1595
23/06/25.

The Registrar

Raja Mahendra Pratap Singh Univ.

Aligarh.

23/06/2025

Sub: FYUP Course in Statistics.

Sir,

With reference to your letter No 1265 Dt 21/6/25 & 1212 Dt 17/06/2025 I am submitting you the syllabus after approved by BOS ~~at~~ online Dt 18/06/2025

Submitted to you for kind approval.

(Prof Anil Kr Vershney)

Deptt of Stat

DR (Aff)

24/6/25

Registrar

24/06/25

SEMESTER WISE TITLES OF THE PAPER IN U.G.(HONOR'S), U.G. (HONOR'S WITH RESERACH) & P.G. in SUBJECTS OF ARTS AND SCIENCE FOR PRACTICAL SUBJECTS

YEAR	SEM	COURSE CODE	PAPER TITLE	THEORY / PRACTICAL	CREDIT	TOTAL
4th YEAR	VII	RB060701T	Real Analysis and Matrix Algebra	THEORY	4	20/16
		RB060702T	Probability and Distribution Theory	THEORY	4	
		RB060703T RB060704T	**Choose both for U.G.(Honor's) and one for U.G. (Honor's with Research) -** I. Sampling Theory II. Computer Science	THEORY	4 4	
		RB060705P	PRACTICAL	PRACTICAL	4	
	VIII	RB060801T	Statistical Inference–I	THEORY	4	20/24
		RB060802T	Linear Estimation and Design of Experiments	THEORY	4	
		RB060803T RB060804T	**Choose both for U.G.(Honor's) and one for U.G. (Honor's with Research) -** I. Multivariate Analysis II. Data Analysis Using R	THEORY	4 4	
		RB060805P	**RESEARCH PROJECT (SUBMISSION AND EVALUATION)**	PRACTICAL	8	

FOR POST GRADUATION COURSES

5th YEAR	IX	RB060901T	Statistical Inference–II	THEORY	4	16
		RB060902T	Operations Research	THEORY	4	
		RB060903T RB060904T	**Choose both for U.G.(Honor's) and one for U.G. (Honor's with Research) -** I. Population Studies II. Official Statistics	THEORY THEORY	4 4	
		RB060905P	PRACTICAL	PRACTICAL	4	
	X	RB061001T	Decision Theory and Bayesian Inference	THEORY	4	24
		RB061002T	Advanced Sample Survey	THEORY	4	
		RB061003T RB061004T	**Choose both for U.G.(Honor's) and one for U.G. (Honor's with Research) -** I. Data Science II. Research Methodology	THEORY THEORY	4 4	
		RB061005P	**RESEARCH PROJECT (SUBMISSION AND EVALUATION)**	PRACTICAL	8	

Real Analysis and Matrix Algebra

Course Code: RB060701T

Unit 1

Axiomatic introduction of real number system as an ordered field with order completeness property, Archimedean property, Extended Real number system, Schwartz Inequality, Euclidean space R^k Wiestrass Theory in R^1, Limit point of a sequence, Cauchy's General Principle of convergence in R^1.

Unit 2

Riemann Integrals, Properties of Darboux Sums, Conditions of Integrability, Classes of Integrable Functions, Algebra of Integrable Functions, Riemann - Stieltges Integral, Existence Theorem, Uniform Convergence Test for Uniform Convergence, Properties of Uniformly Convergent Sequence and Series.

Unit 3

Algebra of Matrices, Trace, Determinants, Inverse, Generalised Inverse, Rank, Linear Equations, Characteristic Roots and Vectors.

Unit 4

Vector Spaces, Subspaces, Linear Independence and Dependence of Vectors, and Relative theorems Dimension and Basis of a Vector Space, Introduction to inner product Space.

Books Recommended:

1. Mathematical Analysis—T.M. Apostol
2. Principles of Mathematical Analysis—Walter Rudin
3. Topics in Algebra of Matrices—S. Biswas
4. Linear Algebra—A.R. Rao and P. Bhimasankaram
5. Matrix Algebra Useful for Statistics—S.R. Searle
6. A Course of mathematics Analysis—Shanti Narayan and P.K. Mittal

Probability and Distribution Theory

Course Code: RB060702T

Unit 1

Classes of sets, sequences of sets, limit superior and limit inferior of a sequence of sets, fields, sigma field, minimal sigma field, Borel sigma field on real line. Event and event space, sample space, probability measure, properties of measure, independent events, conditional probability.

