Publications.
2. Shanti Narain: A text books of matrices, S. Chand and Company (Pvt) Ltd.
3. Frank Ayres , JR: Schaum's outline series Theory and problems.
4. A.I. Kostrikin, Introduction to Algebra, Springer Verlag, 1984.
5. S. H. Friedberg, A. L. Insel and L. E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
6. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.

Programme/Class: P.G.	Year: First	Semester: I (for 2 year PG Programme)

Subject: STATISTICS

Course Title: **Real analysis and Complex Analysis**

Credits:	T- 2	P- 2	**Elective- I**

Course Outcome:

The main objective of this course is to introduce students with the knowledge of real field and complex field with their properties and relativity between complex plane and real line. These properties and relations provide grounds for Probability Theory and help in theoretical research in Statistics.

Syllabus

Monotone functions and functions of bounded variation. Absolute continuity of functions, standard properties. Uniform convergence of sequence of functions and series of functions. Cauchy's criterion and Weirstrass M-test. Conditions for termwise differentiation and termwise integration (statements only). Power series and radius of convergence.

Riemann-Stieltjes integration. Statement of the standard properties and problems based on them. Multiple integrals and their evaluation by repeated integration. Change of variable in multiple integration. Beta and gamma functions. Differentiation under integral sign. Leibnitz rule. Dirichlet integral, Liouville's extension.

Maxima-minima of functions of several variables, Constrained maxima-minima of functions.

Analytic function, Cauchy-Riemann equations. Statement of Cauchy theorem and of Cauchy integral formula with applications,Taylor's series. Singularities, Laurent series. Residue and contour integration. Fourier and Laplace transforms.

Books Recommended:

1. Apostol, T.M. (1975). Mathematical Analysis, Addison- Wesley.
2. Bartle, R.G. (1976). Elements of Real Analysis, John Wiley & Sons.
3. Berbarian, S.K. (1998). Fundamentals of Real Analysis, Springer-Verlag.
4. Conway, J.B. (1978). Functions of one Complex Variable, Springer-Verlag.
5. Priestley, H.A. (1985). Complex Analysis, Clarenton Press Oxford.
6. Rudin, W. (1985). Principles of Mathematical Analysis, McGraw Hill.

Programme/Class: P.G.	Year: First	Semester: I (for 2 year PG Programme)

Subject: STATISTICS		

Course Title: **Linear Algebra**			
Credits:	T- 2	P- 2	**Elective I**

Course Outcome:

The main objective of this paper is to allow students to manipulate and understand multi dimensional space.

Syllabus

Vector Space, subspace,

Linear dependence and independence, maximal linearly independent subset,

Basis and dimension of vector space, finite dimensional vector spaces,

Example of vector spaces over real and complex variable.

Linear transformation, algebra of linear transformation,

Null space and ranges, rank and nullity of linear transformation, Rank nullity theorem,

Eigenvalues and eigenvectors for Linear Transformations,

Matrix representation of linear transformation.

Vector spaces with an inner product,

Gram-Schmidt orthogonalization process, orthonormal projection of a vector.

Books Recommended:

1. Biswas, S, (1984): Topics in Algebra of matrices, Academic Publications.
2. Shanti Narain: A text books of matrices, S. Chand and Company (Pvt) Ltd.
3. Stephen H. Friedberg, Arnold J. Insel Lawrence E. Spence: Liner Algebra, Pearson Education Limited.
4. Kenneth Hoffman and Ray Kunje:Linear Algebra, Prentice-Hall Inc

Programme/Class: P.G.	Year: First	Semester: I (for 2 year PG Programme)

Subject: STATISTICS		

Course Title: **Distribution Theory**			

Credits:	T- 2	P- 2	**Elective I**

Course Outcome:
To provide the knowledge of discrete distributions, continuous distributions, discuss the appropriate distribution with their properties and application of to solve problems, knowledge of sampling distributions and order statistics.

Syllabus

Univariate Discrete distributions; properties and applications of Uniform Discrete, Binomial, Poisson, Hypergeometric, Geometric Negative Binomial distribution and Multinomial distribution.

Univariate continuous Distribution; statement, derivation of properties and applications of Normal, Beta, Gamma, Cauchy, Exponential

Sampling distribution from Binomial, Poisson, Exponential and Normal populations, Bivariate distributions; bivariate normal. Distribution of functions of random variables.

Large sample tests. Derivation and properties of chi-square, t and F distribution and their inter relationship. Test of significance based on chi-square, t and F distribution.

Order statistics, their distributions and properties, joint and marginal distributions of order statistics, extreme values and their asymptotic distributions (statement only) with applications.

Books Recommended:
1. Rao, C.R. (1973): Linear Statistical Inference and its Application, Wiley Eastern.
2. Kendall, M.G., Stuart, A: The Advanced Theory of Statistics: Distribution Theory. Vol. 1.
3. Johnson and Kotz: Continuous Univariate Distribution, Vol. 1 and Vol. 2, Wiley.
4. Dudwvicz, E.J. and Mishra, S.N. (1988): Modern Mathematics Statistics, Wiley. International students edition.

Programme/Class: P.G.	Year: First	Semester: I (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Decision Theory and Bayesian Analysis**		
Credits:	T- 2	P- 2	**Elective I**

Course Outcome:

The objective of this course is to provide the understanding of the decision theory and fundamentals of Bayesian inference including concept of subjectivity and priors by examining some simple Bayesian framework.

Syllabus

Decision problem and two person game, Utility theory, loss functions, Randomized and nonrandomized decision rules, Essential completeness and completeness of class of rules based on sufficient statistic and the class of nonrandomized rules for convex loss , Optimal decision rules – unbiasedness, invariance, Bayes Rule, extended Bayes rule, Minimax rule, methods for finding minimax rules, admissibility of decision rules

Generalized bayes and limit of bayes rule, Concept of admissibility and completeness Bayes rules, Admissibility of Bayes and minimax rules, Supporting and separating hyper plane theorems, complete class theorem, Minimax estimators of Normal and Poisson means

Subjective interpretation of probability in terms of fair odds, Evaluation of (i) subjective probability of an event using a subjectively unbiased coin (ii) subjective prior distribution of a parameter, Bayes theorem and computation of the posterior distribution, Natural Conjugate family of priors for a model, Hyper parameters of a prior from conjugate family

Bayesian point estimation as a prediction problem from posterior distribution, Bayes estimators for (i) absolute error loss (ii) squared error loss (iii) 0 -1 loss, Bayesian interval estimation: credible intervals, Highest posterior density regions.

Interpretation of the confidence coefficient of an interval and its comparison with the interpretation of the confidence coefficient for a classical confidence interval, Bayesian Testing Hypothesis: Specification of the appropriate from of the prior distribution for a Bayesian testing of hypothesis problem, Prior odds, Posterior odds, Bayes factor.

Books Recommended:

1. James O Berger (1985) : Statistical Decision Theory and Bayesian analysis. Springer.
2. Fergusion T.S. (1967) : Mathematical Statistics - A decisions theoretic Approach. Academic Press.
3. DeGroot. M.H. : Optimal Statistical Decisions. McGraw Hill.
4. Leonard T and Hsu J.S.J. : Bayesian Methods. Cambridge University Press.
5. Bernardo, J.M. and Smith AFM : Bayesian Theory. John Willey.
6. Rao, C. R. (1973): Linear Statistical Inference and its Applications, Wiley Eastern.
7. Robert, C. P.: The Bayesian Choice: A Decision Theoretic Motivation, Springer

Programme/Class: P.G.		Year: First	Semester: I (for 2 year PG Programme)
Subject: STATISTICS			
Course Title: **Acturial Statistics**			
Credits:	T- 2	P- 2	**Elective I**

Course Outcome: In this course students learn about statistical models of transfers between multiple states, including processes with single or multiple decrements, and derive relationships between probabilities of transfer and transition intensities.

