P.G. DEPARTMENT OF STATISTICS

UTKAL UNIVERSITY

COURSES OF STUDY
FOR
M.A. / M.SC. (STATISTICS)
EXAMINATION
(UNDER CHOICE BASED CREDIT SYSTEM)

(Effective from 2016-17 Academic Session)

UTKAL UNIVERSITY

M.A. / M.SC. (STATISTICS) EXAMINATION, 2016 ONWARDS

(CBCS SYSTEM)

COURSE OUTLINE

	Paper Code	Paper Title	Credits
SEMESTER- I			
CORE COURSES	ST-C-101	Mathematical Analysis and Linear Algebra	6
	ST-C-102	Statistical Methods	6
	ST-C-103	Probability Theory and Distributions-I	6
	ST-C-104	Statistical Inference-I	6
	ST-C-105	Statistical Computing-I: Computer Applications and Data Processing using Advanced Excel & SPSS	6
SEMESTER- II			
CORE COURSES	ST-C-201	Probability Theory and Distributions -II	6
	ST-C-202	Statistical Inference-II	6
	ST-C-203	Survey Sampling Methods	6
ALLIED ELECTIVE	ST-AE-204	Any one paper out of the following papers: 1. Operations Research 2. Official Statistics	6
CORE COURSES	ST-C-205	Statistical Computing-II : R Programming Language	6
	SEMESTER- III		
CORE COURSES	ST-C-301	Multivariate Analysis	6
	ST-C-302	Design and Analysis of Experiments	6
CORE ELECTIVE	ST-CE-303	Any one paper out of the following papers: 1. Decision Theory & Bayesian Inference 2. Applied Stochastic Processes	6
ALLIED ELECTIVE	ST-AE-304	Any one paper out of the following papers: 1. Demography & Vital Statistics 2. Biostatistics	6
CORE COURSES	ST-C-305	Statistical Computing-III: Advanced R and C/C++ Programming	6
	SEMESTER- IV		
ALLIED ELECTIVE	ST-AE-401	Any one paper out of the following papers: 1. Linear Model and Regression Analysis 2. Econometrics	6
CORE ELECTIVE	ST-CE-402	Any one paper out of the following papers: 1. Advanced Survey Sampling Methods 2. Advanced Design and Analysis of Experiments 3. Advanced Operations Research	6
	ST-CE-403	Any one paper out of the following papers: 1. Time Series Analysis and Statistical Quality Control 2. Reliability Theory	6
FREE ELECTIVE	ST-FE-404	Any one paper out of the following papers: 1. Actuarial Statistics 2. Quantitative Epidemiology 3. Survival Analysis& Clinical Trials 4. Big Data Analytic Techniques	6
CORE COURSES	ST-C-405	Project Work and Seminar Presentation	6

DETAILED SYLLABUS
FIRST SEMESTER

ST-C-101: MATHEMATICAL ANALYSIS AND LINEAR ALGEBRA
(100 MARKS).

UNIT-I

Sequence and series, convergence, Bolzano-Weirstrass theorem, Heine Borel theorem. Real valued function, continuous functions, Uniform continuity, sequences and series of functions, Uniform convergence.Differentiation, maxima-minima of functions.

UNIT-II

Functions of several variables, partial and total differentials, maxima-minima of functions, multiple integrals, change of variables in multiple integration, Improper Integrals, Convergence of improper integrals of first and second kinds.

UNIT-III

The Lebesgue integral – length of open sets and closed sets, inner and outer measures. Definition and existence of Lebesgue integral for bounded functions, properties of Lebesgue integral for bounded measurable functions, Lebesgue integral for unbounded functions, Dominated Convergence Theorem and its applications.

UNIT-IV

Metric space - limits and metric space, continuous functions in metric spaces, connectedness, completeness and compactness. Normed linear Spaces. Spaces of continuous functions as examples.

UNIT – V

Vector spaces, linear dependence and independence, Dimension and basis, orthonormal basis, Matrix: Characteristic roots and vectors, Cayley-Hamilton theorem, minimal polynomial, similar matrices, spectral decomposition of a real symmetric matrix, Hermitian matrix. Real quadratic forms, reduction and classification of quadratic forms.

Books Recommended

1. Ruddin, Walter: Principles of Mathematical Analysis, McGraw-Hill.
2. Goldberg, R.R.: Methods of Real Analysis, Oxford & IBH Publication
3. Apostal, T.M.: Mathematical Analysis, Narosa Publishing House
4. Graybill, F.E.: Matrices with Applications in Statistics, 2nd ed., Wadsworth
5. Searle, S.R.: Matrix Algebra Useful for Statistics, John Wiley & Sons
6. Strang, G. (1980). Linear Algebra and its Application, 2nd edition, Academic Press, London-New York

ST-C-102 : STATISTICAL METHODS
(100 MARKS)

UNIT-I

Review of descriptive statistics– detailed study on the interpretation, analysis and measurements of various numerical characteristics of a frequency distribution.

UNIT-II

Bivariate and multivariate data, Curve fittings and orthogonal polynomials, regression and correlation analysis, rank correlation, correlation ratio, intra-class correlation.

UNIT-III

Concept of multivariate distribution, multiple regression analysis, partial and multiple correlations, properties of residuals and residual variance. Random sampling, sampling distribution and standard error, standard errors of moments and functions of moments.

UNIT-IV

Exact sampling distributions – *t*, *F* and chi-square distributions, sampling from bivariate normal distribution, distribution of sample correlation coefficient (null case) and regression coefficient, tests based on *t*, *F* and chi-square distributions.

UNIT – V

Association and contingency: Categorical response data, Likelihood Functions and Maximum Likelihood Estimation, Wald–Likelihood Ratio–Score Test Triad, statistical inference for binomial and multinomial parameters.

Contingency Tables: Probability structure, Comparing Two Proportions, Partial Association in Stratified 2×2 Tables and I×J tables, Inference for Contingency Tables: Testing Independence in Two-Way Contingency Tables, Following-Up Chi-Squared Tests, Two-Way Tables with Ordered Classifications, Small-Sample Tests of Independence, Small-Sample Confidence Intervals for 2×2 and multiway Tables.

Books Recommended

1. Mukhopadhyaya, P.: Mathematical Statistics, New Central Book Agency, Calcutta
2. Gun, A.M., Gupta, M.K. and Dasgupta, B.: An Outline of Statistical Theory, Vol.II (4th Edition), World Press.
3. Kale, B.K.: A First Course in Parametric Inference, Narosa Publishing House
4. Casella, G. and Berger, R.L.: Statistical Inference. Wodsworth& Brooks Pacific Grove, California.
5. Rao, C.R: Linear Statistical Inference and Its Application. John Wiley.
6. Agresti, A. (2002): Categorical Data Analysis, second Edition, Wiley-Interscience.

