NATIONAL EDUCATION POLICY-2020
Dr. B.R. AMBEDKAR UNIVERSITY, AGRA
PAPER CODING AND CREDIT DISTRIBUTION
M.Sc. (STATISTICS)

S.No.	Name of Degree	SEMESTER	TITLE OF PAPER	CREDITS	CODE NUMBER
1	Bachelor (Research) of Science in Statistics	VII	Real Analysis & Matrix Algebra	4	B060701T
			Probability and Distribution Theory	4	B060702T
			Sampling Theory	4	B060703T
			Computer Science	4	B060704T
			Practical	4	B060705P
			Research Project Work		
2		VIII	Statistical Inference-I	4	B060801T
			Linear Estimation and Design of Experiments	4	B060802T
			Multivariate Analysis	4	B060803T
			Elective-I (Choose any **ONE** paper) B060804T/ B060805T / B060806T		
			Data Analysis Using SPSS	4	B060804T
			Data Analysis Using R	4	B060805T
			Data Analysis Using Python	4	B060806T
			Practical	4	B060807P
			Research Project Work	**8**	**B060808R**
		One Minor Paper to be selected from OTHER FACULTY in VII or VIII Semester		4/5/6	
3	Master of Science in Statistics	IX	Statistical Inference-II	4	B060901T
			Operations Research	4	B060902T
			Elective-II and III (Choose any **TWO** papers) B060903T/ B060904T/ B060905T/ B060906T/ B060907T/ B060908T		
			Data Mining	4	B060903T
			Population Studies	4	B060904T
			Medical Statistics	4	B060905T
			Official Statistics	4	B060906T
			Econometrics	4	B060907T
			Actuarial Statistics	4	B060908T
			Practical	4	B060809P
			Research Project Work		
4		X	**Elective-IV, V, VI and VII** (Choose any **FOUR** papers) B061001T/ B061002T/ B061003T/ B061004T/ B061005T/ B061006T/ B061007T/ B061008T/ B061009T		
			Decision Theory and Bayesian Inference	4	B061001T
			Advanced Sample Survey	4	B061002T
			Quadratic Forms and Sequential Statistical Inference	4	B061003T
			Limit Theorems and Stochastic Process	4	B061004T
			Data Science	4	B061005T
			Reliability Theory and Survival Analysis	4	B061006T
			Linear Models and Regression Analysis	4	B061007T
			Research Methodology	4	B061008T
			Marketing Research Statistics	4	B061009T
			Practical	4	B061010P
			Research Project Work	**8**	**B061011R**

Students of Science Faculty may choose **MINOR** paper from Faculty of Commerce/ Arts, Humanities and Social Sciences/ Languages/Fine Art and Performing Art/Education/Rural Science.

Real Analysis and Matrix Algebra

Course Code : B060701T

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, Dimension and Basis of a Vector Space, Gram-Schmidt Orthogonalization.

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 : B060702T

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 and Bayes' theorem.

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, Khintchin's Theorem and Kolmogorov Strong Law of Large Numbers, Borel zero- one Law, Borel – Cantelli lemma.

Unit 4

Transformation of random variables. Probability sampling distributions of Chi-square, t and F statistics and their distributions. Order statistics and their distributions.

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 : B060703T

Unit 1

Review of simple random sampling with and without replacement. Determination of sample size. Sampling with varying probabilities, ordered and unordered estimates, Des Raj estimator ,Horvitz-Thompson estimator.

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, post stratification. 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 : B060704T

Unit1

Introduction to Computer, Evolution of Computer Technology, Types of Computers, Basic elements of Computer, Components of Computer, Generations of Computer and Computer languages, Introduction to Statistical Software e.g. SPSS, STATA etc.

Unit2

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.

Unit3

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 & Regression, One-way ANOVA, Factorial ANOVA, Nonparametric Tests, Discriminant Analysis, Factor Analysis, Cluster Analysis.