Syllabus

Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory: Utility functions, expected utility criterion, types of utility function, insurance and utility theory, models for individual claims and their sums.

Survival function, Uncertainty of age at death, time until-death for a person, curate future lifetime, force of mortality. Life table and its relation with survival function, life table characteristics, assumptions for fractional ages, some analytical laws of mortality, select and ultimate life table

Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding. Principles of Premium Calculation: Properties of premium principles, examples of premium principles. Individual risk models: models for individual claims, the sum of independent claims, approximations and their applications.

Life insurance: Insurance payable at the moment of death and at the end of the year of deathlevel 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 payments, commutation functions, varying annuities, recursions, complete annuities.

Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits. A brief outline of payment premiums and net premiums, Gross premiums and provisions. Profit testing Determining provisions using profit testing. Factor affecting mortality and selections.

Books Recommended:

1. Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A. and Nesbitt, C.J. (1997). Actuarial Mathematics. Society of Actuaries, Itasca, Illinois, U.S.A.
2. Daykin, C. D., Pentikainen, T. and Pesonen, M. (1993). Practical Risk Theory for Actuaries. Chapman & Hall/CRC.
3. Deshmukh, S.R. (2009). Actuarial Statistics: An Introduction Using R, University Press, India.
4. Dickson, C. M. D. (2005). Insurance Risk and Ruin (International Series no.1 Actuarial Science), Cambridge University Press.
5. Klugman,S. A., Panjer, H. H., and Willmotand, G. E. (2019). Loss Models: From Data to Decisions. Willy publication.
7. Rotar, V.I. (2015). Actuarial Models: The Mathematics of Insurance, 2nd ed., CRC Press, New York.
8. Spurgeon, E.T. (1972). Life Contingencies, Cambridge University Press.

P.G First Year- Second Semester (For Two Year P.G. Programme)

Programme/Class: P.G.	Year: First	Semester: II (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Sample Surveys**		
Credits:	T- 4	Core: **Core I**
Course Outcome: The main objective of this course is to learn techniques in survey sampling with practical applications in daily life which would be beneficial for the students to their further research.		
Syllabus		
Basic Principles: Census and sample surveys, advantages and disadvantages of sample surveys. Basic principles in sampling, survey enquiries, choice of sampling units, problems of sample size, Bias in selection and estimation, simple random sampling, sampling from finite populations with and without replacement, sampling of attributes, unbiased estimates of population total, mean and estimation of their variances. Stratified Sampling: Reason for stratification, choice of strata, choice of sampling unit, stratified random sampling, estimation of population mean and its variance, choice of sample sizes in different strata, variances of estimates with different allocation, effects of deviation from optimum allocation, estimation of the gain in precision due to stratification, cost function, construction of strata. Systematic Sampling: Estimation of sample mean and its variance, comparison of systematic sampling with simple random and stratified sampling. Ratio and Regression Estimation: Ratio and regression methods of estimation, variances of the estimates, optimum property of ratio estimates, comparison among ratio and regression and simple and biased estimates. Cluster Sampling: Estimates of mean and its variance for equal and unequal clusters, efficiency in terms of intra-class correlation, optimum unit of sampling, sampling with replacement, estimation of mean and variance. Double Sampling: Multistage sampling with special reference to two stage design, Nonsampling errors, problems of non response, errors of measurements, Interpenetrating sub sampling. Randomized response techniques. Pilot survey. PPS Sampling schemes, sampling techniques with varying probabilities for simple random sampling. Herwits Thompson Estimators, Mid Zuno Sen Sampling Scheme.		
Books Recommended:		
1. Cochran W.G.: Sampling Techniques, Wiley Eastern Ltd., New Delhi. 2. Des Raj and Chandhok (1998): Sampling Theory, Narosa Publishing House. 3. Mukhopadhayay Parimal: Theory and Methods of Survey Sampling-Prentice Hall of India Ltd. 4. Kish L: Survey Sampling.		

Programme/Class: P.G.	Year: First	Semester: II (for 2 year PG Programme)

Subject: STATISTICS

Course Title: **Block Design and Their Analysis**

Credits:	P- 4	Core: **Core II**

Course Outcome:

This course provides to students the ability to understand the design and conduct experiments, as well as to analyze data and interpret the results.

Syllabus

Fixed, mixed and random effects models; Variance components estimation: study of various methods, Tests for variance components.

General block design and its information matrix (C), criteria for connectedness, balance design and orthogonality: Intrablock analysis (estimability, best point estimates/Interval estimates of estimable linear parametric functions and testing of linear hypotheses).

BIBD - recovery of interblock information, Youden design - intrablock analysis, Lattice Design, Split plot design.

Analysis of covariance in a general Gauss-Markov model and its applications to standard designs, Missing plot technique - general theory and applications

Finite group and finite field, Finite geometry: projective and Euclidean, Construction of complete set of mutually orthogonal latin square (mols), Construction of BIBD's using mols and finite geometries, Symmetrically repeated differences, Steiner Triples and their use in construction of BIBD.

Books Recommended:

1. Raghava Rao D. (1971) : Construction and Combinatorial problems in Design of experiment. Wiley
2. Aloke Dey (1986) : Theory of Block Designs, Wiley Eastern.
3. Das, M.N. & Giri, N.(1979): Design and Analysis of experiments, Wiley Eastern.
4. Giri, N. (1986) : Analysis of Variance, South Asian Publishers.
5. Rao, C.R. and Kleffe, J.(1988) : Estimation of Variance Components and applications, North Holland.
6. Searle, S.R., Casella, G. and McCulloch, C.E. (1992) : Variance Components, Wiley.
7. Nigam, Puri & Gupta (1987-88) : Characterisation and Analysis of Block Design, Wiley Eastern.
8. V.K. Gupta & A.K. Nigam (1978-79) : Handbook an analysis of Agriculture Experiment, IASRI Publication.

Programme/Class: P.G.	Year: First	Semester: II (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Official Statistics**		
Credits:	T- 4	Core: **Core III**

Course Outcome:
This paper will help to know about different dimensions and issues related to our country through data and images such as graphs and visuals. It will help to provide basic information for decision making, evaluation related to administrative issues and policy making.

Syllabus

Introduction to Indian and International Statistical systems.

Present Official Statistical System in India, role, functions and activates of central and state organization.

Organization of large scale sample surveys methods of collection of official statistics,

Role of National Sample Survey Organization.

General and special data dissemination systems,

Population growth in developed and developing countries.

Evaluation of performance of family welfare programs projection of labor force and manpower.

Scope and content of population of census of India.

System of collection of agriculture Statistics, Crop forecasting and estimation.

Support prices buffer stock, impact of irrigation projects.

Statistics related to industries, balance of payment, cost of living, educational and other Social Statistics.

Books Recommended:
1. Basic Statistics relating to Indian Economy (CSO) 1990.
2. Statistical system in India (CSO) 1975.
3. Guide to Official Statistics (CSO) 1999.
4. Principles and accommodation of National Populations Census. UNESCO.

Programme/Class: P.G.		Year: First	Semester: II (for 2 year PG Programme)
Subject: STATISTICS			
Course Title: **Advanced Operation Research**			
Credits:	P- 4		Core: **Core IV**

Course Outcome: To acquire the knowledge of Advanced Operations research, Dynamic Programming, Queuing Models, Non-Linear Programming, Inventory Control, Integer Programming, Sequencing and scheduling problems, Sensitivity analysis. Parametric programming and Replacement problems etc.

Syllabus

Dynamic Programming: Bellman's principle of optimality; general formulation of dynamic programming; computational methods and applications of dynamic programming.

Queuing Models: Steady-state solutions of (M/M/1) and (M/M/C) models with associated distributions of queue length and waiting time; M/G/1. Non-Linear Programming: Kuhn-Tucker conditions; Wolfe's and Beale's algorithms for solving quadratic programming problems. Inventory Control- Economic lot Size, Formulae of Harris for known demand and its extension allowing shortage, Random demand: Discrete and Continuous case

Integer Programming: Branch and bound algorithm and cutting plane algorithm. Multicriterion and goal programming. Stochastic Programming; quantile rules. Two-stage programming; use of fractional programming.