Unit 2

Measurable functions, random variables, functions of random variables, induced probability measure. Distribution function, joint and marginal and conditional distribution in R^n. Expected values, moments, some related inequalities.

Unit 3

Probability generating function, moment generating function, characteristic function and their properties: uniqueness, continuity and inversion with application. Weak (WLLN) and Strong (SLLN) Law of Large Numbers.

Unit 4

Transformation of random variables. Modes of convergence of a sequence of random variable. Holder's inequality.

Books Recommended:

1. Bhat, B.R.(1981). Modern Probability Theory, III Edition, New Age International(P).
2. Das,K.K and Bhattacharyajee,D.(2008). A Treatise On Statistical Inference And Distributions, Asian Books, New Delhi.
3. Feller,W.(1969). Introduction To Probability And Its Applications, Vol.II, Wiley Eastern Ltd.
4. Hogg, R.V. Craig, A. and Mckean, J.W. (2005). Introduction To Mathematical Statistics, Sixth Edition, Pearson.
5. Johnson, S. and Kotz (1995). Distributions In Statistics, Vol.-I, II And III, Houghton And Miffin.
6. Loeve,M.(1978). Probability Theory (Springer Verlag), Fourth Edition.
7. Mood, A.M., Graybill, F.A. and Boes, D.C. (1974). Introduction To Theory Of Statistics, Third Edition, Mc Graw Hill.
8. Mukhopadhyaya,P.(1996). Mathematical Statistics, Calcutta publishing house.
9. Rohatgi,V.K.(1984). An introduction to probability theory and mathematical statistics, Wiley Eastern.

Sampling Theory

Course Code: RB060703T

Unit 1

Introduction: Census and sample surveys, advantages and disadvantages of sample surveys, Limitations of sampling, Basic principles of sample survey, Principle steps in sample survey, Sampling and non-sampling errors, Inter-penetrating, Sub samples, Pilot survey.

Simple Random Sampling: Simple random sampling, Sampling from finite populations with and without replacement, Unbiased estimation and confidence intervals for population mean and total, Simple random sampling of attributes.

Unit 2

Stratified random sampling, different types of allocation, allocation problems, problem of allocation with more than one item. Effect of deviation from optimum allocation, construction of strata, number of strata, method of collapsed strata. Systematic sampling (circular, population with trend), domain estimation in SRS. Comparison with SRS and stratified random sampling. Cluster sampling with equal and unequal cluster sizes, estimation of mean and variances. Efficiency of cluster sampling in terms of intra- class correlation coefficient.

Unit 3

Ratio method of estimation- concept of ratio estimators, ratio method of estimation in simple random sampling, their bias, variance/MSE. Conditions under which ratio estimators are BLUE, ratio estimators in stratified random sampling. Regression method of estimation- concept of regression estimators, difference estimator, regression estimator in SRS, their bias, variance/MSE, regression estimator in stratified random sampling.

Unit 4

Two stage sampling with equal first stage units and unequal first stage units- estimator of population mean and variance/MSE. Determination of optimal sample sizes at both the stages. Double sampling and its use in ratio and regression method of estimation. Non-sampling errors, error in surveys, observational error: mathematical model of measurement of observational error. Incomplete samples. Effect of non-response.

Books Recommended:

1. Cochran,W.G.(1997). Sampling Techniques, Wiley Eastern, New Delhi.
2. Des Raj and Chandok,P. (1998). Sampling Theory, Narosa, New Delhi.
3. Mukhopadhyay, P.(1998). Theory And Methods Of Survey Sampling, Pentice Hall of India, New Delhi.
4. Murthy,M.N.(1977). Sampling Theory And Methods, Statistical Publishing Society, Kolkata.
5. Sukhatme,P.V.,Sukhatme,B.V., Sukhatme, S. and Asok,C.(1984). Sampling Theory Of Surveys And Applications, Iowa State University press and IARS.

Computer Science

Course Code: RB060704T

Unit 1

Introduction to Computer, Evolution of Computer Technology, Types of Computers, Basic elements of Computer, Components of Computer, Generations of Computer and Computer languages.

Unit 2

Introduction to R: What is R? Installation of R and its packages, R environment, creation of data objects (vector, matrices, arrays, lists and data frames) in R, Management of data through R, Data Import and export. Basic manipulation of data and summary.