Reference Books:

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 : B060801T

Unit 1

Data Reduction: Data reduction, Sufficiency, Sufficient partition, Completeness, bounded completeness Minimal sufficiency and Ancillary statistic, Basu's theorem, Exponential families and Pitman families, Invariance property ofSufficiency 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 resultsTo multi parameter case. Fisher Information for one and several parameters models Minimum VarianceUnbiased Estimators (UMVUES), Lower bounds for variance of estimators, Frechet Cramer and Rao (FCR), Chapman, Robbins and Kiefer (CRK) and Bhattacharya lower bounds, necessary and sufficient conditions for MVUE

Unit 3

Asymptotic Inference: Consistency and asymptotic relative efficiency of estimators, Consistent and Asymptotically normal (CAN) estimators for real vector valued parameters, BAN estimators and their properties, Invariance of consistency under continuous transformation. Invariance of CAN estimators under differentiable Transformations, generation of CAN estimators using central limit theorem.

Unit 4

Maximum Likelihood Estimation and their large sample properties, restricted parameter space, Inconsistent MLES, MLEs in Irregular cases. Asymptotic distribution of MLE in special class of distributions: Cramer regularity conditions, Special cases such as exponential class of densities and multinomial distribution, Cramer-Huzurbazar theorem, Solutions of likelihood equations, method of scoring, Fisher lowerBound to asymptotic variance, MLE in Pitman family and double exponential distribution, MLE in censored and Truncated distributions. Asymptotic distribution and properties of Likelihood ratio test, Rao's score test and Wald's test in simple hypothesis case. Tests based on MLEs. Likelihood ratio tests, asymptotic distribution of log likelihood ratio, Wald Test, Score Test, locally most powerful tests, Pearson's chi-square test and LR test, Consistent Test and their Applications.

Books Recommended :

1. Kale, B. K.(1999) : A first course on parametric inference, Narosa Publishing House.
2. Rohatagi, V. (1988): An Introduction to probability and mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)
3. Lehmann E.L. (1983) : Theory of Point Estimation
4. Rao C.R. (1973) : Linear Statistical Inference and Its Applications
5. Berger J.C. (1980) : Statistical Decision Theory
6. Wilks S.S. (1962) : Mathematical Statistical
7. Forguson T.S. (1967) : Mathematical Statistics–A Decision Theoretic Approach

Linear Estimation and Design of Experiments

Course Code : B060802T

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 EasternLimited.
3. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer. FirstIndian Reprint 2006.
4. Joshi, D.D. (1987). Linear Estimation and Design of Experiments, Wiley Eastern, NewDelhi.
5. Montgomery, D.C. (2005). Design and Analysis of Experiments, Sixth Edition, JohnWiley and Sons.

Multivariate Analysis

Course Code : B060803T

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. Wishart distribution (without derivation) and its properties. Generalised variance, distribution of sample generalised variance. Classification problems, Fisher's discriminant function. D^2-statistic and its application.

Unit 3

Analysis of dispersion, and testing of general linear hypothesis, equality of mean vectors, Wilk's lamda 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. Kshirsagar,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 SPSS

Course Code : B060804T

Unit-1

Introduction to SPSS, Data analysis: general aspects, workflow, critical issues , SPSS GUI: windows, menus, commands - File management: SPSS native formats.

Unit-2

Input and data management , Data file import , Defining variables , Labelling variables and their values

Data manipulation - Preparing data for analysis: cleaning, data transformations, missing value management , SPSS output files , SPSS syntax files and script

Unit-3

Descriptive and graphical data analysis : Frequencies , Descriptives , Explore ,Crosstabs , Creating charts with SPSS

Statistical tests and Working with data files - Means , T-test , One-way ANOVA , Normality tests - Merging files , Split, filter and weight data, Comparing datasets

Unit-4

Introduction to correlation and regression :Linear correlation , Simple and multiple linear regression, Logistic regression, Time series

Unit-5

Introduction to multivariate analysis: Principal component analysis, Factor analysis, Cluster analysis, Discriminant analysis

Books

1. Margan G A: SPSS for Introductory Statistics; Uses and Interpretation.
2. Practical Work Book by Bristol Information Services: Introduction to SPSS for Windows.

Data Analysis Using R

Course Code : B060805T

Unit–I

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-II

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-III

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, longitudinal data (Random effect and mixed effect).