Sequencing and scheduling problems: 2 machines n-job and 3-machines n-job problems with identical machine sequence for all jobs; 2-job n-machine problem with different routing; branch and bound method for solving travelling-salesman problems.

Sensitivity analysis. Parametric programming.

Project management: CPM and PERT; probability of project completion; PERT-crashing.

Replacement problems: block and age replacement policies; dynamic programming approach for maintenance problems; replacement of items with long life.

Transient solution of M/M/1 queue; bulk queues(bulk arrival and bulk service); finite queues; queues in tandem; GI/G/1 queue and its solutions; simulation of queues.

Books Recommended:

1. Sharma, S.D.: Operation Research, Pragati Prakashan, Meerut.
2. Taha, H.A. (1982): Operations Research: An Introduction; MacMillan Publishing Company, New York.
3. Kanti Swaroop, Gupta, P.K. and Singh, M.M. (1985): Operations Research; Sultan Chand and Sons.
4. Hadley, G and Whitin, T.M. (1963): Analysis of Inventory System; Prentice Hall.
5. Shamblin, J.E. and Stevens, G.T. (1974): Operations Research: A Fundamental Approach; McGraw Hill
6. Kleinrock, L. (1975): Queuing Systems, Vol. I; John Wiley.
7. Starr, M.K. and Miller, D.W. (1962): Inventory Control-Theory and Practice; Prentice Hall.

Programme/Class: P.G.	Year: First	Semester: II (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Linear Models and Regression Analysis**		
Credits:	T- 2	P- 2	**Elective I**	

Course Outcome:

The main objective of this course is to provide students the ability to learn and use linear and non-linear models for normal data, and generalized linear models for normal and non-normal responses.

Syllabus

Standard Gauss-Markov models: Estimability of parameters,

Best linear unbiased estimator (BLUE),

Method of least square and Gauss-Markov theorem,

Variance and Covariance of BLUE.

Introducing of one way random effects linear models and estimation of Variance components.

Maximum likelihood, MINQUE and restricted maximum likelihood estimators of variance components, best linear unbiased predicators (BLUP).

Bi-variate and multiple linear regression,

Polynomial regression, use of orthogonal polynomial.

Linear and non-linear regression models.

Books Recommended:

1. Rao, C.R. and Kleffe, J. (1988). Estimation of variance component and applications, North Holland.
2. Chatterjee, S. and Prince, B. (1991): Regression Analysis by example, John Wiley, New York.
3. Draper, N.R. and Smith H. (1998): Applied Regression Analysis, 3rd Ed. Wiley.
4. Cook, R.D. and Weisherg, S. (1982): Residuals and Inference in Regression, Chapman and Hall.

Programme/Class: P.G.	Year: First	Semester: II (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Reliability Theory**		
Credits:	T- 2	P- 2	**Elective I**

Course Outcome:
The aim is to equip the students with the knowledge of the fundamentals of Reliability concepts and measures

Syllabus

Reliability concepts and measures; components and systems; coherent systems; Reliability of coherent system; cuts and paths; modular decomposition; bounds on system reliability; structural and reliability importance of components.

Life distributions; reliability function; hazard rate; common life distributions – exponential, Weibull, gamma, normal, etc.; Estimation of parameters and tests in these models.

Reliability estimation based on failure times in variously censored life tests and in tests with replacement of failed items; stress-strength reliability and its estimation.

Basic ideas of accelerated life testing.

Notions of aging; IFR; IFRA; NBU; DMRL and NBUE classes and their duals; lo of memory property of the exponential distribution; closures of these classes under formation of coherent systems; convolution and mixtures.

Univariate shock models and life distribution arising out of them; bivariate shock models; common bivariate exponential distributions and their properties.

Maintenance and replacement policies; availability of reparable systems; modelling of a repairable system by a non-homogeneous Poisson process.

Reliability growth models; Probability plotting techniques.

Books Recommended:

1. Cox, D. R. and Oakes, D. (1984): Analysis of Survival Data, Chapman and Hall, New York.
2. Gross A. j. and Clark, V.A. (1975): Survival Distribution: Reliability applications in the Biomedical Sciences, John Wiley and Sons.
3. Elandt – Johnson, R.E. Johnson N. L.: Survival Models and Data Analysis, John Wiley and Sons.
4. Miller, R. G. (1981): Survival Analysis (John Wiley).
5. Kalbfleisch J. D. and Prentice R. (1980): The Statistical Analysis of failure Time data, John Wiley.

Programme/Class: P.G.		Year: First	Semester: II (for 2 year PG Programme)
Subject: STATISTICS			

Course Title: **Statistical Methodology and Data Mining**			
Credits:	T- 2	P- 2	**Elective I**

Course Outcome:This course will present statistical methods that have proven to be of value in the field of knowledge discovery in databases, with special attention to techniques that help managers to make intelligent use of these repositories by recognizing patterns and making predictions.

Syllabus

Truncated distributions, Compound distributions, Mixture of distributions, Generalized power series distributions, Exponential family of distributions, Non-central distributions of Beta, Chi-square, t and F and their properties.

Introduction to databases, tasks in building a data mining and database, goal of data mining, data warehouses, applications of data mining, supervised and unsupervised learning, data processing: representation, visualization, cleaning, reduction, transformation, outlier detection.

Clustering: Similarity and distance measures, squared error clustering, single linked clustering, centroid clustering, K-means clustering, Hierarchical clustering, Block clustering, Support vector machine (SVM) with linear class boundaries, multiclass SVM, Latent variable models for blind source separation: Independent component analysis (ICA) and its applications.

Classification and Regression Trees (CART): Classification trees, Minimum spanning tree, node impurity function and entropy function, choosing the best split pruning algorithm for classification trees. Regression trees, terminal node value and splitting strategy, pruning the tree and best pruned subtree.

Artificial neural networks: Introduction, Rosenblatt's Single layer perceptron, single unit perceptron gradient descent learning algorithm, multilayer perceptron network, feed forward and back propogation learning algorithm, McCullon-Pitts Neuron (Threshold Logic Unit), self-organizing feature map (SOM) or Kohonen neural network, extensions of regression models.

Books Recommended:

1. Bishop, C.M. (1995): Neural Networks for pattern Recognition, Oxford University Press.
2. Breiman, L., Friedman, J.H., Olshen, R.A. and Stone, C.J. (1984): Classification and Regression Trees. Wadsworth and Brooks.
3. Dunham, M. H. (2003). Data Mining: Introductory and Advanced Topics, Pearson Education.
4. Han, J. (2000): Data Mining: Concepts and Techniques. Morgan Kaufmann.
5. Han, J. and Kamber, M (2006). Data Mining: Concepts and Techniques, 2nd edition, Morgan Kaufmann.
6. Hand, D., Mannila, H., and Smyth, P. (2001). Principles of Data Mining, MIT Press.
7. Hastie T., Tibshirani R. and Friedman J. H., (2008). The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer.
8. Haykin, S. (1998) Neural Networks: A Comprehensive Foundation, 2nd ed., Prentice Hall.
9. James G., Witten, D., Hastie, T. Tibshirani, R. (2013). An Introduction to Statistical Learning: With Applications in R, Springer
10. Mohammad J. Zaki and Wagner Meira. (2014). Data Mining and Analysis. Fundamental Concepts and Algorithms. Cambridge University Press, New York.
11. Nisbet, R., Miner, G. and Elder, J (2009): Handbook of Statistical Analysis and Data Mining Applications. Academic Press.
12. Shmueli, G., Patel, N. Bruce, P. (2010). Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XL Miner, Wiley.
13. Yang, Xin-She (2019): Introduction to Algorithms for Data Mining and Machine Learning. Academic Press.