Unit 3

Using R-Graphical representation of data, Tabulation of data, Descriptive Statistics, Summarizing Data, Creating & Editing Charts, modifying data values, Sorting & Selecting Data Values, Chi- Square and t-test.

Unit 4

Data Analysis in R: Correlation Analysis, Linear Regression, Assumptions of Regression, Introduction to Multiple Regression, Logistic Regression, One-way ANOVA, Multiple comparison test, Non - Parametric tests.

Books Recommended:

1. Argyrous, G. (2012), Statistics for Research: With a Guide to SPSS, Sage South Asia; Third Edition.
2. Cox & Lambert (2010), Microsoft Word 2010: Step by Step, Microsoft Press.
3. George Darren: SPSS for Window Step by Step.
4. Griffith, A. (2007), SPSS For Dummies, Published by Wiley Publishing, Inc.
5. Hothorn, T and Everitt, B.S. (2014). A Handbook of Statistical Analyses Using R. Chapman & Hall/CRC Press, Boca Raton, Florida, USA, 3rd edition.
6. Knell, R.J. (2013), Introductory R: A Beginner's Guide to Data Visualisation and Analysis using R.
7. Norton, P. (2010), Introduction to Computers, McGraw Hill Education (India) Private Limited.
8. Patric L. A. K. and Feeney B. C.: A Simple Guide to SPSS.
9. Sheridon J Coaks: SPSS

Statistical Inference–I

Course Code: RB060801T

Unit 1

Data Reduction: Data reduction, Sufficiency, Sufficient partition, Completeness, Minimal sufficiency and Ancillary statistic, Basu's theorem, Exponential families and Pitman families, Invariance property of Sufficiency under one-one transformations of sample and parameter spaces, Minimal sufficiency and completeness, Neyman factorization theorem (Proof for discrete case only), examples.

Unit 2

Point Estimation: Estimability of parametric functions, Unbiased Estimator, Rao-Blackwell and Lehmann-Scheffe theorem, some special class of distributions admitting complete sufficient statistics, extension of results to multi parameter case. Fisher Information for one and several Parameters models Minimum Variance Unbiased Estimators (UMVUEs), Lower bounds for variance of estimators, necessary and sufficient conditions for MVUE.

Unit 3

Asymptotic Inference: Consistency and asymptotic relative efficiency of estimators, Consistent and Asymptotically normal (CAN), Best Asymptotically Normal (BAN) estimators and related properties.

Unit 4

Maximum Likelihood Estimation (MLE), Its small and large sample properties. Method of moments, least squares and method of minimum chi-square. Hazoor Bazar's Theorem.

Books Recommended:

1. Lehmann, E.L. (1986): Testing statistical hypotheses (Student Edition).
2. Rao, C.R. (1973): Linear Statistical inference.
3. Goon A.M., Gupta M. Dasgupta B. (1980): An Outline of Statistical Theory
4. Zacks, S. (1971): Theory of statistical Inference, John Wiley & Sons, New York.

Linear Estimation and Design of Experiments
Course Code: RB060802T

Linear Estimation:

Unit 1

The Linear Model, Estimable functions, Estimation and Error space, Best estimates, Gauss-Markov theorem, Variance and Covariance of Estimates, Sums of Squares, Degrees of Freedom, Linear Hypothesis, Estimable Linear Hypothesis, The Generalized t-test and Generalized F-test.

Design of Experiment:

Unit 2

Planning of experiment, Completely Randomized Design, Randomized Block Design, Latin Square Design. Analysis of Covariance with One Concomitant Variable.

Unit 3

General Incomplete Block Design, Balanced Incomplete Block Design, Partially Balanced Incomplete Block Design (with two associate classes), Split Plot Design.

Unit 4

Symmetric and Asymmetrical Factorial Design, Yates method of analysis for 2^n and 3^n Design, Partial and total confounding in 2^2, 3^2 and 3^3 Design. Fractional Replication in 2^n Design.

Books Recommended:

1. Cochran, W.G. and Cox, G.M. (1959). Exponential Designs, Asia Publishing House, Singapore.
2. Das, M.N. and Giri, N.C. (1986). Design and Analysis of Experiments, Wiley Eastern Limited.
3. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer. First Indian Reprint 2006.
4. Joshi, D.D. (1987). Linear Estimation and Design of Experiments, Wiley Eastern, New Delhi.
5. Montgomery, D.C. (2005). Design and Analysis of Experiments, Sixth Edition, John Wiley and Sons.