ST-C-103 : PROBABILITY THEORY AND DISTRIBUTIONS – I

(100 MARKS)

UNIT-I

Sequence of sets, limsup, liminf and limit of sequence of sets, classes of sets, field, sigma field, minimal sigma field, Borel sigma field, set functions. Measure and its properties, measurable functions and inverse functions. Probability measure, sample space, probability axioms, properties of probability, conditional probability, Bayes' theorem, independence of events.

UNIT-II

Random variables and probability distributions, distribution function of a random variable. Discrete and continuous random variables, functions of a random variable. Moments, probability generating and moment generating functions and moment inequalities, Markov, Holder, Jenson, Liapnov and Chebyshev's inequalities.

UNIT-III

Random vectors – distribution function of a vector of random variables, joint, marginal and conditional distributions. Independence of a sequence of random variables. Functions of random vectors and their distributions. Extreme values and their asymptotic distributions. Order statistics and their distributions. Conditional expectations.

UNIT-IV

Discrete probability distributions – Degenerate, Uniform, Hypergeometric, Binomial, Poisson, Negative binomial, Geometric distributions and their properties.

UNIT-V

Continuous probability distributions – Uniform, Normal, Cauchy, Gamma and Beta, Lognormal, Weibull distributions and their properties.

Books Recommended

1. Rohatgi, V.K. and Ehsanes Saleh, A.K.M.: An Introduction to Probability and Statistics, 2nd ed., Wiley-Interscience.
2. Bhat, B.R.: Modern Probability Theory, 3rd ed., New Age International.
3. Gun, A.M., Gupta, M.K. and Dasgupta, B.: An Outline of Statistical Theory, Vol.I (4th ed.), World Press.
4. Jonson, S. and Kotz, S. (1972): Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.
5. Arnold, B.C, Balakrishnan, N, and Nagaraja, H.N: A First Course in Order Statistics. John Wiley
6. Pitman J: Probability Distributions. Narosa Publishing House.

ST-C- 104 :STATISTICAL INFERENCE -I

(100 MARKS)

UNIT-I

Point estimation, properties of estimators: unbiasedness, consistency, efficiency, sufficiency. Neyman factorization criterion, minimal sufficient statistics, invariance properties of sufficiency, completeness.

Unit II

Mean square error, Unbiasedness and minimum variance, Minimum Variance Unbiased Estimators(MVUE), C-R inequality, Cramer-Rao lower bound, Bhattacharya bounds, Rao-Blackwell Theorem, Chapman-Robbins Inequality, Lehmann-Scheffe theorem, necessary and sufficient conditions for MVUE.

Unit III

Consistent estimators, sufficient conditions for consistency, Efficient estimators. Methods of estimation: Method of Maximum Likelihood and its properties, Minimum Chi-square and modified minimum Chi-square Methods, Method of moments, Method of least squares, Method of Percentiles.

UNIT-IV

Consistent Asymptotic Normal (CAN) estimators: Method of Moments and Percentiles, properties of CAN estimators, CAN estimators obtained by ML method in one parameter exponential case.

UNIT - V

Interval estimation – confidence level, construction of confidence intervals, shortest confidence intervals, uniformly most accurate one sided confidence intervals, unbiased confidence intervals, confidence coefficient, confidence belt, Theory of confidence sets.

Books Recommended

1. Kale, B.K.: A First Course on Parametric Inference, Narosa Publishing House
2. Rohatgi, V.K. and Ehsanes Saleh, A.K.M.: An Introduction to Probability and Statistics, 2nded., Wiley-Interscience.
3. Gun, A.M., Gupta, M.K. and Dasgupta, B.: An Outline of Statistical Theory, Vol.II, (4thed.), World Press.
4. George Casella and Roger L. Berger: Statistical Inference. Wodsworth& Brooks Pacific Grove, California.
5. Lehmann E. L& Casella, G.(1999): Theory of Point Estimation. Springer.
6. Rao, C. R: Linear Statistical Inference and Its Applications. Wiley Eastern.

ST-C- 105 :STATISTICAL COMPUTING-I:
COMPUTER APPLICATIONS AND DATA PROCESSING
USING ADVANCED EXCEL & SPSS

(100 MARKS)

PART-A

Computer application and Data Processing: Basics of Computer: Operations of a computer, Different units of a computer system like central processing unit, memory unit, arithmetic and logical unit, input unit, output unit etc., Hardware including different types of input, output and peripheral devices, Software, system and application software, number systems, Operating systems, packages and utilities, Low and High level languages, Compiler, Assembler, Memory– RAM, ROM, unit of computer memory (bits, bytes etc.).

Network – LAN, WAN, internet, intranet, basics of computer security, virus, antivirus, firewall, spyware, malware etc.

Basics of Programming: Algorithm, Flowchart, Data, Information, Database, overview of different programming languages, front end and back end of a project, variables, Controls structures, arrays and their usages, functions, modules, loops, conditional statements, exceptions, debugging and related concepts.

PART- B

Data analysis using Excel and SPSS.

I. Frequency distribution, measures of central tendency, dispersion, moments, skewness and kurtosis

II. Correlation, regression, rank correlation

III. Test of hypothesis - t and F tests, chi-square test, z test

IV. Fitting of distributions.

Books Recommended:

1. Rajaraman,V, “Fundamentals of Computers”, PHI
2. Norton , Peter (2001), “Introduction to Computers”, 4th Ed., TMH.
3. Berk, K.N. & Carey, P. (2000): Data Analysis with Microsoft Excel, Duxbury Press

Marks Distribution

PART-A: Computer application and Data Processing - 20 marks

PART- B:Data analysis using Excel and SPSS - 60 marks

Viva-voce + Records - 20 marks

SECOND SEMESTER

ST-C- 201 :PROBABILITY THEORY & DISTRIBUTIONS – II

(100 MARKS)

UNIT-I

Non central chi-square, t and F distributions. Bivariate normal and bivariate hypergeometric distributions. Exponential family of distributions.

UNIT-II

Convergence on a probability space – convergence in distribution (law), convergence in probability, convergence in r-th mean, convergence almost surely and their relationships.

UNIT-III

Characteristic function – definition and properties, inversion theorem, uniqueness theorem, characteristic function and moments.

UNIT-IV

Convergence of distribution function and characteristic function. Helly-Bray theorem, Extended Helly-Bray theorem, continuity theorem, Borel-Cantelli lemma.