Programme/Class: P.G.	Year: First	Semester: II (for 2 year PG Programme)
Subject: STATISTICS		
Course Title: **Bio Statistics**		
Credits:	T- 2	P- 2	**Elective I**

Course Outcome:
To provide the basic knowledge of Bio Statistics, biological assays, Response surfaces, clinical trials, Analysis of categorical outcomes and DNA sequences.

Syllabus

Type of biological assays: direct assays, indirect assays, parallel line assays. Incomplete block designs for bio assays.

Response surfaces: Linear Response surface designs, second order response surface designs, variance of estimated response.

Introduction to clinical trials: the need of clinical trials, bias and random error in clinical studies, overview of phase 1-4 trials.

Analysis of categorical outcomes from phase I-III Trials, analysis of survival data from clinical trials. Analysis of One DNA sequence: Shotgun Sequencing, Modeling signals in DNA.

Analysis of multiple DNA or Protein Sequences: Alignment Algorithms for Two sequences, Protein sequences and Substitution Matrices.

Books Recommended:

1. Z. Govindarajulu(2000): Statistical technique in Bioassay, S. Kargar.
2. 2. Das, M.N. and Giri, N. (1975): Design and Analysis of experiments, New age international.
3. S. Piantadosi (1997): Clinical trials. A methodological perspective. Wiley & sons.
4. J.L. Fleiss (1989): The design and analysis of clinical experiments, Wiley & sons.

Programme/Class: P.G.	Year: First	Semester: II (for 2 year PG Programme)

Subject: STATISTICS		

Course Title: **Statistical Quality Control and Educational Statistics**		

Credits:	T- 2	P- 2	**Elective I**

Course Outcome:
Familiarity with different aspects of Statistical Quality Control in manufacturing units, Ability to understand the concept of Sampling Inspection plans for products, Knowledge of Statistical tools to be applied in Educational Statistics, Familiarity with various scaling procedures, Knowledge to understand the concept of statistical quality control and different, control charts for variables and attributes.

Syllabus

Educational Statistics: Different Scaling procedures: scaling of test items, test scores, rating of qualitative answers and judgements, scaling in terms of normal curve, equivalent scale, percentile scaling, z-scores, tscores.

Test theory: linear model of test theory, parallel tests, true score, test reliability, methods for assessing reliability: Parallel test method, test-retest method, split half method, Kuder-Richardson method, Cronbach's α. Validity of test: conduct validity, construct validity, criterion validity and content validity.

Statistical Quality Control: Process control, product control, Control Charts: control charts for variables and attributes, modified control charts, group control charts, CUSUM charts, V mask.

Sampling inspection by attributes – single and double sampling plans, Producer's and consumer's risk, OC, ASN, ATI functions, AOQL and LTPD for these sampling plans, Sampling inspection by variables – simple cases.

Books Recommended:
1. Montgomery D.C.: Introduction to Statistical Quality Control.
2. Wetherill, G.B. and Brown, D. W.: Statistical Quality Control: Theory and Practice.
3. Burr, I.W.: Statistical Quality Control Methods.
4. Croxton F.E. and Cowden D.J.: Applied General Statistics
5. Goon, A.M., Gupta, M.K. and Dasgupta, B.: Fundamentals of Statistics, Vol. II
6. Kapoor, V.K. and Gupta, S.C.: Fundamentals of Applied Statistics
7. Garrett H.L.: Statistics in psychology and education.
8. Grant, E.L.: Statistical Quality Control
9. Edwards, A.L.: Attitude Scale Construction Techniques.

P.G. Second Year (for Two year P.G. program) And

1 year P.G. program for (4 year U.G. passed students)

P.G. (Second Year)-
- ➢ **Third semester (For two year program-** *P.G. first year passed students)*
- ➢ **First semester (For one year program-** *U.G. 4 years passed students)*

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I
Subject: STATISTICS		
Course Title: **Multivariate Analysis and Curve Fitting**		
Credits:	T- 4	**Core- 1**
Course Outcome: The main objective of this course is to introduce students to the analysis of observations on several correlated random variables for a number of individuals. Such analysis becomes necessary in Anthropology, Psychology, Biology, Medicine, Education, Agriculture and Economics when one deals with several variables simultaneously.		
Syllabus		
Multivariate normal distribution and its properties. Random sampling from multivariate normal distribution. Maximum likelihood estimators of parameters, distribution of sample mean vector. Wishart matrix- its distribution and properties, distribution of sample generalized variance, null and non-null distribution of multiple correlation coefficient. Hotelling's T^2 and its sampling distribution, application in test on mean vector for one and more multivariate normal population. Classification and discrimination procedures for discrimination between two multivariate normal populations-sample discriminant function, test associated with discriminant functions, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations, Fisher Behren Problem. Mahalonobis D^2 Statistics and its application, Principal component, Canonical variables and canonical correlations: definition, use, estimation and computation.		
Books Recommended:		
1. Anderson, T.W. (1983): An Introduction to Multivariate Statistical Analysis, 2nd Ed., Wiley. 2. N.S. Giri: Multivariate Statistical Analysis. 3. Johnson, R. and Wychern(1992): Applied Multivariate Statistical Analysis, Prentice Hall, 3rd Edition. 4. Sharma, S. (1996): Applied Multivariate Techniques, Wiley.		

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I

Subject: STATISTICS		
Course Title: **Non Parametric and Semi Parametric Methods**		
Credits:	T- 4	**Core- 2**

Course Outcome:
To acquire the basic knowledge and analysis of Non Parametric and Semi Parametric Methods and their applications in different fields of life.

Syllabus

Empirical distribution function, Glivenko Cantelli Theorem, Kolmogorov Goodness of fit test.

One sample U-statistics, Kernel and symmetric kernel, Two sample U-statistics, Asymptotic distribution of U-statistics. UMVUE property of U-statistics, Asymptotic distribution of linear function of order statistics.

Rank tests, Locally most powerful rank tests, Linear rank statistics and their distributional properties under null hypothesis, Pitman's asymptotic relative efficiency. One sample location problem, sign test and signed rank test, two sample Kolmogorov Smirnov tests. Two sample location and scale problems. Wilcoxon-Mann-Whitney test,

Normal score test, ARE of various tests based on linear rank statistics. Kruskal-Wallis K sample test.

Cox's Proportional Hazard Model, rank test (partial likelihood) for regression coefficients. Concepts of jackknifing method of Quenouille for reducing bias, Bootstrap methods, Confidence intervals.

Books Recommended:

1. Davison, A.C. and Hinkley, D.V. (1997): Bootstrap methods and their application, Cambridge University Press.
2. Gibbons, J.D. (1985): Nonparametric statistical inference, 2nd ed., Marcel Dekker, Inc.
3. Randles, R.H. and Wolfe, D.A. (1979): Introduction to the theory of nonparametric statistics, John Wiley & Sons, Inc.
4. Puri, M.L. and Sen, P.K. (1971): Nonparametric methods in multivariate analysis, John Wiley & Sons, Inc.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I

Subject: STATISTICS

Course Title: **Advanced Statistical Analysis using SPSS**

Credits:		P- 4	**Core- 3**

Course Outcome:
The objective of this course is to make students understand the significance of Data Preparation for Data Analysis and how to present and interpret data using statistical analysis software package SPSS. Discuss Data Analysis using Frequency Diagrams and Cross Tabulate ions. Introduce the visual representation of variables in graphs, bar charts and histograms. Understand the role and scope of Descriptive Statistics and Inferential Statistics

Syllabus

SPSS Environment & Interface, Data Preparation, Data Transformation: File Handling, File Transformation. Exploratory Data Analysis: Frequencies, Descriptive Statistics, Explore, Cross-tabs, OLAP Cubes. Graphs. Correlation and Partial Correlation. Simple and Multiple Linear Regression Models, Regression Diagnostics, Generalized Linear Regression Models: Binary Logistic, Ordinal Logistic, Poisson, Log Linear Regression Models. Parametric and Nonparametric Tests: One and Two Sample problems. ANOVA: One-Way, Kruskal Wallis, General linear model: Two way ANOVA and ANCOVA, Repeated Measures. Basic experimental designs and factorial experiments. Factor Analysis, Discriminant Analysis, Nearest Neighbor Analysis, Choosing Procedures for Clustering, Two Step Cluster analysis, K-Means Cluster Analysis, Hierarchical Cluster Analysis. Control Charts. Time Series Analysis: Creating and manipulating a time series, Components of a time series, autocorrelation and partial correlation function. Developing Predictive Models: Forecasting using exponential models, predictive accuracy measures for time-series forecast, testing for stationarity, Forecasting using ARIMA models.