Multivariate Analysis
Course Code: RB060803T

Unit 1

Multivariate normal distribution, moment generating function and characteristic function, marginal and conditional distributions, multiple and partial correlation coefficients. Maximum likelihood estimators of the mean vector and covariance matrix, Distribution of sample mean vector. Wishart distribution and its properties.

Unit 2

Hotelling T^2 -statistic as a function of likelihood ratio criterion, its distribution, optimum properties and applications. Generalised variance, distribution of sample generalised variance. Classification problems, Fisher's discriminant function. D2 -statistic and its application.

Unit 3

Analysis of dispersion, and testing of general linear hypothesis, equality of mean vectors, Wilk's lambda effect, equality of dispersion matrices. Principal components, maximum likelihood estimates of principal components and their variances.

Unit 4

Canonical variates and correlation- use, estimation and computation. Cluster analysis, factor analysis.

Books Recommended:

1. Anderson, T.W (1958). An Introduction to Multivariate Statistical Analysis, Second Edition, Wiley.
2. Giri, N. C. (1977). Multivariate Statistical Inference, Academic Press, New York.
3. Johnson, R. A. and Wichern, D.W. (2003). An Introduction to Applied Multivariate Analysis, 5/e, Pearson Education.
4. Johnson, R. A. and Wichern, D. W. (1986). Applied Multivariate Analysis, Wiley.
5. K shirsagar, A. M. (1972). Multivariate Analysis, Marcel-Dekker.
6. Morrison, D.F. (1976). Multivariate Statistical Methods, Mc Graw-Hill.
7. Singh, B.M. (2002). Multivariate Statistical Analysis, South Asian Publishers, New Delhi.
8. Srivastava, M.S. and Khatri, C.G. (1979). An Introduction to Multivariate Statistics, North Holland.

Data Analysis Using R
Course Code: RB060804T

Unit 1
R-Programming, Overview of R, R data Types & Objectives, Reading & Writing Data, Control Structures, Function, Scoping Rules, Loop Functions, Simulation. Writing functions, Looping in R, Operations on vectors and matrices.

Unit 2
Tabulation and Graphics to Display the Data Distribution with R (scatter plot, histogram, Q-Q Plot, P-P plot, Box Plot etc.). High level plotting functions, Low level plotting functions, Interactive graphic function. Measure of Statistical Distribution (measure of central tendency and Dispersion).

Unit 3
Generation of random numbers and simple inferences, Probability distribution, Sampling distributions- t-test, chi-square test, z-test, F-test, Parametric and non-parametric tests, Correlation & Regression, Analysis of Variance.

Unit 4
Meta-Analysis (Systemic Review and meta regression analysis) Non parametric Inference (Bootstrap), Stochastic Process (Markov chain, Metropolis- Hastings and Gibbs sampler). Monte Carlo computation, Simulation, Application of Monte Carlo methods.

Books Recommended:

1. Reimann, C., Filzmoser, P., Garrett, R., & Dutter, R. (2011). Statistical data analysis explained: applied environmental statistics with R. John Wiley & Sons.
2. Schmuller, J. (2017). Statistical Analysis with R For Dummies. John Wiley & Sons.
3. Gareth, J., Daniela, W., Trevor, H., & Robert, T. (2013). An introduction to statistical learning: with applications in R. Spinger.
4. Dalgaard, P. (2020). Introductory statistics with R. Ripley, B. D. (2009). Stochastic simulation. John Wiley & Sons.
5. Tattar, P. N., Ramaiah, S., & Manjunath, B. G. (2016). A Course in Statistics with R. John Wiley & Sons.
6. Robert, C., & Casella, G. (2011). A short history of Markov chain Monte Carlo: Subjective recollections from incomplete data. Statistical Science, 26(1), 102-115.
7. Hothorn, T., & Everitt, B. S. (2006). A handbook of statistical analyses using R. Chapman and Hall/CRC.
8. Gilks, W. R., Richardson, S., & Spiegelhalter, D. (Eds.). (1995). Markov chain Monte Carlo in practice. CRC press
9. Rizzo, M. L. (2019). Statistical computing with R. Chapman and Hall/CRC.
10. Kohl, M. (2015). Introduction to statistical data analysis with R. London: bookboon. Com

Statistical Inference–II
Course Code: RB060901T

Unit 1
Interval estimation, Confidence interval, one sided lower and upper confidence intervals, Two-sided confidence intervals, Pivotal method of constructing Confidence Interval, General method of constructing large sample confidence intervals with examples.