UNIT-V

Laws of large numbers – Chebyshev's, Khinchin's, and Bernoulli's laws of large numbers. Hajek-Reni and Kolmogorov inequalities (statements only) and Kolmogorv's strong law of large numbers. Central limit theorem – Lindberg –Levy and Liapounov forms with proofs and applications. Lindberg-Feller form (without proof).

Books Recommended

1. Rohatgi, V.K. and Ehsanes Saleh, A.K.M.: An Introduction to Probability and Statistics, 2nd ed., Wiley-Inter Science
2. Bhat, B.R.: Modern Probability Theory, 3rd Edition, New Age International.
3. Gun, A.M., Gupta, M.K. and Das Gupta, B.: An Outline of Statistical Theory, Vol-I (4thed.), World Press
4. Ash, R.B. and Doleans-Dade, C.A.: Probability and Measure Theory. Elsevier.
5. Billingsley, P: Probability and Measure. John Wiley.
6. Sen, A. K: Measure and Probability. Narosa Publishing House.
7. Feller, W: An Introduction to Probability Theory and its Applications, Vol I. John Wiley.

ST-C-202 :STATISTICAL INFERENCE-II

(100 MARKS)

UNIT-I

Tests of hypothesis, concepts of critical regions, test functions, two kinds of errors, size function, power function, level, MP and UMP test, Neyman-Pearson Lemma, MP test for simple null against simple alternative hypothesis. UMP tests for simple null hypothesis against composite alternative.

UNIT-II

Type A and type A1 tests, similar tests, tests having Neyman structure, The Likelihood Ratio Test, One-tailed and two-tailed likelihood ratio tests for mean and variance of normal populations, Asymptotic property of LRT and applications, Monotone Likelihood Ratio Test and applications,

UNIT-III

Wald's sequential probability ratio test and its properties, OC and ASN function, derivation of OC and ASN functions, Efficiency of SPRT, SPRT for a Composite Hypothesis.

UNIT-IV

Non Parametric tests: Kolmogorov-Smirnov one sample test, comparison of the chi-square & KS tests, one sample & paired sample problems: the ordinary sign test, paired sample sign test, Wilcoxon signed rank test, Wilcoxon paired sample signed rank test, comparison of the sign test & Wilcoxon signed rank test.

UNIT-V

Two sample problems: Wald-Wolfowitz runs tests, Kolmogorov-Smirnov two sample test, U statistics, Mann-Whitney U-test, rank tests, Wilcoxon two sample (or rank sum) test, Krushkal-Wallis test, Freedman's test.

Books Recommended

1. Kale, B.K.: A First Course on Parametric Inference, Narosa Publishing House
2. Rohatgi, V.K. and Ehsanes Saleh, A.K.M.: An Introduction to Probability and Statistics, 2nd ed., Wiley-Interscience.
3. Gun, A.M., Gupta, M.K. and Dasgupta, B.: An Outline of Statistical Theory, Vol.II, (4thed.), World Press.
4. Lehmann E. L& Romano, J.P. (2005): Testing Statistical Hypotheses. Springer.
5. Gibbons, J.D.&Chakraborti, S. (2003): Nonparametric Inference, McGraw-Hill.

ST-C-203 : SURVEY SAMPLINGMETHODS
(100 MARKS)

UNIT-I

Basic concepts of finite population and sampling techniques. An outline of fixed-population and super-population approaches, distinctive features of finite population sampling, sampling designs, Methodologies in sample surveys (questionnaires, sampling design and methods followed in field investigation) by NSSO, simple random sampling with and without replacement. Determination of sample size.

UNIT-II

Stratified random sampling – estimation of population mean/total with standard error and its estimate, problems of allocations, comparison with unrestricted sampling.

Systematic sampling – method of selection, estimation of population mean/total, sampling variance, comparison with simple random sampling and stratified sampling, efficiency forstructural populations.

UNIT-III

Cluster sampling – equal size, estimation of population mean/total, standard error and its estimation, comparison with mean per unit estimator.

Two-stage sampling with equal first stage units, estimation of population mean/total, standard error and its estimation, comparison with single-stage sampling, Three-stage sampling.

UNIT-IV

Use of auxiliary information in sample surveys, Methods of estimation – ratio, product, difference and regression methods, sampling variance and efficiency of the estimators, Multivariate ratio estimator (Olkin's estimator), Double sampling.

UNIT-V

Errors in surveys – Unit and item non-response, effect of unit non-response on the estimate, methods of studying non-response (call back, without callback and imputation),non-sampling errors, Warner's randomized response technique.

Probability proportional to size sampling with replacement, the Hansen-Hurwitz and the Horvitz-Thompson estimators, non-negative variance estimation with reference to the Horvitz-Thompson estimator.

Books Recommended

1. Cochran, W.G.: Sampling Techniques, 3rd ed., Wiley
2. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C.: Sampling Theory of Surveys With Applications, Indian Soc. of Agric. Stat., New Delhi
3. Swain, A.K.P.C.: Finite Population Sampling – Theory & Methods, South Asian Publishers
4. Sampath, S: Sampling Theory and Methods. NarosaPublising House.
5. Mukhopadhyay, Parimal: Theory and Methods of Survey Sampling. Prentice Hall.
6. Murthy, M. N: Sampling Theory and Methods. Statistical Publishing Society.

ST-AE-204: OPERATIONS RESEARCH
(100 MARKS)

UNIT-I

Definition and Scope of Operations Research: Phases in Operation Research, models and their solutions, decision making under uncertainty and risk, use of different criteria, sensitivity analysis, duality theorem, economic interpretation of duality, Karmakar interior point algorithm.

UNIT - II

Transportation, Assignment and Transshipment problems, Travelling salesman's problem, Non-linear programming – constrained optimization and Kuhn-Tucker conditions, Wolfe's and Beale's algorithm.

UNIT-III

Analytical structure of inventory problems, Harris EOQ formula, its sensitivity analysis, extension allowing quantity discounts and shortages, multi-item inventory models, probabilistic inventory problems, Models with random demand, the static risk model. P and Q-systems with constant and random lead times. Network scheduling by PERT/CPM. Resource analysis, crashing, project cost, optimization algorithm, updating.

UNIT-IV

Game Theory: Two-person Zero sum game, Maximin-Minimax Principle, Games without saddle points, $2 \times n$, $n \times 2$ and $m \times n$ games, Dominance property, Simulation model, Monte Carlo simulation, Introduction to fuzzy sets, fuzzy measures, fuzzy relations, fuzzy set theory and applications.