Unit-IV

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 to compute expected values of functions of random variables, such as Laplace transform, Fourier transform.

Recommended Books:

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). *Markovchain 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

Data Analysis using Python

Course Code : B060806T

Unit-1

Introduction to Python- Python data structures, data types, indexing and slicing, vectors, arrays, developing programs, functions, modules and packages, data structures for statistics, tools for statistical modeling, data visualization, data input and output.

Unit-2

Display of Statistical data with Python- Univariate and multivariate data, discrete and continuous distributions: binomial, Poisson, normal, Weibull. Sampling distributions: t, chi-square and F.

Unit-3

Hypothesis testing with Python- Test for means: t test for single and two samples, Wilcoxon and Mann-Whitney test, test for categorical data, one proportion and frequency tables, chi-square test for independence, relation between hypothesis and confidence intervals, one- and two -way ANOVA.

Unit-4

Statistical Modeling with Python-Correlation and Regression coefficients, simple and multiple regression analyses, model selection criteria, bootstrapping, generalized linear models.

Books Recommended:

1. Haslwanter, T. (2016): An Introduction to Statistics with Python: with Applications in the Life Sciences, Springer.

2. Sheppard, K. (2018): Introduction to Python for Econometrics, Statistics and Data analysis, Oxford University press.

Statistical Inference–II
Course Code : B060901T

Unit 1

Testing of Hypotheses: Review of notions of randomized and nonrandomized tests, level, size, p-value, power Function, Neyman-Pearson fundamental lemma and its applications, UMP tests. Extension of these results to Pitman family when only upper or lower end depends on the parameters and to Distributions with MLR property. Families of distributions with Monotone Likelihood Ratio, UMP tests for one- Sided testing problems, UMP tests for one-parameter exponential families, Generalized Neyman-Pearson Lemma. Non-existence of UMP tests for simple null against two-sided alternatives in one parameter exponential family, Unbiased Test, UMPU tests for one-parameter exponential family, one- and two-sided testing problems

Unit 2

Testing of Hypotheses (Multi-parameter Case): Similar tests, Neyman Structure, UMPU tests for composite Hypotheses, Invariance tests and UMP invariant tests, Likelihood ratio test, Asymptotic distribution of LRT Statistic, Consistency of large sample test, Asymptotic power of large sample test

Unit 3

Moments of Order Statistics, Asymptotic distribution of an order statistic,non-parametric estimation of distribution function and Glivenko-Cantelli fundamental theorem of statistics. The Mann-Whitney U test, Application of U-statistic to rank tests, One sample and two sample Kolmogorov-Smirnov tests. The Kruskal-Wallis One-Way ANOVA Test, Friedman's Two-Way Analysis of Variance by ranks. Efficiency criteria, Theoretical basis for Calculating the ARE, Pitman ARE.

Unit 4

Confidence Interval, confidence sets, relation with hypothesis testing, confidence level, Construction of confidence intervals with pivots and shortest expected length, Uniformly most accurate (UMA) One-sided confidence interval and its relation to UMP tests for one-sided null against one-sided alternative Hypotheses, Confidence intervals for the parameter for Normal, Exponential, Binomial and Poisson distributions. CI for quantiles, concept of tolerance limits and examples.

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.

Operations Research

Course Code : B060902T

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

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 3

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).

Unit 4

Simulation, Revised Simplex Method, NLPP, simple problems on Integer programming.

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

Data Mining

Course Code : B060903T

Unit 1

Introduction, Relational Databases, Data Warehouse, Transactional Databases, Advanced Data and Information Systems and Advanced Applications.Data Mining Functionalities. Concept/Class Description: Characterization and Discrimination, Mining Frequent Patterns, Associations, and Correlations, Classification and Prediction, Cluster Analysis, Outlier Analysis, Evolution Analysis. Classification of Data Mining Systems, Data Mining Task Primitives, Integration of a Data Mining System with a Database or Data Warehouse System, Major Issues in Data Mining.