Unit 2
Shortest length Confidence Intervals, and Relationship with the Testing of Hypothesis. Estimation of Quantiles, Construction of Confidence Interval for Population Quantiles.

Unit 3
Non-parametric or distribution-free methods, Tests for location, Sign test for one and two-sample problems, Wilcoxon's signed rank test. Test for Randomness, Median test, Mann-Whitney test, Kolmogorov-Smirnov's test for one and two samples.

Unit 4
The sequential probability ratio test (SPRT) and its application to Binomial, Poisson, Normal, and other simple cases. Operating characteristic (OC) function of SPRT, Average sample number (ASN) function and their application, termination theorem of SPRT with probability one, Wald's fundamental identity and its uses.

Books Recommended:

1. Lehmann, E.L. (1986): Testing statistical hypotheses (Student Edition).
2. Rao, C.R. (1973): Linear Statistical inference.
3. Goon A.M., Gupta M. das Gupta B. (1980): An Outline of Statistical Theory.
4. Zacks, S. (1971): Theory of statistical Inference, John Wiley & Sons, New York.

Operations Research
Course Code: RB060902T

Unit 1
Definitions of Operation Research, History of Operations Research, Scope of Operations Research, Models in Operations Research. Hyperplane, Convex Sets, Convex Functions, Convex Null, Local and Global Extrema.

Unit 2
Introduction to LPP, Graphical method to solve LPP, Simplex method, Revised simplex method, Big M method, two phase method.

Unit 3
Network analysis, Dynamic programming.

Inventory Control—Meaning and Importance, Various Costs Involved in Inventory Control, Deterministic Models, Multi-item Deterministic Models with Restrictions, Probabilistic Inventory Models, Models with Lead time, Inventory Models with Price Breaks.

Unit 4
Essential Features of Queuing System, Steady State, Transient State, Distribution of Arrivals, Inter - Arrivals and Waiting Time, Queuing Models M/M/1: (∞/FIFO), M/M/1: (N/FIFO), M/M/C: (∞/FIFO)

Books Recommended:

1. Operations Research—B.S. Goel and S.K. Mittal
2. Operations Research—K. Swarup, P.K. Gupta and M. Mohan
3. Operations Research—S.D. Sharma
4. Operations Research: Theory and application—J.K. Sharma
5. Operations Research: An Introduction—H.A. Taha 6. Linear Programming—G. Hedley.

Population Statistics
Course Code: RB060903T

Unit 1
Definition and scope of demography, sources of demographic data: census, registration and sample surveys. Errors in census and vital statistics and their adjustments, Whipple's and Myer's indices. Chandrasekharan Deming formula to check completeness of registration data.

Unit 2
Fertility, its measures. Measures of reproduction and replacement. Fertility models. Distribution of time of first birth/conception, number of births/ conceptions in a specified time; inter-live birth intervals (for both homogeneous and non-homogeneous groups of women), estimation of parameters.

Unit 3
Mortality, its measures. Standardised death rates. Life table, its type. Construction of complete and abridged life tables. Macham's and Gompertz curve. Migration rates and ratios. Method to estimate intercensal migration using vital statistics, survival ratio and growth rate. Migration models.

Unit 4
Theory of stable population, quasi and stationary population. Stochastic models of population growth. Growth curves and methods of their fitting. Population estimates and projection. Component method of population projection.

Books Recommended:

1. Benjamin, B. (1969). Demographic Analysis, George, Allen and Unwin.
2. Biswas, S. (1988). Stochastic Processes in Demography and Applications, Wiley Eastern, New Delhi.
3. Chiang, C.L. (1968). Introduction To Stochastic Processes in Biostatistics, John Wiley, New York.
4. Cox, P.R. (1970). Demography, Cambridge University Press.
5. Keyfitz, N. (1977). Applied Mathematical Demography, Springer Verlag.
6. Kumar, R. (1986). Technical Demography, Wiley Eastern Ltd.
7. Pathak, K.B. and Ram, F. (1992). Techniques Of Demographic Analysis, Himalayan Publishing House, Bombay.
8. Shryock, H.S. (1976). The Methods and Materials of Demography, Academic Press, New York.
9. Spiegelman, M. (1969). Introduction To Demographic Analysis, Harvard University Press.
10. Wolfenden, H.H. (1954). Population Statistics and Their Compilation, American Acturial Society.