UNIT-V

Queuing systems and their characteristics, transient and steady state solutions in Poisson queues (M/M/1 and M/M/c models), Non-poisson queuing systems: M/G/1 queue and Pollazcek-Khinchine result. Sequencing and scheduling problems. 2-machine n-job and 3-machine n-job problems with identical machine sequence for all jobs, Replacement problems – Block and age replacement policies.

Books Recommended

1. Taha, H.A. (1992): Operational Research: An Introduction, Mc. Millan.
2. Kantiswarup, Gupta, P.K. and Man Mohan (2007): Operations Research, Sultan Chand & Sons.
3. Ravindran, A., Phillips, D.T. and Solberg, J.J. (2009): Operations Research: Principles and Practice, Wiley-India.
4. Zimermann, H.J. (2001): Fuzzy Set Theory and its Applications, 2nd ed., Allied Publishers.
5. Lee, K.H. (2006): Fuzzy logic and Its Applications, Springer.
6. Rajasekharan, S. and Pai, G.A.V. (2006): Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI.

OR

ST-AE-204:OFFICIAL STATISTICS

(100 MARKS)

UNIT-I

Introduction to Indian and International statistical systems, Role, function and activities of Central and State statistical organizations.

UNIT-II

Organization of large scale sample surveys. Role of National Sample Survey Office. General and special data dissemination systems.

UNIT-III

Population growth in developed and developing countries, evaluation of performance of family welfare programmes projections of labour force and manpower. Scope and content of population census of India.

UNIT-IV

Estimation of national income-product approach, income approach and expenditure approach.

UNIT-V

System of collection of Agricultural Statistics. Crop forecasting and estimation, Productivity, fragmentation of holdings, support process, buffer stocks, impact of irrigation projects. Statistics related to industries.

Books Recommended

1. Basic Statistics Relating to the 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. Panse, V.G., Estimation of Crop Yields (FAO)
6. Family Welfare Yearbook. Annual Publications of D/o Family Welfare.
7. Monthly Statistics of foreign Trade in India, DGCIS, Calcutta and other Govt. Publication.

ST-C- 205: STATISTICAL COMPUTING-II : R PROGRAMMING LANGUAGE (100 MARKS)

Programming on R

Data types in R: numeric, character, logical; real, integer, complex, strings and the paste command, matrices, dataframes, lists, setwd, read.table, read.csv, write. matrix, write.csv, creation of new variables, categorisation, cut, factor; round, apply, creation of patterned variables, saving output to a file; source; print, saving workspace/history.

Graphics in R: the plot command, histogram, barplot, boxplot, points, lines, segments, arrows, paste, inserting mathematical symbols in a plot, pie diagram, customisation of plot- setting graphical parameters, text and mtext, the pairs command, colours and palettes, saving to a file; graphical parameters such as mar/mai/mfrow, xlab/ylab/las/xaxp/yaxp/xlim/ylim /cex/axis/tck/srt main/title/legend/locator, identify.

Vector matrix operations: matrix operations, addition, subtraction, multiplication, linear equations and eigenvalues, matrix decomposition and inverse, the linear model and qr decomposition, determinant, g inverse, finding a basis, orthonormalisation, finding rank.

Marks Distribution:

Programming	- 80 marks
Viva-voce + Records	- 20 marks

Books Recommended

1. Randall L. Eubank and Ana Kupresanin: Statistical Computing in C++ and R. Chapman &Hall/CRC The R Series.

2. Verzani, John. Using R for Introductory Statistics. Taylor & Francis.

THIRD SEMESRER

ST-C- 301: MULTIVARIATE ANALYSIS

(100 MARKS)

UNIT-I

Multivariate normal distribution – distribution of linear combination of normally distributed variables, marginal and conditional distributions, distribution of quadratic forms. Random sampling from normal distribution, maximum likelihood estimators of parameters, distributions of sample mean vector and matrix of corrected sum of squares and cross products.

UNIT-II

Estimation of partial and multiple correlation coefficients and their sampling distributions (null case only). Hotelling's T^2 statistic – properties, distribution and uses, tests on mean vector for one and more multivariate normal populations and also on equality of the components of a mean vector in a multivariate normal population. Mahalanobis – D^2 statistic and its use.

UNIT-III

Classification and discrimination procedures – discrimination between two multivariate normal populations, sample discriminant function, tests associated with discriminant functions, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations. Fisher's dicsriminant function.

UNIT-IV

Cluster Analysis, Factor Analysis, Wishart matrix – distribution and properties, characteristic function, reproductive property, marginal and conditional distributions. Distribution of sample generalized variance.

UNIT-V

Principal components – definition, MLE of principal components and their variances. Canonical variables and canonical correlations – definition, use, estimation and computation, Multivariate Analysis of Variance (MANOVA).

Books Recommended

1. Anderson, T.W.: An Introduction to Multivariate Statistical Analysis, 2nd ed., Wiley
2. Morrison, D.F.: Multivariate Statistical Methods, 2nd ed., McGraw-Hill
3. Giri, N.C: Multivariate Statistical Inference. Academic Press, NY
4. Rao, C.R: Linear Statistical Inference and Its Application. John Wiley.
5. Sharma, S: Applied Multivariate Techniques, John Wiley.

ST-C-302: DESIGN&ANALYSIS OF EXPERIMENTS

(100 MARKS)

UNIT-I

Analysis of variance – components and models, analysis of variance of one-way and two-way fixed and random effect models, variance component estimation and study of various methods, tests for variance components. Analysis of unbalanced data. Principles of designs of experiment, experimental error and data interpretation.

UNIT-II

Complete block designs - completely randomized designs, randomized block designs, latin square designs, Graeco-Latin square designs, cross-over designs. Missing plot techniques – general theory and applications.

UNIT-III

Analysis of covariance. General factorial experiments, factorial effects, best estimates and testing the significance of factorial effects, study of 2n, 32, 33 factorial experiments in randomized blocks.

UNIT-IV

Confounding in 2^n , 3^2 and 3^3 factorial experiments - complete and partial confoundings, advantages and disadvantages, construction and analysis, fractional replication for symmetric factorials.

UNIT-V

Incomplete block designs – balanced incomplete block design, parametric equality and inequality, intra-block analysis, analysis with recovery of inter-block information. Split plot and strip plot designs – models and analysis.

Books Recommended

1. Das, M.N. and Giri, N.C.: Designs of Experiments, New Age International.
2. Kempthorne, O.: Design and Analysis of Experiments, Wiley Eastern.
3. Gun, A.M., Gupta, M.K. and Dasgupta, B.: An Outline of Statistical Theory, Vol.II, (4^{th} ed.), World Press.
4. Dey, Aloke: Theory of Block Designs. New Age International.
5. Dean, Angela and Voss, Daniel: Design and Analysis of Experiments. New Age International.
6. Chakrabarty, M.C. : Mathematics of Design of Experiments. Asian pub. House.
7. Montgomery, C.D.: Design and Analysis of Experiments. John Wiley, New York.