Books Recommended:
1. Margan G A: SPSS for Introductory Statistics; Uses and Interpretation. 2. Practical Work Book by Bristol Information Services: Introduction to SPSS for Windows. 3. Rao A.R. and Bhimsankaran P. (1992): Linear Algebra, Tata McGraw Hill Publishing Company Ltd. 4. Rao CR and Mitra S.K.(1971): Generalized Inverse of Matrices and Its Applications, John Wiley & Sons, Inc.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I

Subject: STATISTICS

Course Title: **Factorial Experiments and Response Surfaces**

Credits:	T- 4	**Elective- 1**

Course Outcome:
This course provides the students the ability to understand the design and conduct experiments, as well as to analyze data and interpret the results.

Syllabus
General factorial experiments, factorial effects, symmetric factorial experiments, best estimates and testing the significance of factorial effects; analysis of 2n factorial experiment
3n factorial experiments in randomized blocks, analysis of 32 , 33 and 3n factorial experiments, Extension of Yates table for 3n factorial experiments
Complete and partial confounding in case of 2n and 3n factorial experiments, Fractional replication for symmetric factorials
Response surface experiments, first order designs and orthogonal designs.
Clinical trials, longitudinal data, treatment- control designs, Model validation and use of transformation, Tukey's test for additivity

Books Recommended:

1. Raghava Rao D. (1971) : Construction and Combinatorial problems in Design of experiment. Wiley
2. Aloke Dey (1986) : Theory of Block Designs, Wiley Eastern.
3. Angela Dean and Daniel Voss (1999): Design and Analysis of Experiments, Springer.
4. Das, M.N. & Giri, N.(1979): Design and Analysis of experiments, Wiley Eastern.
5. Giri, N. (1986) : Analysis of Variance, South Asian Publishers
6. John P.W.M.(1971): Statistical design and analysis of experiments, Mc Millan.
7. Joshi, D.D. (1987) : Linear Estimation and Design of Experiments, Wiley Eastern.
8. Montgomery, C.D.(1976): Design and analysis of experiments, Wiley, New York.
.9. Meyer, R.H.(1971) : Response surface methodology. Allyn & Bacon.
10.Pearce, S.C.(1984) : Design of experiments Wiley, New York.
11. Rao, C.R. and Kleffe, J.(1988) : Estimation of Variance Components and applications, North Holland.
12. Searle, S.R., Casella, G. and McCulloch, C.E. (1992) : Variance Components, Wiley.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I

Subject: STATISTICS		
Course Title: **Survival Analysis**		
Credits:	T- 4	**Elective- 1**

Course Outcome:
To improve the basic fundamentals and the analytical approach of Survival Analysis.

Syllabus

Concept of time, order and random censoring, likelihood in the distributions – exponential, gamma, Weibull, lognormal, Pareto, Linear failure rate, inference for these distribution.

Life tables, failure rate, mean residual life and their elementary classes and their properties.

Estimation of survival function – actuarial estimator, Kaplan – Meier estimator, estimation under the assumption of IFR/DFR, tests of exponentiality against non-parametric classes, total time on test.

Two sample problem – Gehan test, log rank test.

Semi-parametric regression for failure rate – Cox's proportional hazards model with one and several covariates. rank test for the regression coefficient.

Competing risk model, parametric and non-parametric inference for this model.
Multiple decrement life table.

Books Recommended:

1. Barlow, R.E. and Proschan, F. (1985): Statistical Theory of Reliability and Life Testing; Holt, Rinehart and Winston.
2. Lawless, J.F. (1982): Statistical Models and Methods of Life Time Data; John Wiley.
3. Nelson, W. (1982): Applied life Data Analysis; John Wiley.
4. Zacks, S.: Reliability Theory; Springer
5. Bain, L. J. and Engelhardt (1991): Statistical Analysis of Reliability and Life Testing Models; Marcel Dekker.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I

Subject: STATISTICS		
Course Title: **Applied Regression Analysis**		
Credits:	T- 4	**Elective- 1**

Course Outcome:
To acquire the knowledge of applied regression analysis, Residuals and their analysis, Robust and L-1 regression, Non-linear regression models, Generalized linear models and Bayes analysis of linear and generalized linear models

Syllabus

Residuals and their analysis, influential observations, power transformations for dependent and independent variables.

Robust and L-1 regression, estimation of prediction error by cross-validation and boot-strap.

Non-linear regression models, different methods of estimation (Least squares, Maximum Likelihood), Asymptotic properties of estimators

Generalized linear models, analysis of binary and grouped data by using logistic models, log-linear models.

Bayes analysis of linear and generalized linear models.

Books Recommended:
1. Bates, D.M. and Watts, D.G. (1988): Nonlinear Regression, Analysis and its Application, Wiley, New York.
2. Cook, R.D. and Weisberg, S. (1982): Residuals and Inference in Regression, Chapman and Hall, London.
3. Draper, N.R. and Smith, H. (1998): Applied Regression Analysis, 3rd Ed., Willey, New York.
4. Efron, B. and Tibsirani, J.R. (1993): An Introduction to the Bootstrap, Chapman and Hall, New York.
5. Kashirsagar, A.M. (1995): Growth Curves, Marcel and Dekker, New York.
6. McCullagh, P. and Nelder, J.A. (1989): Generalized Linear Models, 2nd Ed., Chapman and Hall, London.
7. Searle, S.R. (1987): Linear Models for Unbalanced Data, Wiley, New York. 8. Seber, G.A. and Wild, G.J. (1989): Nonlinear Regression, Wiley, New York. 9. Robert, C.P.: The Bayesian Choice: A Decision Theoretic Motivation, Springer.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I

Subject: STATISTICS		
Course Title: **Demography**		
Credits:	P- 4	**Elective- 2**

Course Outcome:

This subject introduces the main theories used to understand socio- economic and demographic patterns and changes in Indian context and all over the world. It covers a range of topics including the relationships between population size and available resources; social, biological and economic influences on population growth rates, fertility decline, population distribution and migration and gender statistics. The subject is very important to understand and develop statistical structures of economic policies and program implementation.

Syllabus

Coverage and content errors in demographic data, Chandrasekharan—Deming formula to check completeness of registration data, adjustment of age data- use of Whipple, Myer and UN indices. population transition theory.

Measures of fertility; stochastic models for reproduction, distributions of time of birth, inter-live birth intervals and of number of births (for both homogeneous and homogeneous groups of women), estimation of parameters; estimation of parity progression from open birth interval data.

Measures of Mortality; construction of abridged life tables, infant mortality rate and its adjustments, model life table.

Stable and quasi-stable populations, intrinsic growth rate. Models of population growth and their filling to population data.

Internal migration and its measurement, migration models, concept of international migration.

Methods for population projection, component method of population projection, Nuptiality and its measurements.

Books Recommended:

1. Kumar, R. (1986): Technical Demography, Wiley Eastern Ltd.
2. Benjamin, B. (1969): Demographic Analysis, George, Allen and Unwin.
3. Chiang, C.L. (1968): Introduction to Stochastic Progression.
4. Cox, P.R. (1970): Demography, Cambridge University Press.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I

Subject: STATISTICS		
Course Title: **Time Series Analysis**		
Credits:	P- 4	**Elective- 2**

Course Outcome:

To improve the analytical ability to study the time series data and their properties, Exploratory time Series analysis, stationary processes, peridogram and correlogram analyses and computations based on Fourier transform.