Unit 2

Data Preprocessing, Descriptive Data Summarization: Measuring the Central Tendency, Measuring the Dispersion of Data, Graphic Displays of Basic Descriptive Data Summaries. Data Cleaning: Missing Values, Noisy Data, Data Cleaning as a Process. Data Integration and Transformation: Data Integration, Data Transformation. Data Reduction: Data Cube Aggregation, Attribute Subset Selection, Dimensionality Reduction, Numerosity Reduction. Data Discretization and Concept Hierarchy Generation: Discretization and Concept Hierarchy Generation for Numerical Data, Concept Hierarchy Generation for Categorical Data.

Unit 3

Mining Frequent Patterns, Associations, and Correlations,Market Basket Analysis: Frequent Itemsets, Closed Itemsets and Association Rules, Frequent Patterns Mining: Efficient and Scalable Frequent Itemset Mining Methods: The Apriori Algorithm: Finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, Mining Frequent Itemsets without Candidate Generation, Mining Frequent Itemsets Using Vertical Data Format, Mining Closed Frequent Itemsets. Mining Various Kinds of Association Rules: Mining Multilevel Association Rules, Mining Multidimensional Association Rules from Relational Databases and Data Warehouses. From Association Mining to Correlation Analysis: From Association Analysis to Correlation Analysis. Constraint-Based Association Mining: Metarule-Guided Mining of Association Rules, Constraint Pushing: Mining Guided by Rule Constraints.

Unit 4

Issues Regarding Classification and Prediction: Preparing the Data for Classification and Prediction, Comparing Classification and Prediction Methods, Classification by Decision.Tree Induction: Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Scalability and Decision Tree Induction, Bayesian Classification: Bayes' Theorem, Naïve Bayesian

Classification, Bayesian Belief Networks, Training Bayesian Belief Networks, Rule-Based Classification: Using IF-THEN Rules for Classification, Rule Extraction from a Decision Tree, Rule Induction Using a Sequential Covering Algorithm,Associative Classification: Classification by Association Rule Analysis, *k*-Nearest-Neighbor Classifiers, Case-Based Reasoning,

Unit 5

Prediction: Linear Regression, Nonlinear Regression, Other Regression-Based Methods, Accuracy and Error Measures: Classifier Accuracy Measures, Predictor Error Measures, Evaluating The Accuracy of a Classifier or

Predictor: Holdout Method and Random Subsampling, Cross-Validation, Bootstrap, Ensemble Methods—Increasing the Accuracy: Bagging, Boosting, Model Selection: Estimating Confidence Intervals, ROC Curves.

Reference Book:

1. Data Mining: Concepts & Techniques (Second Edition,Jiawei Han &Micheline Kamber (Morgan Kaufman Publisher, 2006)
2. Principles of Data Mining, David Hand, HeikkiMannila, Padhraic Smyth (Printice Hall of India Private Limited, 2007)
3. Data Mining, VikramPudi& P. Radha Krishna(Oxford University Press, 2009)

Population Studies

Course Code : B060904T

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, Whipples 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. Standerdised death rates. Life table, its type. Construction of complete and abridged life tables. Makeham's and Gompertz curve.

Unit 4

Migration rates and ratios. Method to estimate intercensal migration using vital statistics, survival ratio and growth rate. Migration models.

Unit 5

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). Appplied 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.

Medical Statistics

Course Code : B060905T

Unit-1

Introduction to medical statistics- Definition and uses, Statistical Data, Types of Data: attributes and variables, discrete & continuous data, Primary data, Secondary data, Different types of scales- nominal, ordinal, ratio and interval. Descriptive Epidemiological Studies: Case report, Case series, Correlation studies, Cross sectional studies, Design, analysis, merits and demerits of all these studies , Analytical Epidemiological studies – Case control & Cohort

Unit-2

Measuring the occurrence of disease, Measures of morbidity - prevalence and incidence rate, association between prevalence and incidence, uses of prevalence and incidence, Measures of exposure effect – Relative and absolute measures of exposure effect, Relative measures - Risk ratio rate ratio and odds ratio , Absolute measures – Attributable risk Attributable risk percentage population excess risk

Unit-3

Clinical Epidemiology: Definition, reliability, validity, sensitivity, specificity, predictive values. Observational studies: retrospective, cross sectional and prospective studies. Likelihood ratio test, selection and interpretation of diagnostic test. Deciding on the best therapy. ROC curves, multiple and parallel test. Screening for diseases, Critical approach, and Meta analysis. Epidemiological Models- Epidemometric studies- Deterministic epidemic models: simple, General Recurrent- Stochastic epidemic models.