ST-CE-303: DECISION THEORY AND BAYESIAN INFERENCE

(100 MARKS)

UNIT-I

Game theory and decision theory – composition, decision and risk functions, loss functions, expected loss, utility and subjective probability, randomization. Optimal decision rules – ordering of the decision rules, geometrical interpretation, form of Bayes' rules for estimation problem.

UNIT-II

Theorems of decision theory – admissibility and completeness, existence and admissibility of Bayes' rules, existence of a minimal complete class.

UNIT-III

The separating hyper plane theorem, essential completeness of the class of non-randomized decision rules, Jensen's inequality, the minimax theorem, the complete class theorems and their applications, solving of minimax rules.

UNIT-IV

Subjective probability, its existence and interpretation. Prior distribution, subjective determination of prior distribution. Improper priors, non-informative (default) priors, invariant priors. Conjugate prior families, construction of conjugate families using sufficient statistics of fixed dimension.

UNIT-V

Bayesian inference : Bayes sufficiency, summary through posterior, predictive inference. Point estimation, credible sets, testing of hypotheses. Comparison with classical procedures. Admissibility and minimaxity of Bayes and generalized Bayes procedures.

Books Recommended

1. Ferguson, T.W.: Mathematical Statistics- A Decision Theoretic Approach, Academic Press.
2. De Groot, M.A.: Optimal Statistical Decision, McGraw-Hill
3. Berger, J.O.: Statistical Decision Theory and Bayesian Analysis, Springer-Verlag.
4. Bernando, J.M. and Smith, A.F.M. : Bayesian Theory, John Wiley and Sons.
5. Robert, C.P. : The Bayesian Choice: A Decision Theoretic Motivation, Springer.
6. Box, G.P. and Tiao, G.C.: Bayesian Inference in Statistical Analysis, Addison-Wesley.

OR

ST-CE- 303: APPLIED STOCHASTIC PROCESSES

(100 MARKS)

UNIT-I

Notations and specification of stochastic process, stationary process, martingales, random walk and ruin problems, expected duration of the game, generating function of the duration of the game and for the first passage times, random walk in the plane and space. Markov chains - classification of states and chains, and related problems.

UNIT-II

Determination of higher transition probabilities, stability of a Markov system, limiting behavior of finite irreducible chains, ergodic theorem, graph theoretic approach, reducible chains, ergodic theorem for reducible chains (without proof), finite reducible chains with a single closed class and with more than one closed class. Markov chain with continuous state space, non-homogeneous chains.

UNIT-III

Markov processes with discrete state space – poisson process, properties of poisson process, poison process and related distributions. Generalization of poisson process – pure birth process, Yule-Furry process, birth-immigration process, time-dependent poisson processes, pure death process, birth and death processes.

UNIT-IV

Markov processes with discrete state space – Champman-Kolmogorov foreward and backward equations, derivation of poison process, pure birth process, pure death process by using Chapman-Kolmogorov equations, Erlang process.

UNIT-V

Markov processes with continuous state space – Brownian motion, Wiener process, differential equations for a Wiener process, Kolmogorov equations, first passage time distribution for Wiener process.

Books Recommended

1. Medhi, J. (1982): Stochastic Processes, Wiley Eastern.
2. Feller, W. (1968): Introduction to Probability and its Applications, Vol.1, Wiley Eastern.
3. Hoel, P.G, Port S.C. and Stone, C.J. (1972): Introduction to Stochastic Processes, Houghton Miffin and Co.
4. Karlin, S. and Taylor,H.M. (1975): A First course in Stochastic Processes, Vol.1,Academic Press.

ST-AE-304: DEMOGRAPHY& VITAL STATISTICS
(100 MARKS)

UNIT-I

Coverage and errors in demographic data, Chandrasekharan Deming formula. Adjustment of age data, Whiples, Mayers and UN indices. Population projection methods: Component & Growth Models, Leslie Matrix, Population distribution: Lorenz curve and Gini concentration ratio, Population pyramid.

UNIT-II

Measures of fertility (period and cohort), Coales fertility index, Measures of reproduction, Calculation of PPR, Model age patterns of fertility: Brass Polynomial model & Coale-Trussell model. Nuptiality rate, Net Nuptiality table, Proportion Single and Singulate. Mean age at marriage, Hajnal's method of estimating SMAM, Mean duration of fertile union.

UNIT-III

Measures of mortality, comparative mortality index, Lexis Diagram and IMR, life table functions, Construction of Reed Merell, Greville life table, UN and Coale-Demeny model life tables, multiple decrement life table, Age decomposition of differences in life expectancies at birth, Model age patterns of mortality, Fitting Gompertz law, Estimation of Child mortality (Brass method),

UNIT-IV

Measures of internal migration & international migration methods of estimation, Migration models. Models of population growth: A simple Birth and Death process, Immigration process, Emigration process, Birth-Emigration process, Immigration-Emigration process.

UNIT-V

Stationary and stable population models, Simplified example of stable population, Lotka's demonstration of conditions producing a stable population, The equations characterizing a stable Population, Identification of the intrinsic growth rate, Construction of a stable equivalent population, Momentum of population growth and its estimation.

Books Recommended

1. Pathak, K.B. and Ram, F.: Techniques of Demography Analysis, Himalayan Publishers
2. Srinivasan, K.: Basic Demographic Techniques and Applications, Sage Publishers
3. Ramkumar, R.: Technical Demography, Wiley Eastern.
4. S.H. Preston, P.Heuveline& M. Guillot, Blackwell, 2003_-Demography
5. Applied Mathematical Demography by Nathan Keyfitz, Springer Verl

OR

ST-AE-304: BIOSTATISTICS

(100 MARKS)

UNIT-I

Quantitative Genetics: Genotypes, Phenotypes, Mendel's theory, linkage, Population genetics, random and nonrandom mating, genetic change in a finite population, selection and mutation.

UNIT-II

Estimation of genetic parameters and testing genetic hypotheses, problems of human genetics, inheritance of quantitative characters.

UNIT-III

Stochastic models in Biology and Epidemiology: Discrete and continuous time stochastic models, diffusion equation, stochastic models for population growth and extinction (includes branching process)

UNIT-IV

Stochastic models for interacting population of species- competition and predation, chemical kinetics, photosynthesis and neuron behaviour.

UNIT-V

Deterministic and stochastic models for epidemics and endemics, interference models, vaccination models, geographical spread, parasitic diseases, parameter estimation related to latent, infection and incubation periods.