Syllabus

Time-series as discrete parameter stochastic process, auto covariance and autocorrelation functions and their properties. Exploratory time Series analysis, tests for trend and seasonality, exponential and moving average smoothing. Holt and Winters smoothing, forecasting based on smoothing. Detailed study of the stationary processes: (1) moving average (MA), (2) auto regressive (AR), (3) ARMA and (4) AR integrated MA (ARIMA) models. Box-Jenkins models, choice of AR and MA periods. Discussion (without proof) of estimation of mean, auto covariance and autocorrelation functions under large sample theory, estimation of ARIMA model parameters.

Spectral analysis of weakly stationary process, peridogram and correlogram analyses, computations based on Fourier transform.

Books Recommended:

1. Box, G.E.P. and Jenkins, G.M. (1976): Time series analysis—Forecasting and Control, Holden-day, San Francisco.
2. Anderson, T.W. (1971): The Statistical Analysis of Time Series, Wiley, N.Y. 3. Montgemory, D.C. and Johnson, L.A. (1977): Forecasting and Time Series Analysis, McGraw Hill.
4. Kendall, Sir Maurice and Ord, J.K. (1990): Time Series (Third Edition), Edward Arnold.
5. Brockwell, P.J. and Davis, R.A.: Time Series: Theory and Methods (Second Edition), SpringerVerlag.
6. Fuller, W.A. (1976): Introduction to Statistical Time Series, John Wiley, N.Y.
7. Granger, C.W.J. and Newbold (1984): Forecasting Econometric Time Series, Third Edition, Academic Press.
8. Priestley, M.B. (1981): Spectral Analysis & Time Series, Griffin, London.
9. Kendall, M.G. and Stuart A. (1966): The Advanced Theory of Statistics, Volume 3, Charles Griffin, London.
10. Bloomfield, P. (1976): Fourier Analysis of Time Series—An Introduction, Wiley.
11. Granger, C.W.J. and Hatanka, M. (1964): Spectral Analysis of Economic Time Series, Princeton Univ. Press, N.J.
12. Koopmans, L.H. (1974). The spectral Analysis of Time Series, Academic Press.
13. Nelson, C.R. (1973): Applied Time Series for Managerial Forecasting, Holden-Day.
14. Findley, D.F. (Ed.) (1981): Applied Time Series Analysis II, Academic Press.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: III
	Year: First (for 4 year UG Passed Students)	Semester: I

Subject: STATISTICS

Course Title: **Computer Intensive Statistical Methods**

Credits:	P- 4	**Elective- 2**

Course Outcome:

To improve the knowledge regarding analysis of the complex data on computers related to Exploratory data analysis, Linear regression , Generalized linear models, Nonlinear regression, EM algorithm, Stochastic simulation, Stochastic simulation, Variance reduction, Markov Chain Monte Carlo Methods, Simulation based testing, Bootstrap methods and Jackknife and cross validation etc.

Syllabus

Exploratory data analysis: transforming data, graphical methods of clustering, outliers. Linear regression: Influential observations and diagnostics robust methods, collinearity, variable selection. Generalized linear models: exponential families and ML estimation, analysis of deviance and variable selection, logistic regression. Nonlinear regression: estimation, hypothesis testing, goodness of fit. EM algorithm: applications to missing and incomplete data problems, mixture models. Smoothing with kernels, density estimation, simple non-parametric regression. Stochastic simulation: generating random variables, simulating standard univariate and multivariate distributions. Variance reduction: importance sampling for integration, control variates and antithetic variables. Markov Chain Monte Carlo Methods: Gibbs sampling for standard distributions. Simulation based testing: simulating test statistics and power functions, permutation tests. Bootstrap methods: re sampling paradigms, bias and standard errors, confidence intervals. Jackknife and cross validation.

Books Recommended:

1. R. Gnandesikan (1997): Methods for Statistical Data Analysis of Multivariate Observations, Second edition, Wiley.
2. D.A. Belsley, E. Kuh, and R.E. Welsch (1980): Regression Diagnostics, Wiley.
3. P. McCullagh and J.A. Nelder (1999): Generalized Linear Models, Third edition, Chapman and Hall.
4. G.E.F. Seber and C.J. Wild (1989): Nonlinear Regression, Wiley.
5. G.J. McLachlan and T. Krishnan (1997): The EM Algorithms and Extensions, Wiley.
6. J.S. Simonoff (1996): Smoothing Methods in Statistics, Springer.
7. G.S. Fishman (1996): Monte Carlo: Concepts, Algorithms, and Applications, Springer.
8. R.Y. Rubinstein (1981): Simulation and the Monte Carlo Method, Wiley.
9. M.A. Tanner (1996): Tools for Statistical Interference, Third edition, Springer.
10. B. Efron and R.J. Tibshirani (1993): An introduction to the Bootstrap, Chapman and Hall.
11. J. Shao and D. Tu (1995): Jackknife and the Bootstrap, Springer Verlag.

P.G. (Second Year)-

> ## Fourth Semester (For two year program*)*
> ## Second semester (For one year program*)*

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: IV
	Year: First (for 4 year UG Passed Students)	Semester: II
Subject: STATISTICS		
Course Title: **Econometrics**		
Credits:	T- 4	**Core- 1**
Course Outcome:		
The objective of this course is to study more advanced topics in econometrics and time series models, G.L.M. 2-SLS, 3-SLS estimators etc.		
Syllabus		
Nature of econometrics, The general linear model (GLM) and its extensions, Use of dummy variables and seasonal adjustment, Generalized least squares (GLS) estimation and prediction, Heteroscedastic disturbances, Pure and mixed estimation, Grouping of observations and of equations.		
Auto correlation, its consequences and tests, Theil BLUS procedure: estimation and prediction, Multicollinearity problem, its implications and tools for handling the problem, Ridge regression.		
Linear regression with stochastic regressors, Instrumental variable estimation, Errors in variables, Autoregressive linear regression, Distributed lag models, Simultaneous linear equations model, Examples, Identification problem, Restrictions on structural parameters - rank and order conditions, Restrictions on variances and covariances.		
Estimation in simultaneous equations model, Recursive systems, 2 SLS Estimators. Limited information estimators, k - class estimators. 3 SLS estimation, Full information maximum likelihood method.		
Books Recommended:		
1. Johnston, J. (1984): Econometrics methods, Third Edition, McGraw Hill. 2. Apte, P.G. (1990): Text books of Econometrics, Tata McGraw Hill. 3. Damodar N. Gujrati(2004): Basic Econometrics, Fourth edition, McGraw Hill. 4. Cramer, J.S. (1971): Empirical Econometrics, North Holland.		

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: IV
	Year: First (for 4 year UG Passed Students)	Semester: II
Subject: STATISTICS		
Course Title: **Stochastic Processes**		
Credits:	T- 4	**Core- 2**

Course Outcome:
The main objective of this course is to develop awareness for the use of stochastic models for representing random phenomena evolving in time such as inventory or queuing situations or stock prices behaviour.

Syllabus

Probability generating function, Binomial, Poisson, Geometric and Negative Binomial. Convolution. General Stochastic Process, Definition, classification and examples. Compound distribution.

Branching process, Properties of Generating function, Probability of extinction, Distribution of total progeny. Random walk, first passage time, Gambler's ruin problem, duration of game.

Markov chains, higher transition probabilities. Classifications of states and chain, determination of higher transition probabilities. Stability of Markov system, limiting behavior. P

Poisson process and related distribution. Generalization of Poisson process. Birth process, Yule-Furry process, Generalized Birth death processes, Linear Birth death processes.

Books Recommended:

1. Medhi, J. (1982): Stochastic process, New age international, New Delhi.
2. Bhat, B.R.: Stochastic models, Analysis and applications
3. Ross, S.M.: Stochastic process, New age international, New Delhi.
4. Bailey, N.T.J.: Elements of Stochastic process.