Unit-4

Planning and design of clinical trials, Phase I, II, and III trials. Consideration in planning a clinical trial, designs for comparative trials. Sample size calculation problem in different study designs

Books

1. K J Rothman and S Greenland (ed.): Modern Epidemiology, Lippincott-Raven.
2. S. Selvin (1996): Statistical Analysis of Epidemiology data, Oxford University Press.
3. D Mcneil (1996): Epidemiological Research Methods, Wiley and sons.
4. J F Jekel, J G Elmore, D L Katz (1996): Epidemiology, Biostatistics and Preventing Medicine,
5. Collett, D. (2003). Modelling Survival Data in Medical Research, Chapman & Hall/CRC.
6. Cox, D.R. and Oakes, D. (1984). Analysis of Survival Data, Chapman and Hall.
7. Friedman, L.M., Furburg, C. and DeMets, D.L. (1998). Fundamentals of Clinical Trials,\ Springer Verlag.
8. Gordis Leon (1996). Epidemiology Elsevier Philadelphia.
9. Greenland & Rothman Kenneth (2008). Modern epidemiology Wolters Kluwer Health (India) Pvt Ltd New Delhi.
10. Indrayan, A. (2008). Medical Biostatistics, 2nd ed., Chapman & Hall/CRC.
11. Lee, Elisa, T. (1992). Statistical Methods for Survival Data Analysis, John Wiley & Sons.
12. Miller, R.G. (1981). Survival Analysis, John Wiley & Sons.
13. Robert F. Woolson (1987). Statistical Methods for the analysis of biomedical data, John Wiley & Sons.

Official Statistics

Course Code : B060906T

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.

Unit 4

Statistics of Labour & Employment, Statistics of Transport and Communication, Financial and banking Statistics, Miscellaneous Statistics.

Unit 5

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

Econometrics

Course Code : B060907T

Unit 1

Definitions of Econometrics, Scope of Econometrics, Division of Econometrics, Models and Methodology of Econometric Research.

Unit 2

Two Variable Linear Model, Least Square and Maximum Likelihood Estimation, Properties of Estimators, Tests of Significance and Confidence Intervals of Parameters, Analysis of Variance in Regression, Extension of Two Variable Model.

Unit 3

General Linear Model, Least Square and M.L.E. Estimation, Properties, Significance Tests and Confidence Intervals, Generalized Least-Squares (AITKEN) Estimator.

Unit 4

Nature of Heteroscedasticity, Consequences, Detection and Remedial Measures of Heteroscedasticity, Introduction of Auto Correlation, OLS Estimation in Presence of Auto Correlation, Detection and Remedial Measures of Auto Correlation.

Unit 5

Nature of Multi Collinearity, Practical Consequences, Detection and Remedial Measures of Multicollinearity, Simultaneous Equalition Systems.

Books Recommended :

1. Basic Econometrics—D.N. Gujarati
2. Econometric Methods—J. Johnston
3. Theory of Econometrics—A. Koutsoyiannis

Actuarial Statistics

Course Code : B060908T

Unit-1

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.

Unit-2

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.

Unit-3

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.

Unit-4

Life insurance: Insurance payable at the moment of death and at the end of the year of death level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions. Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities.

Unit-5

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

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.
6. Neill, A. (1977). Life Contingencies, Heinemann.
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.

Decision Theory & Bayesian Inference

Course Code : B061001T

Unit -1

Decision theoretic problem as a game, basic elements, Loss function, Risk function, Randomised and Non-Randomised Decision Rules, Admissible Decision Rule, Complete, Essential complete and minimal complete classes of decision rules and their relationship, Minimax and Bayes decision rules, Estimation testing viewed as decision rule problem.