Books Recommended

1. Jain and Prabhakaran: Genetics of Population, South Asian Publiscations.
2. Narain, P. (1990): Statistical Genetics, John Wiley and Sons
3. Ewens, W. J. (1979). Mathematics of Population Genetics, Springer Verlag.

ST-C- 305 :STATISTICAL COMPUTING – III: ADVANCED R AND C/C++ PROGRAMMING

(100 MARKS)

Advanced R Programming

Basic Statistics: r help-command help, help.search(), R mailing list, contributed documentation on cran, one and two sample t tests, bartletts test for variance, f test for equality of variances, multi sample means, chi squared tests - homogeneity, independence, exact tests and confidence intervals, checking the assumptions, distribution fitting.

Linear models: the lm function; fitting a linear model; anova/ancova/regression models, the summary function, goodness of fit measures, predicted values and residuals; residual plots, the anova table, confidence intervals.

R functions: some useful inbuilt R functions - sort, order, rank, ceiling, floor, round, trunc, signif, apply, lapply, by, programming in R- for/while/if loops, functions, the source command.

Random number generation and simulations: rnorm, rchisq, rt, rbinometc; sample; set.seed, monte-carlo techniques, problems on monte carlo techniques.

Regression: case study from regression analysis.

R libraries: what is an r library? How to load a library? How to use an unknown library? How to get help- documentation and vignettes?
Problems based on:

I. Multivariate Analysis
II. Design of Experiments
III. Demographic data

Marks Distribution:

Programming - 80 marks

Viva-voce + Records - 20 marks

Books Recommended

1. Randall L. Eubank and Ana Kupresanin: Statistical Computing in C++ and R. Chapman &Hall/CRC The R Series.

2. Verzani, John. Using R for Introductory Statistics.Taylor & Francis.

Marks Distribution:

Computational Lab. Work - 80 marks

Viva-Voce + Record - 20 marks

FOURTH SEMESTER

ST-AE- 401: LINEAR MODELS AND REGRESSION ANALYSIS

(100 MARKS)

UNIT-I

Regression on the full rank model - methods of estimation and their consequences, distributional properties, general linear hypothesis, testing of common hypothesis and reduced models.

UNIT-II

Regression on dummy variables – regression on allocated codes, regression on dummy (0,1) variables, use of dummy variables on multiple regression.

UNIT-III

Regression models (not of full rank) – consequences and distributional properties. Estimable functions – properties, testing for estimability, general linear hypothesis.

UNIT-IV

Selecting the 'best' regression equation – all possible regressions, backward and forward elimination procedures, step-wise regression procedures.

UNIT-V

Multiple regression applied to analysis of variance problems – one way and two way classifications using the models.

Books Recommended

1. Searle, S.R.: Linear Models, John Wiley & Sons
2. Draper, N.R. and Smith, H.: Applied Regression Analysis, John Wiley & Sons.
3. Rao, C.R: Linear Statistical Inference and its Applications, Wiley Eastern Ltd.
4. Kshirsagar, A M: A Course in Linear Models. Marcel Dekker, N. Y.
5. Joshi, D D: Linear Estimation and Design of Experiments. New Age International Publication.
6. Weisberg, S. Applied Linear Regression. Wiley.
7. Chatterjee, S. and Price, B: Regression Analysis by Example. John Wiley, New York.

OR

ST-AE- 401: ECONOMETRICS

(100 MARKS)

UNIT-I

Nature of econometrics, ordinary least squares (OLS)estimation and prediction, the general linear model (GLM) and its extensions, generalized least squares (GLS) estimation (Aitken estimators)and prediction, heteroscedastic disturbances–nature, OLS estimators in the presence of heteroscedasticity, detection, consequences and remedial measures, pure and mixed estimation.

UNIT-II

Autocorrelation-Nature and reasons of autocorrelation, OLS estimation in the presence of autocorrelation, its consequences and tests. Theil BLUS procedure, estimation and prediction, Multicollinearity- detection, consequences and remedial measures, its implications and tools for handling the problem, ridge regression.

UNIT-III

Linear regression and stochastic regression, instrumental variable estimation, errors in variables, autoregressive linear regression, lagged variables, distributed lag models, estimation of lags by OLS method, Koyck's geometric lag model.

UNIT-IV

Simultaneous equation models – examples, the simultaneous-equation bias. Identification problem – concepts and definitions, under, just or exact and over identifications, rules for identification, test of simultaneity, restrictions on structural parameters, rank and order conditions.

UNIT - V

Simultaneous equation methods – approaches to estimation, recursive systems, method of indirect least squares (ILS), method of two-stage least squares (2SLS), limited information estimators, k-class estimators, 3 SLS estimator, full information maximum likelihood method, prediction and simultaneous confidence intervals.

Books Recommended

1. Johnston, J.: Econometric Methods, McGraw-Hill
2. Gujarati, D.: Basic Econometrics, McGraw-Hill.
3. Theil, H.: Introduction to the Theory and Practice of Econometrics, John Wiley.
4. Apte, P.G.: Text Book of Econometrics, Tata McGraw-Hill.
5. Cramer, J.S.: Empirical Econometrics, North Holland.
6. Maddala, G.S.: Econometrics, McGraw-Hill.

ST-CE-402: ADVANCED SURVEY SAMPLING METHODS (100 MARKS)

UNIT-I

Unequal probability sampling with replacement – probability proportional to size with replacement sampling, estimation of mean/total, method of selection, standard error of estimate and it's estimation, comparison with SRSWR, gain due to PPSWR sampling, optimum size measure, estimator based on distinct units in PPSWR sampling

UNIT-II

Unequal probability sampling without replacement – Des Raj's ordered estimator, Murthy's unordered estimator, Horvitv-Thompson estimator and it's optimal properties. Midzuno, Narain, Brewer, Durbin, Sampford , and Rao-Hartly-Cochran sampling procedures, systematic sampling with varying probabilities.

UNIT-III

Multi-phase Sampling – double sampling for ratio and regression methods, stratification and PPS sampling. Sampling on two and more occasions.

UNIT-IV

Problems of finite population inference under a fixed population set up – PDF of data, likelihood function, sufficiency, UMVUE, admissibility, average variance under a model, comparison of strategies. Inference from finite population using prediction theoretic approach - principle, prediction under polynomial and multiple regression models, predicting a super-population mean.

UNIT-V

Errors in surveys – types of errors, mathematical models for measurement error. Problems of non response – Hansen and Hurwitz technique, Politz-Simon technique. Randomized response techniques – Warner's model and unrelated question model. Variance estimation – methods of random groups, the Jack knife, balanced half sample, and the bootstrap. Small area estimation – direct, synthetic and composite estimators.