Programme/Class: P.G.		Year: Second (for 2 year PG Programme)	Semester: IV
		Year: First (for 4 year UG Passed Students)	Semester: II
Subject: STATISTICS			
Course Title: **Data Analysis Using R**			
Credits:	P- 4	**Core- 3**	
Course Outcome: The main objectives of this course are: To learn the principles and methods of data analysis, to provide a basic understanding of methods of analyzing data from different fields and to learn R software.			
Syllabus			
Introduction of R, R-Calculator, Vector and Matrices, Loading Packages, Data Entry and Exporting Data. Identify the components of R interface for Windows. Standard Arithmetic Calculation: Both Numerical and Matrix. Access R help, Load R Packages, Import and Export Data. Summary Statistics, Creating Summary for a Single Group and by different groups, Graphics in R. Probability and Distributions. Parametric and Nonparametric tests. Karl Pearson's Correlation. Simple and Multiple Regressions, Regression Diagnostics. Tabular Data and Analysis of Categorical Data. R Programming, Grouping, Loops and Conditional execution, functions, grouped expression and control statements, writing own functions. Single and double integration, Gaussian integration. Monte Carlo Methods: Monte Carlo integration, Metropolis-Hastings and Gibbs sampler methods. Application of Monte Carlo methods to compute expected values of functions of random variables. Random number generation by linear congruential, mixed congruential, inverse transforms, composition and acceptance-rejection methods. Statistical tests for pseudo random numbers. Bootstrap methods: resampling paradigms, bias and standard errors, confidence intervals, bootstrapping in regression. Jackknife and cross validation. Multivariate analyses. EM algorithm: applications to missing and incomplete data problems, mixture models. Smoothing with kernels: density estimation, choice of kernels.			
Books Recommended: 1. McLachlan, G.J. and Krishnan, T. (1997). The EM Algorithms and Extensions, John Wiley & Sons. 2. Petra, Kuhnert and Bill, Venables: An Introduction to R; Software for Statistical Modeling and Computing. 3. Robert, J. Knell: Introductory R: A Beginner's Guide to Data Visualization and Analysis using R. 4. Robert, C.P. and Casella, G. (2004) Monte Carlo Statistical Methods, 2nd ed., Springer 5. Rubinstein, R.Y. (1981). Simulation and the Monte Carlo Method, John Wiley & Sons. 6. Sarah, S (2014): Using R for Statistics. 7. Sheskin, D. J. (2004): The Handbook of Parametric and Nonparametric Statistical Procedures, 3rd Edition, Chapman and Hall/CRC. 8. Everitt, Brian S. and Hothorn, Torsten (2006): A Handbook of Analyses Using R. Chapman & Hall. 9. Voss, J. (2014). An introduction to statistical computing: a simulation-based approach, Wiley series in computational statistics.			

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: IV
	Year: First (for 4 year UG Passed Students)	Semester: II

Subject: STATISTICS		
Course Title: **Financial Statistics**		
Credits:	T- 4	**Elective- 1**

Course Outcome:
To develop the practical knowledge towards Financial Statistics, Time models, Martingales and their Applications, CRR Model, to study the Financial Markets Instruments and Jump Processes etc.

Syllabus

Review and Extensions- Assets, Portfolios and Arbitrage, Derivatives, Pricing, Hedging, Greeks, Discrete Time Models, Continuous Time Models, Random walk, Geometric Random Walk, Brownian Motion, Wiener Process.

Review and Extensions- Stochastic Calculus, Stochastic Differential Equations, Partial Differential Equations, Black- Scholes' PDE, Martingales and their Applications in Pricing of Assets, Plain Vanilla Options, Greeks of Plain Vanilla Options, Estimation of Volatility, CRR Model.

Financial Markets Instruments- Exotic Options, Reflection Principle, Asian Options, Change of Numeraire, Pricing of Exchange Options, Forward Rates Modelling, Forward Vesicek Rates, Interest Rates Derivatives and their Pricing, Default Risk in Bond Markets, Credit Default Swaps.

Jump Processes- Poisson Process, Compound Poisson Processes, Stochastic Integrals with Jumps, Itô- Integral with Jumps, Stochastic Differential Equations with Jumps, Girsanov Theorem for Jumps Processes, Lèvy Processes, Pricing and Hedging in Jump Processes, Risk Neutral Measures, Black Scholes' PDE with jumps.

Books Recommended:

1. Lamberton, D. and Lepeyre, B. (2008). Introduction to Stochastic Calculus Applied to Finance, 2nd ed., Chapman and Hall/CRC Press.
2. Privault, N. (2014). Stochastic Finance –An Introduction with Market Examples, Chapman and Hall/CRC. Financial Mathematics Series, CRC Press, Boca Raton, 2014.
3. Tankov, P. (2010). Financial Modeling with Lèvy Processes, e-Book.

| Programme/Class: P.G. | Year: Second (for 2 year PG Programme) | Semester: IV |
| | Year: First (for 4 year UG Passed Students) | Semester: II |

Subject: STATISTICS

Course Title: **Ethics, Integrity and Aptitude**

Credits:	T- 4	**Elective- 1**

Course Outcome: This paper includes questions to develop the student's attitude and approach to issues relating to integrity, probity in public and social life and his/her approach to various issues and conflicts faced by him/her while dealing with society. Case study approach may be utilized to inculcate these values and appropriate positive aptitude for in depth understanding.

Syllabus

Ethics and Human Interface- Essence, determinants and consequences of Ethics in human actions; dimensions of ethics; ethics in private and public relationships. Human Values - lessons from the lives and teachings of great leaders, reformers and administrators; role of family, society and educational institutions in inculcating values.

Attitude- content, structure, function; its influence and relation with thought and behaviour; moral and political attitudes; social influence and persuasion. Aptitude and foundational values for integrity, impartiality and non-partisanship, objectivity, dedication to social service, empathy, tolerance and compassion towards the weaker-sections.

Emotional intelligence-concepts, and their utilities and application in academic, corporate sector and public services. Contributions of moral thinkers and philosophers from India and world. Values and Ethics in academic and pubic administration- Status and problems; ethical concerns and dilemmas in government and private institutions; laws, rules, regulations and conscience as sources of ethical guidance; strengthening of ethical and moral values in academic life

Probity in Education and Research- Concept of Intellectual Property Rights (IPR) , Philosophical basis of teaching and probity; Information sharing and transparency in Education and Research, Codes of Ethics, Codes of Conduct, Citizen's Charters, Work culture, Quality of service delivery, challenges of corruption.

Global Issues: Globalization and MNCs –Cross Culture Issues – Business Ethics – Media Ethics – Environmental Ethics – Endangering Lives – Bio Ethics – Computer Ethics – War Ethics – Research Ethics -Intellectual Property Rights.

Books Recommended:

1. P.D.Sharma: Ethics, integrity and Aptitude, Rawat Publications, Jaipur.
2. G. Subba Rao and P.N. Roy Chowdhury: Ethics, Integrity and Aptitude, Access Publishing.
3. Nanda Kishore Reddy and Santosh Ajmera: Ethics, Integrity and Aptitude, Mcgraw Hill Education.
4. Professional Ethics by R. Subramaniam – Oxford Publications, New Delhi.
5. Ethics in Engineering by Mike W. Martin and Roland Schinzinger – Tata McGraw-Hill – 2003.
6. Professional Ethics and Morals by Prof.A.R.Aryasri, DharanikotaSuyodhana – Maruthi Publications.
7. Engineering Ethics by Harris, Pritchard, and Rabins, Cengage Specific, New Delhi.
8. Human Values & Professional Ethics by S. B. Gogate, Vikas Publishing House Pvt. Ltd., Noida.
9. Engineering Ethics & Human Values by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Specific Pvt. Ltd – 2009.
10. Professional Ethics and Human Values by A. Alavudeen, R.Kalil Rahman and M. Jayakumaran – University Science Press.
11. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: IV
	Year: First (for 4 year UG Passed Students)	Semester: II

Subject: STATISTICS		
Course Title: **Data Analysis using STATA**		
Credits:	P- 4	**Elective- 2**

Course Outcome:

This program is designed to improve the knowledge on data analysis using sophisticated computer software called STATA. STATA is the most preferred computer software in developed nations. Our aim is to strengthen the students on data analysis using STATA.