Unit-2

Bayes and minimax estimators. Minimax and Bayes tests in simple cases, relationship of Bayes and minimax decision rules, optimal decision rules, Unbiasedness, invariance ordering, Bayes and Minimax principles, generalized Bayes rules, extended Bayes rules, limit of Bayes rules.Admissibility, Completeness, minimal complete class, separating and supporting hyper plane theorems, Complete class Theorem, equalizer rules and examples, minimax theorem.

Unit-3

Review of Basic Probability Concepts, Comparing Likelihood and Bayesian Approaches, Concept of Inverse Probability and Bayes Theorem, Classes of Prior Distributions. Conjugate Families for One Parameter Exponential Family Models, Prior and posterior distributions, Improper priors, non-informative (default) priors, invariant priors. Jeffery's prior, Conjugate prior families Bayes estimators under squared error loss function, posterior variance and Bayes risk. Parametric Empirical Bayes, Bayesian inference, summary through posterior, predictive inference, credible sets, testing of hypotheses. Comparison with classical procedures, Admissibility and minimaxity of Bayes and generalized Bayes procedures.

Unit-4

Bayesian sufficiency, improper prior densities, Natural conjugate Bayesian densities (NCBD), posterior odd ratio, HPD regions, Bayesian inference for Normal populations, Bayesian calculation, Monte-Carlo Integration and Markov chain Monte Carlo techniques. Gibbs sampling and Metropolis algorithm, Applications in real-life situations, Bayesian inference using software packages.

Books:

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 : B061002T

Unit 1

Fixed Population Approach :

(a) Unified Theory of Sampling : Inference Aspect of Sample Survey, Sampling Designs and Sampling Schemes, Correspondence; Classes of Estimators, Homogeneous Linear Estimators and Condition of Unbiasedness; Godambe's UMV Non-Existence and Existence Theorems Under Restricted Conditions Relating to Labeled Populations, Basu's Difference Estimator. Sufficiency, Completeness, Admissibility of Estimators in Survey Sampling. Optimal Estimators in Useful Sampling Designs.

(b) 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.

(c) Integration of Different Principles and Methods of Sampling in Adopting Composite Sampling Procedures in Actual Practice. Integration of Surveys—Lahiri and Keyfitz's Procedures. Variance Estimation with Complex Designs. Taylor's Series Linearization, Balanced Repeated Replication, Jackknife and Bootstrap Methods.

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.

Unit 5

Large-Scale Surveys : Organizational Aspects of Planning Large-Scale Sample Surveys, Non-Sampling Errors, Non-Response. Familiarity with NSS Work and Some Specific Large-Scale Surveys. Special Topics Include Wildlife Surveys, Non-Sampling Error Adjustment, Categorical Data Analysis and Practical Survey Examples.

Reference Books :

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 Wretman, 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

Quadratic Forms and Sequential Statistical Inference

Course Code : B061003T

Unit 1

Definite and semi definite quadratic forms, rank, index, and signature of a quadratic form. Equivalence, congruence relation of quadratic forms. Simultaneous reduction of quadratic forms. Differentiation of functions of vectors.

Unit 2

Distribution of quadratic forms, characteristic function, independence of quadratic forms.

Unit 3

Introduction to sequential analysis. Fundamental ideas of sequential sampling. Sequential decision procedure.

Unit 4

Sequential unbiased estimation. Sequential probability ratio test (SPRT). Construction of SPRT. Connection between SPRT and random walks. Properties of SPRT.

Unit 5

Derivation of O.C. and A.S.N. function. Sequential sampling inspection plan.

Books Recommended :

1. Graybill, F. A. (1983). Matrices With Applications In Statistics, Second Edition.
2. Rao,C.R.(1973). Linear Statistical Inference And Its Applications, Second Edition, Wiley Eastern.
3. Rohatgi,V.K.(1986). An Introduction To Probability Theory And Mathematical Statistics, Wiley Eastern.
4. Searle, S.R.(1982). Matrix Algebra Useful For Statistics, John Wiley & Sons.
5. Singh,B.M.(2002). Multivariate Statistical Analysis, South Asian Publishers.

Limit Theorems and Stochastic Processes

Course Code : B061004T

Unit-1

Limit Theorems- Introduction, Modes of Convergence, weak law of large numbers, strong law of large numbers, limiting moment generating function, central limit theorem

Unit-2

One dimensional Central Limit Theorems: Lindeberg- Levy for i.i.d. random variables, Lyapunov (without proof), Lindeberg & Feller Theorem (without proof) for independent random variables.