Official Statistics
Course Code: RB060904T

Unit 1
Introduction to Indian and International Statistical System, Methods of Collection of Official Statistics, Their Reliability and Limitations. Role, Functions and Activities of Central and State Statistical Organizations, Organization of large-scale Sample Surveys.

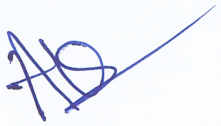
Unit 2
Role of national Sample Survey Organization, Other Agencies Responsible for Data Collection and Their Main Functions, Principal Publications on various Topics of Data Collection, Scope and Contents of Population Census of India.

Unit 3
Population Statistics, Agricultural Statistics, Medical Statistics, Industrial Statistics, Trade Statistics, Price Statistics, Statistics of Labour & Employment, Statistics of Transport and Communication.

Unit 4
Financial and banking Statistics, Miscellaneous Statistics. National Income and Its Computation, Utility and Difficulties in Estimation of National Income.

Books Recommended:

1. Basic Statistics Relating to Indian Economy (CSO) 1990
2. Guide to Official Statistics (CSO) 1999
3. Statistical System in India (CSO) 1995
4. Principles and Accommodation of National Population Censuses (UNESCO)
5. National Accounts Statistics—Sources and Health (CSO) 1980



Decision Theory and Bayesian Inference
Course Code: RB061001T

Unit 1
Bayes Estimation: An outline of Bayesian' framework, Bayes Theorem, Types of priors, Conjugate prior, proper and improper prior, subjective prior etc., Methods of obtaining 12 priors. Types of loss functions, Squared error loss function, Absolute error loss, 0-1 loss, Asymmetric loss functions.

Unit 2
Computation of posterior distribution, Bayesian calculations, Monte Carlo Technique, Approximation methods, Emperical method, Gibbs sampler.

Unit 3
Bayesian Interval Estimation: Credible Intervals, Highest Posterior Density Regions, Interpretation of the Confidence Coefficient of an Interval & its Comparison with the Coefficient of Class1cal Confidence Intervals.

Unit 4
Bayesian Hypothesis testing: Specification of the Appropriate Form of the Prior Distribution for a Bayesian Testing of Hypothesis Problem, Prior Odds, Posterior Odds, Bayes Factor, Bayesian Information Criterion (BIC).

Books Recommended:

1. Hogg, R. V. and Craig, A. T. (2004): Introduction to Mathematical Statistics, Pearson Edward (Indian Print).
2. Rohatgi, V. K. and Saleh A. K. Md. E (2001). An Introduction to Probability and Statistics, Wiley, New York.
3. Berger, J.O. (1993) Statistical Decision Theory and Bayesian Analysis, Springer Verlag.
4. Bernando, J.M. and Smith, A.F.M. (1994). Bayesian Theory, John Wiley and Sons.
5. Box, G.P. and Tiao, G.C. (1992). Bayesian Inference in Statistical Analysis, Addison-Wesley.
6. Gemerman, D and Lopes, H. F. (2006) Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, Chapman Hall.
7. Leonard, T. and Hsu, J.S.J. (1999) Bayesian Methods, Cambridge University Press.
8. Robert, C.P. (1994). The Bayesian Choice: A Decision Theoretic Motivation, Springer.
9. Robert, C.P. and Casella, G. (2004) Monte Carlo Statistical Methods, Springer Verlag.

Advanced Sample Surveys
Course Code: RB061002T

Unit 1

Unbiased Ratio and Regression Type Estimators, Multivariate Ratio and Regression Methods of Estimation, Product Estimator, Optimum Properties of Ratio and Regression Estimators. Regression Analysis and Categorical Data Analysis with Data from Complex Surveys. Bias Adjustment in Ratio Estimator Due to Murthy, Beale and Tin. Jackknife Ratio Estimator, Olkin's Multivariate Ratio Estimator. Self-weighting Designs.

Unit 2

Model Based Approach and Prediction Approach: Inference Under Super-Population Model, Concept of Designs and Model Unbiased Estimation, Traditional Model-Based and Optimal Estimators Under Various Useful Sampling Designs. Prediction Approach, predicting a Super Population Mean.

Unit 3

Bayesian Theories in Finite Population: Non-Informative Bayesian Approach, Extension of Polya Posterior, Empirical Bayes Estimation, Estimation of Stratum Means, Hierarchical Bayes Estimation.