Books Recommended

1. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C.: Sampling Theory of Surveys with Applications, Indian Soc. of Agric. Stat., New Delhi
2. Cochran, W. G: Sampling Techniques. Wiley Eastern.
3. Murthy, M. N: Sampling Theory and Methods. Statistical Publishing Society.
4. Mukhopadhyay, Parimal: Small Area Estimation in Survey Sampling. NarosaPublising House.

OR

ST–CE-402: ADVANCED DESIGN& ANALYSIS OF EXPERIMENT

(100 MARKS)

UNIT-I

Analysis of fixed effects model: Estimation of model parameters, Unbalanced data, Model adequacy checking, Practical interpretation of results, determination of sample size.

UNIT-II

Two-Level Fractional Factorial Designs: The one-half fraction of the 2^k Design, one-quarter fraction of the 2^k Design, the general 2^{k-p} Fractional Factorial Design, Alias structure.

UNIT-III

Factorial experiments with mixed levels: Factors at two and Three levels, factors at two and four levels, Constructing Fractional Factorial Designs using an Optimal design tool.

UNIT-IV

Response surface designs – linear response surface designs, second order response surface designs. Experimental designs for fitting response surfaces, Mixture experiments.

UNIT-V

Rubust Design: Introduction, Crossed array designs and analysis, Combined array designs and the response model approach, Choice of designs.

Books Recommended

1. Montgomery, D.C. (2014): Design and Analysis of Experiments, Eighth edition, Wiley, NY
2. Dey, A.: Theory of Incomplete Block Designs, Wiley Eastern.
3. Das, M.N. and Giri, N.: Design and Analysis of Experiments, New Age International.
4. Kempthorne, O. (1952): The Design and Analysis of Experiments, Wiley, NY.
5. Chakrabarty, M.C. : Mathematics of Design of Experiments. Asian pub. House.
6. Khuri, A. and Cornell, M. : Response Surface Methodology. Marcel Dekker.

OR

ST-CE-402: ADVANCED OPERATIONS RESEARCH

(100 MARKS)

UNIT-I

Dynamic programming: Basic concepts, development of dynamic programming, continuous state dynamic programming, multiple state variables, Goal programming: categorization, formulation, graphical goal attainment method, simplex method.

UNIT - II

Fuzzy logic: Fuzzy relations, fuzzy systems, defuzzification methods, Non-Linear programming: Unconstrained optimization, constrained optimization: Equality constraints and inequality constraints.

UNIT-III

Simulation Modeling: examples, pseudo-random numbers, techniques for generating for random deviates, simulation languages, advanced concepts in simulation analysis: Design of simulation experiments, variance reduction techniques, statistical analysis of simulation output, optimization of simulation parameters.

UNIT-IV

Integer programming: Pure and mixed integer programming problem, Gomory's all integer programming problem, Gomory's constraints, fractional cut method: all integer and mixed integer, Branch and Bound algorithm.

UNIT-V

Network routing problems: Minimal spanning tree, shortest route algorithm, maximal flow problems, minimum cost flow, Resource analysis in network scheduling: Project cost, time cost optimization algorithm, linear programming formulation, updating, resource allocation and scheduling.

Books Recommended:

1. Hardly, G.(1964): Non-linear and Dynamic Programming, Addison Wesley
2. Wagner, H.M.(1969): Principles of Operations Research with Applications to Managerial Decisions, Prentice Hall
3. Ravindran, A., Phillips, D.T. and Solberg, J.J. (2009): Operations Research: Principles and Practice, Wiley-India.
4. Zimermann, H.J. (2001): Fuzzy Set Theory and its Applications, 2nd ed., Allied Publishers.
5. Lee, K.H. (2006): Fuzzy logic and Its Applications, Springer.
6. Rajasekharan, S. and Pai, G.A.V. (2006): Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI.

ST–CE-403: TIME SERIES AND STATISTICAL QUALITY CONTROL

(100 MARKS)

UNIT-I

Time series as discrete parameter stochastic process. Auto covariance and autocorrelation function 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, Adaptive smoothing.

UNIT-II

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, Discussion (without proof) of estimation of mean, auto covariance and autocorrelation functions under large sample theory, Choice of AR and MA periods. Estimation of ARIMA model parameters.

UNIT-III

Industrial statistics – statistical quality control, need for statistical quality control, control charts in general, random and assignable causes, purpose of control charts, process control, control charts for measurements, charts for averages, attributes, defectives and defects, CUSUM chart, V-Mask technique, economic design of $\bar{X}, R$ Charts.

UNIT-IV

Acceptance sampling plans – single and double sampling plans for attributes, Five curves and their importance, producer's and consumer's risk, variable sampling plans, sequential sampling plans. Sequential probability ratio test- OC and ASN functions, sequential tests for testing means of normal and binomial populations.

UNIT-V

Tolerance and Specification limits, Capability indices Cp, Cpk and Cpm. Estimation, confidence intervals and tests of hypotheses relating to capability indices for normally distributed characteristics.

Books Recommended

1. Box, G.E.P., Jenkins, G. M. and Reinsel, G. C.: Time Series Analysis, Pearson Edition
2. Burr, I.W.: Engineering Statistics and Quality Control, McGraw-Hill
3. Grant, E.L. and Leavenworth, R.S.: Statistical Quality Control, McGraw-Hill.
4. Anderson, T.W. (1971).The Statistical Analysis of Time Series, Wiley, N.V.
5. Montgomerv, D.C. (1985) Introduction to Statistical Quality Control: Wiley
6. Wetherill, G.B. and Brown, D.W. Statistical Process Control. Theory andPractice: Chapman and Hall

OR

ST–CE-403: RELIABILITY THEORY

(100 MARKS)

UNIT-I

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.

UNIT-II

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

UNIT-III

Notions of aging; IFR; IFRA; NBU; DMRL and NBUE classes and their duals; loss of memory property of the exponential distribution; closures of these classes under formation of coherent systems; partial ordering of life distributions, convolution and mixtures.

UNIT-IV

Reliability estimation based on failure times from variously censored life-tests data for parametric families, stress-strength reliability and its estimation. Kaplan – Meier estimation of reliability curve, Greenwood formula, Non – parametric methods for comparison of several reliability curves, Log rank tests. Regression models in reliability, Cox PH and Accelerated failure time models; Estimation of parameters and diagnostics.

UNIT-V

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.