Unit-3

Two state Markov sequences, Markov chains, determination of n-step transition probabilities, Chapman-Kolmogorov equations, first return and first passage probabilities, classification of states, communicating states, periodicity, stationary probability distributions and limit theorems for ergodic chains.

Unit-4

Continuous time Markov processes, Poisson (point) process, Inter arrival time distribution, Random walk and Brownian motion as a random walk, gambler's ruin problem. Birth and death processes, renewal processes,

Unit-5

Branching processes of discrete type, average size and variance of the population in the n-th generation, fundamental theorem of extinction. Wiener process, Arc-sine law, Martingales, stopping times, optional sampling theorem.

Books recommended:

1. VK Rohtagi- An introduction to probability and statistics, Wiley.
2. Cinlar, E. (1975). Introduction to Stochastic Processes, Prentice Hall.
3. Feller, W. (1968). Introduction to Probability and Applications, New Age India International.
4. Hoel, P. G., Port, S. C. and Stone, C. J. (1991). Introduction to Stochastic Processes, University Book Stall.
5. Karlin, S. and Taylor, H. M. (1995). A First Course in Stochastic Processes, Academic Press.
6. Medhi, J. (2012). Stochastic Processes, 3rd edition, New Age India International.
7. Ross, S. M. (1996). Stochastic Processes, Wiley.

Data Science
Course Code : B061005T

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.

Unit 3
Singular Value Decomposition (SVD): Best rank k approximation, Power method for computing the SVD, PCA.

Unit 4
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.

Unit 5
Algorithm for Massive Data Problems, Frequency moments of data streams, Matrix algorithms using sampling.

Unit 6
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.

SUGGESTED BOOKS:

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

Reliability Theory & Survival Analysis

Course Code : B061006T

Unit-1

Definition of Reliability function, hazard rate function, pdf in form of Hazard function, Reliability function and mean time to failure distribution (MTTF) with DFR and IFR. Basic characteristics for exponential, normal and lognormal, Weibull and gamma distribution, Loss of memory property of exponential distribution. Reliability of System connected in Series, Parallel, k-out-of-n.

Unit -2

Reliability and mean life estimation based on failures time from (i) Complete data (ii)

Censored data with and without replacement of failed items following exponential distribution Accelerated testing: types of acceleration and stress loading. Life stress relationships.

Unit-3

Basis of Survival analysis, Parametric methods - parametric models in survival analysis, Exponential, Weibull, Delta method in relation to MLE, Fitting of these models in one sample and two sample problems.

Unit-4

Regression models in survival analysis. Fitting of Exponential, Weibull, Non-parametric methods for estimating survival function and variance of the estimator viz. Acturial and Kaplan –Meier methods.Cox-proportional, hazard models. Model checking and data diagnostics - Basic graphical methods, graphical checks for overall adequacy of a model, deviance, cox-snell, martingale, and deviance residuals.

Books Recommended:

1. Sinha, S.K. (1980): Reliability and life testing, Wiley, Eastern Ltd.
2. Nelson, W. (1989): Accelerated Testing, Wiley.
3. Zacks, S.O.: Introduction to reliability analysis, probability models and statistical,SpringerVerlag.
4. Klein, J.P. and Moeschberger, M.L. (2003): Survival Analysis, technique for censored and truncated data, Springer.
5. Tableman, M. and Kim, J.S. (2004): Survival Analysis Using S, Chapman & Hall/CRC.
6. Lawless J.F. (2003): Models and Methods for life time data, Second edition, Wiley.
7. Collett (2014): Modeling Survival data in medical Research, Third edition, Chapman &Hall/CRC.

Linear Models & Regression Analysis

Course Code : B061007T

Unit-1

Linear Estimation: Gauss-Markov linear Models, Estimable functions, Error and Estimation Spaces, Best Linear Unbiased Estimator (BLUE), Least square estimator, Normal equations, Gauss-Markov theorem, generalized inverse of matrix and solution of Normal equations, variance and covariance of Least square estimators.