Syllabus

STATA Environment: STATA windows- command window and result window, Review window, variable window, data browser, data editor, do-file editor, viewer and Help. Fileslog files, STATA data files; initial setup- memory allocation and setting setup file and other system parameters; functions, operators and expressions in STATA; STATA command syntax; working with STATA: basic unit of data, loading and saving data, working with data, value and variable labels, some elementary commands-commands for loading or importing and saving data in main memory, commands related to data manipulation, commands related to tabulation, command related to combining data, commands for reshaping/ re-structuring the datasets and commands which having `replace` options. other important commandssorting, dealing with the variables and observations, and dealing with missing data.

Role of log files, concept of immediate commands, other immediate handy options- sample size and power estimation. Exploratory data analysis. Frequencies analysis, cross tabulations, descriptive Statistics, Three-way crosstabs, creation and editing of basic graphs. formatting graphs. Advanced Graphs-Scatter plots, Histograms, Catplot, Bars etc.

Analysis of continuous and binary outcomes, chi-squared test, t-test, one-way ANOVA, correlation, rank correlation, Simple linear regression, multiple linear regression.

Multivariate logistic regression analysis, some epidemiological tests using STATA, Factor analysis, Principal component analysis

Preparing data for advance statistical analysis- dealing with dates, setting time and time series variables. Advanced analysis- analysis of longitudinal data in STATA, Survival Analysis in STATA and Time series analysis

Books Recommended:

1. Rabe- Hesketh, S. and Everitt, Brain (2007): A handbook of statistical analysis using STATA, Chapman Hall/CRC Press.
2. Agresti, A. (2013): Categorical Data Analysis, Third Edition, Wiley.
3. Kothari, Prasad (2015): Data Analysis with STATA. Packt Publishing.
4. Longest, Kyle C. (2019). Using STATA for Quantitative Analysis. SAGE Publications.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)	Semester: IV
	Year: First (for 4 year UG Passed Students)	Semester: II

Subject: STATISTICS		
Course Title: **Qualitative Data Analysis**		
Credits:	P- 4	**Elective- 2**

Course Outcome:

This course equips students with the necessary skills to analyse and interpret qualitative data to answer research and policy questions.

Syllabus

Testing independence for ordinal data: linear trend alternative to independence, extra power with ordinal test, choice of score, trend tests for Ix2 and 2xJ tables, nominal-ordinal tables. Exact inference for small samples: Fisher's exact test for 2x2 table, p-values and conservatism for actual P(Type I error), small sample confidence interval for odds ratio. Association in three-way table: partial tables, conditional versus marginal associations, Simpson's paradox, conditional and marginal odds ratios, conditional independence versus marginal independence, homogeneous associations.

Models for binary response variables: logit, log linear, linear probability and logistic regression models. Logit models for categorical data, probit and extreme value models, models with log-log link, model diagnostics. Fitting logit models, conditional logistic regression, exact trend test. Log-linear models for two dimensions - independence model, saturated model and models for cell probabilities. Item Response Theory, Rasch Model

Loglinear models for two-way and three-way tables: log-linear model of independence for two-way table, saturated model for two-way tables, log-linear models for three-way tables. Inference for loglinear models: Chi-squared goodness of fit tests, log-linear cell residuals, tests about conditional associations, confidence intervals for conditional odds ratios, three factor interactions, large samples and statistical versus practical significance.Fitting Loglinear models. Strategies in model selection, analysis of residuals, Cochran-Mantel-Haenszel test

Models for Matched Pairs: Comparing Dependent Proportions, Conditional Logistic Regression for Binary Matched Pairs, Marginal Models for Square Contingency Tables, Symmetry, Quasi-symmetry, and Quasiindependence, Analyzing Repeated Categorical Response Data: Comparing Marginal Distributions: Multiple Responses, Marginal Modeling: Maximum Likelihood Approach, Marginal Modeling: Generalized Estimating Equations Approach, Quasi-likelihood and Its GEE Multivariate Extension, Markov Chains: Transitional Modeling

Books Recommended:

1. Agresti, A. (2010): Analysis of ordinal categorical data, Wiley.
2. Agresti, A. (2013): Categorical Data Analysis, Third Edition, Wiley.
3. Bilder, C. R. and Loughin, T.M. (2013): Analysis of Categorical Data with R, CRC Press.
4. Bowerman, O. (2000): Linear Statistical models.
5. Congdon, P. (2005): Bayesian Models for Categorical Data, Willey.
6. Kleinbaum, D. G. (1994): Logistic Regression, Springer Verlag.
7. Sutradhar, B. C. (2014): Longitudinal Categorical Data Analysis, Springer.
8. Upton, G.J.G. (2017): Categorical Data Analysis by Example, Wiley.

Programme/Class: P.G.	Year: Second (for 2 year PG Programme)		Semester: IV
	Year: First (for 4 year UG Passed Students)		Semester: II

Subject: STATISTICS

Course Title: **Project Work**

Credits:	P- 4	**Elective- 2**

Course Outcome:

Project-based learning thrusts students into the realm of real-world scenarios where they must navigate complexities and uncertainties. This exposure helps sharpen their problem-solving skills, making them adept at finding solutions under pressure and working effectively and efficiently and they learn that how to interpret data effectively, identify trends, and make informed decisions based on measurable outcomes.

Syllabus

The Project Work will spread over the whole semester. A project may be undertaken by a group of students. However, the project report shall be submitted by each member of the group separately. A project report shall clearly state the problem addressed, the methodology adopted, the assumption and the hypotheses formulated, any previous reference to the study undertaken, statistical analyses performed and the broad conclusion drawn.

Guidelines for Project Submission

The topic for the project should be a theme or a problem in an area of your choice within the framework of the contents of the courses studied. You are free to work on any topic or theme of any discipline.

Format of the project: The project should not be less than 100 pages (including the title page, acknowledgements and bibliographic references). Essential statistical and documentary appendices such as questionnaires, surveys, interview schedules or other data collection materials may be added to the total, but these should be kept to an absolutely relevant minimum. Project should be typed or word-processed on A-4 size paper.

All material in the main part of the project, excluding the bibliographic references, should have 1.5- line spacing and printed on one side of the paper with one-inch margins. Notes and references should be in the prescribed format. Pages should be numbered sequentially at bottom-centre.

The final project should be bound. The sequence of the material in the project should be in the'following order:

1) The Cover Page of the project should state the title of the project, the name and enrolment number of the student, the name of the Academic supervisor, the degree programme for which it is prepared, the name of the university/college and the month and year of submission.

2) Title Page should give the same information as on the cover, together with the statement: "This project is submitted in partial fulfilment of the requirements for the degree of …", followed by the date (month and year) of submission.

3) Certificate issued by the Academic Supervisor that the project submitted by the candidate is his/ her own work and that the same be placed before the examiner.

4) Table of Contents should list the contents of the project by chapters, with sections where appropriate, and the page number for each, together with the page number for the bibliographic references and figures, tables and maps, if any.

5) Acknowledgements: You may wish to acknowledge any help that you have received in the preparation of the project.

6) Main Text comprises of the chapters (usually three, four or five, including the Introduction and Conclusion) bibliographic references and appendices, if any. Each main heading (chapters, bibliographic references and appendices) should start on a new page; sections within main headings may continue on the same page. Numbering of the main text of the dissertation should be sequential. Bibliographic references should list all works cited in the chapters and other valuable sources used in the preparation of the project.

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