Unit 4

Small Area Estimation: Small Area Estimation—Direct Estimators, Synthetic Estimators, Composite Estimators, Repeated Sampling, Balanced Repeated Replication, Jackknife and Bootstrap Methods. Calibration Approach: Introduction to Calibration Estimators, Calibration Estimators Based on Functional Form, With Restricted Weights, Robustness Aspects, Extended Calibration Estimators, Cosmetic and Calibration Estimators, Model Based Calibration Estimators, Estimation of Distribution Function and Quadratic Finite Population Function.

Books Recommended:

1. Cochran, W.G. (1977): Sampling Techniques
2. Des Raj and Chandak (1999): Sampling Theory
3. Mukhopadhyay, P. (1998): theory and Methods of Survey Sampling
4. Mukhopadhyay P. (2007): Survey Sampling
5. Sarndal, C.E. and Swensson, B. and Wertman, J.H. (1992): Model Assisted Survey Sampling.
6. Sukhatme, P.V. and Sukhatme, B.V. (1992): Sampling Theory of Surveys with Applications.
7. Meeden, G, Ghosh, Malay (1997): Bayesian Methods in Finite Population Sampling.
8. Cassel, Sarndal, Wretman (1977): Foundations of Inference in Survey Sampling.

Data Science
Course Code: RB061003T

Unit 1
High Dimensional Space: Properties, Law of large number, Sphere and cube in high dimension, Generation points on the surface of sphere, Gaussians in high dimension, Random projection, Applications.

Unit 2
Random Graphs: Large graphs, G(n,p) model, Giant Component, Connectivity, Cycles, Non-Uniform models, Applications, Singular Value Decomposition (SVD): Best rank k approximation, Power method for computing the SVD, PCA.

Unit 3
Random Walks and Markov Chains: Properties of random walks, Stationary distributions, Random walks on undirected graphs with unit edge weights, Random walks in Euclidean space, Markov Chain Monte Carlo.
Algorithm for Massive Data Problems, Frequency moments of data streams, Matrix algorithms using sampling.

Unit 4
The General Models for Massive Data Problems: Topic Models - Non-Negative Matrix Factorization, Latent Dirichlet Allocation (LDA), Hidden Markov Models, Graphical Models and Belief Propagation, Bayesian Networks, Markov Random Fields.

Books Recommended:

1. Fundamental of Machine Learning: K Phasinam, AK Singh, MK Sharma, T Singh.
2. Foundation of Data Science: Avrim Blum, John Hopcroft, and Ravindran Kannan.

Research Methodology
Course Code: RB061004T

Unit 1
Importance of research methodology in statistical Research: Motivation objectives and the purpose of the research. Types of Statistical research: Empirical, field experiments, Laboratory experiment. Primary and secondary source of data. Planned and ad hoc methods of data collection. Non response and methods of recovering the missing response.

Unit 2
Generating data from standard univariate (discrete and continuous) Distributions and multivariate normal distribution. Exploring univariate and multivariate data using tables and plots.

Unit 3
Population Statistics, Agricultural Statistics, Medical Statistics, Industrial Statistics, Trade Statistics, Price Statistics, Statistics of Labour & Employment, Statistics of Transport and Communication. Resampling techniques such that Bootstrap and Jackknife, Bootstrap Variance Estimation, Bootstrap (Interval and testing).

Unit 4
Reading research papers, reporting and thesis writing: structure and components of scientific reports. Types of reports: Technical reports and thesis: significance: different steps in the preparations: layout structure and language of typical reports. Illustrations and tables: Bibliography, referencing and footnotes: oral presentations: planning: preparation: practice: making presentation, ethical issues: commercialisation: copyright Royalty. Intellual property Rights.

Books Recommended:

1. Casella, George, and C. Robert. "Monte Carlo statistical methods." University of Florida (2008).
2. Coley, Soraya M., and Cynthia A. Scheinberg. Proposal writing: Effective grantsmanship. Sage, 2008.
3. Dey R. A. How to write and publish a scientific paper, Cambridge University Press (1992).
4. Efron, Bradley, and Robert J. Tibshirani. An introduction to the bootstrap. CRC press, 1994.
5. Coburn, Timothy C. "J. de Gruijter, D. Brus, M. Bierkens, and M. Knotters: Sampling for Natural Resource Monitoring." Mathematical Geosciences 40.3 (2008): 349.
6. Kothari, Chakravanti Rajagopalachari. Research methodology: Methods and techniques. New Age International, 2004.