Unit-2

Test of Linear Hypothesis: One way and two way classifications. Fixed, random and mixed effect models (two way classifications only), variance components.

Unit-3

Linear Regression: Bivariate, Multiple and polynomials regression and use of orthogonal polynomials, Residuals and their plots as tests for departure from assumptions of fitness of the model normality, homogeneity of variance and detection of outlines. Remedies.

Unit-4

Non Linear Models: Multi-collinearity, Ridge regression and principal components regression, subset selection of explanatory variables, Mallon's Cp Statistics.

Books Recommended:

1. Goon, A.M., Gupta, M.K. and Das gupta, B. (1987): An Outline of Statistical Theory, Vol.2, The World Press Pvt. Ltd .Culcutta.
2. Rao, C.R. (1973): Introduction to Statistical Infererence and its Applications, WileyEastern.
3. Graybill, F.A. (1961): An introduction to linear Statistical Models, Vol. 1, McGraw Hill Book Co. Inc.
4. Draper, N.R. and Smith, H (1998): Applied regression Analysis, 3rd Ed.Wiley.
5. Weisberg,S.(1985):Applied linear regression, Wiley.
6. Cook, R.D. and Weisberg, S.(1982): Residual and Inference in regression, Chapman &Hall.

Research Methodology

Course Code : B061008T

Unit-1

Importance of research methodology in statistical Reasearch: Motivation objectives and the porpose of the research. Types of Statistical research : Empirical , field experiments, Laboratory experiment. Primary and secondary source of data. Planned and adhoc 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

Resampling techinques such that Bootstrap and Jackknife, Bootstrap Variance Estimation, Bootstrap (Interval and testing)

Unit-4

Simulation methods: Monte Carlo methods, techniques of Handling missing data, Imputation methods.

Unit-5

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 preprations: layout structure and language of typical reports. Illustrations and tables : Bibliography, referencing and footnots: oral presentations: planning: prepration: practice: making presentation, ethical issues: commercialisation: copyright Royalty. Intellual property Rights.

Book 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.

Marketing Research Statistics

Course Code : B061009T

Unit 1

Nature, Scope and Importance of Marketing, Approaches to the Study of Marketing, Changing Concepts of Marketing, Recent Innovations in Modern Marketing, Marketing Environment and Marketing System. Consumer Decision Behaviour, Consumer Buying Decision Pocess, Theory of Consumer Behaviour, Marketing Segmentation and Marketing Mix, Physical Distribution of Goods, Meaning and Objectives of Advertisement, Characteristics of an Effective Advertisement, Different Media of Advertisement, Choice of Advertising Media, Advertising Budget, Measuring the Effectiveness of Advertising.

Unit 2

Meaning and Nature of Marketing Research, Objective and Functions of Marketing Research, Elements of Marketing Research, Advantages and Limitations of Marketing Research, Process of Marketing Research, Marketing Research Design, Marketing Information System, Sampling Plan for Marketing Surveys.

Unit 3

Introduction to the Theory and Models in Marketing, Science and Marketing Models, Complexity of Marketing Models, Decision Support Models, Theoretical Modeling in Marketing, Purchase Incidence Models, Stochastic Models of Brand Choice.

Unit 4

Introduction to Advertisement and New Product Planning, The Effects of Advertising, Objective Setting and Budgeting—Practice and Models, Media Selection and Scheduling–Modelling Approaches, New Product Planning—Types of New Product Situations, Adoption Process for New Products, Models of First Purchase, repeat Purchase Models of New Products.

Unit 5

Brand Preference Index, Stability Index Based on Duration of Use, Stability Index Based on Quantity Ratio and Duration of Use, Brand Awareness Index, Consumer Satisfaction Measure, etc.

Books Recommended :

1. Statistical Process Control with six Sigma – M Ahmad, R Patawa, B Singh, A Jain
2. Marketing Models—Gary L. Lilien, Philip Kotler and K. Sridhar Moorthy
3. Marketing Management—C.B. Gupta
4. Marketing Analysis and Decision Making : Text and Cases—G.C. Darral
5. Advertising Management—A.A. David and J.G. Myers