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.
6. Kalbfleisch, J.D. & Prentice R.L. :The Statistical Analysis of Failure time data, 2nd ed.
7. Lai, C.D.&Xie, M. :Stochastic Ageing and Dependence for Reliability
8. Gertsbakh, I.B. :Reliability Theory with Applications to Preventive maintenance

ST-FE-404:ACTUARIAL STATISTICS

(100 MARKS)

UNIT-I

Mortality – mortality experience, mortality table, graph of Lx, force of mortality, laws of mortality, mortality table as a population model, expectation of life, stationary funds.

UNIT-II

Annuities – pure endowments, annuities, accumulations, assurances, varying annuities and assurances, continuous annuities, family income benefits.

UNIT-III

Policy values – nature of reserve, prospective and retrospective reserves, fractional premiums and fractional duration, modified reserves, continuous reserves, surrender values and paid up policies, industrial assurance, children's deferred assurances, joint life and last survivorship.

UNIT-IV

Contingencies - contingent probabilities, contingent assurances, reversionary annuities, multiple decrement table, forces of decrement, construction of multiple decrement table.

UNIT-V

Pension funds – capital sums on retirement and death, widow's pension, sickness benefits, benefits dependent on marriage.

Books Recommended

1. Dickson, C. M. D. (2005): Insurance Risk And Ruin (International Series On Actuarial Science), Cambridge University Press.
2. 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.

OR

ST-FE- 401: QUANTITATIVE EPIDEMIOLOGY

(100 MARKS)

UNIT-I

Introduction to epidemiology, causation, prevention and commucicable diseases in epidemiology.Clinical environmental and occupational epidemiology.

UNIT-II

Epidemiologic measures - organizing and presenting epidemiologic data, measures of disease frequencies, relative risk and odd ratio, attributable risk.

UNIT-III

Analysis of epidemiologic studies – adjustment of data without use of multivariate model, direct and indirect adjustments. Confounding variables in 2□2 tables, confident limits for adjusted odd ratios, multiple match controls.

UNIT-IV

Regression model, adjustment using multiple regression and multiple logistic models, survival over several intervals, withdrawals, life table for specific causes, comparison of complete survival curves. Product limits, Cox regression.

UNIT-V

Epidemiology of infectious and chronic diseases, epidemiology and cancer prevention. Environmental epidemiology, molecular and genetic epidemiology.

Books Recommended

1. K. J. Rothman and S. Geenland (ed.) (1998). Modern Epidemiology, Lippincott-Raven.
2. S. Selvin (1996). Statistical Analysis of Epidemiologic 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 Preventive Medicine. WB Saunders Co.

OR

ST-FE-404:SURVIVAL ANALYSIS AND CLINICAL TRIALS

(100 MARKS)

UNIT-I

Concept of time, order, Type I, Type II and progressive or random censoring with biological examples, Functions of survival time, hazard function, survival distributions and their applications viz. exponential, gamma, Weibull, Rayleigh, lognormal, Pareto death density function for a distribution having bath-tub shape hazard function.

UNIT-II

Life tables, mean residual life, Non-parametric methods for estimating survival function and variance of the estimator viz. Actuarial and Kaplan –Meier methods. Estimation under the assumption of IFR/DFR. Two sample problem- Gehan test, log rank test.

UNIT-III

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.

UNIT-IV

Introduction to clinical trials: the need and ethics of clinical trials, bias and random Error in clinical studies, conduct of clinical trials, overview of Phase I-IV trials, Multicenter trials, Single and double blinding.

UNIT-V

Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. Longitudinal designs, review of factorial designs, objectives and endpoints of clinical trials, design of Phase I trials, design of single-stage and multi-stage Phase II trials, design and monitoring of phase III trials with sequential stopping.

Books Recommended

1. Kalbfleisch J. D. and Prentice R. (1980): The Statistical Analysis of failure Time data, John Wiley.
2. Kleinbaum, D.G. (1996): Survival Analysis, Springer
3. Lee, Elisa, T. (1992). Statistical Methods for Survival Data Analysis, John Wiley & Sons.
4. Miller, R.G. (1981). Survival Analysis, John Wiley & Sons.
5. Piantadosi. S. (1997): Clinical Trials: A Methodologic Perspective. Wiley and Sons.
6. Friedman, L. M. Furburg, C. Demets, D. L. (1998): Fundamentals of Clinical Trials. Springer Verlag.
7. Marubeni. E. and Valsecchi. M. G. (1994): Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley and Sons.

OR

ST-FE-404:BIG DATA ANALYTIC TECHNIQUES

(100 MARKS)

UNIT-I

Resampling Techniques: Introduction to Jackknife and Bootstrap-methods for estimating bias, standard error and distribution function based on iid random variables, standard examples, Bootstrap confidence intervals

UNIT-II

Missing data analysis: Informative or non-informative missingness; complete case / available case estimation.

UNIT-III

Missing data analysis: Imputation, EM & MCEM algorithms and data augmentation techniques. Standard error estimation.

UNIT-IV

Longitudinal data analysis: Longitudinal regression : Cohort vs longitudinal effect, Weighted least-squares, ML and REML techniques.

UNIT-V

Marginal, subject specific and transition models, GEE.

Books Recommended

1. J.J.Faraway : Linear Models with R
2. J.J.Faraway : Extending the Linear Model with R
3. D.Ruppert et al. : Semiparametric Regression
4. R.J.A.Little&D.B.Rubin : Statistical Analysis with Missing Data
5. C.K.Enders : Applied Missing Data Analysis
6. M.A.Tanner : Tools for Statistical Inference
7. G.J.McLachlan&T.Krishnan : The EM Algorithm and Extensions
8. B.Efron&R.J.Tibshirani : An introduction to bootstrap
9. B.Efron : The jackknife, the bootstrap, and other resampling plans
10. B.Efron : Bootstrap methods – another look at jackknife
11. J.Shao&D.Tu : The Jackknife and Bootstrap
12. P.J. Diggleet. al. : Analysis of Longitudinal Data (2nded).

ST-FE-405:PROJECT WORK AND SEMINAR PRESENTATION

(100 MARKS)

The supervisors are to be allotted to the students before the end of third semester examination and they have to prepare a seminar paper and also a project paper under his/her guidance.

Internal Examination: 30 Marks

Seminar Presentation: 20 Marks.

Each student has to give one seminar presentation before the students and faculties on any area of Statistics with his/her interest carrying 20 Marks. This mark will be the average mark given by the faculties of the department attending the presentation.

Project paper Presentation before the Supervisor: 10 Marks.

The project paper before final presentation is to be presented before their supervisor and it carries 10 Marks.

Semester Examination: 70 Marks

Project Report presentation before Internal and External examiners: 50 marks.

Viva-Voce: 20 Marks