Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara (Autonomous)

Undergraduate Programme

B. Sc. in Statistics

Syllabi of the course

Choice based credit system syllabus

(To be implemented from academic year 2020-21)

Department of Statistics

B.Sc. Part - III

Revised B. Sc. Part-III Statistics (CBCS) Syllabus w. e. f. June 2020

1. Structure of Syllabus:

B.Sc.-III Semester-V

Paper Title	Theory			Practical		
	Paper Code	Lectures Per week	Credits	PaperTitle	Lectures per week	Credits
Compulsory Papers						
Probability Distribution-I	BST501	3	2	BSP508	10	04
Statistical Inference- I	BST502	3	2			
Operation research	BST503	3	2	BSP509 + Project	10	4
Elective Papers (Any one)						
Design of experiment	BST504	3	2			
Demography and Vital Statistics	BST505					
Data Mining	BST506					
Skills in computational Statistics	SECCST507	2	1	SECCSP510	4	**1**

B.Sc.-III Semester-VI

Paper Title	Theory			Practical		
	Paper Code	Lectures Per Week	Credits	PaperTitle	Lectures Per Week	Credits
Compulsory Papers				BSP 608	10	04
Probability Distribution-II	BST 601	3	2			
Statistical Inference – II	BST 602	3	2			
Industrial statistics	BST 603	3	2	BSP609 + Project	10	4
Elective Papers (Any one)						
Sampling Theory	BST604	3	2			
Survey Sampling and Official Statistics	BST605					
Reliability Theory	BST606					
Entrepreneurship development in Statistics	SECCST607	2	1	SECCSP610	4	**1**

Titles of Papers

Sr. No.	Semester-V	Semester-VI
1	BST501: Probability Distribution-I	BST601: Probability Distribution -II
2	BST502: Statistical Inference-I	BST602: Statistical Inference –II
3	BST503: Operation Research	BST603: Industrial Statistics
Elective Papers (Any one)		
4	BPT504: Design of Experiment BPT505: Demography and Vital StatisticsBPT506: Data Mining	BPT604: Sampling Theory BPT605: Survey Sampling and Official Statistics BPT606: Reliability Theory
5	SECCPT507 : Skills in computational Statistics	SECCPT607 : Entrepreneurship development in Statistics
6	BSP 508: Practical Paper -V (A), V(B), V(C)	BSP 608: Practical Paper VII (A) VII(B) VII(C)
7	BSP 509: Practical Paper VI+ Project	BSP 609: Practical Paper VIII+ Project
8	SECCPP510: Skills in computational Statistics	SECCPP610: Entrepreneurship development in Statistics

Paper-IX: BST501: Probability Distribution-I
Theory: 45 Lectures of 48 minutes (36 Hours)
Marks -50 (Credits: 02)

Course Objectives: Students should to
1. Understand probability and probability distribution.
2. Study applications of probability distribution.
3. Study Univariate and Multinomial Probability distributions.
4. Understand Truncated Distributions and Generating Functions.

Unit-1: Univariate Continuous Probability Distributions (15)

1.1: Laplace(Double Exponential)Distribution : P.d.f. with parameters(μ,λ) , Nature of the probability curve, Distribution function, quartiles, m. g. f., mean, variance, moments $\beta 1$, $\beta 2$, $\gamma 1$ and $\gamma 2$ Laplace distribution as the distribution of the difference of two i. i. d. exponential variates with parameter θ , examples and problems

1.2 : Lognormal Distribution: P.d.f. with parameters(μ,σ^2),Nature of the probability curve, mean, variance, median, mode, moments, $\beta 1$, $\beta 2$, $\gamma 1$ and $\gamma 2$ coefficients, Relation with N(μ,σ^2),examples and problems.

1.3 : Cauchy Distribution: P.d.f. with parameters(μ,λ), nature of the probability curve, distribution function, quartiles, non-existence of moments, additive property for two independent Cauchy variates (statement only), statement of distribution of the sample mean, relationship with uniform and Student's 't' distribution, distribution of X/Y where X and Y are i.i.d. N(0,1),example and problems.

1.4 : Weibull Distribution: P.d.f. with parameters (μ, λ), distribution function, quartiles, mean and variance, coefficient of variation, relation with gamma and exponential distribution, examples and problems.

Unit-2: Univariate and Multinomial Probability Distributions (12)

2.1: Logistic distribution: P.d.f. with parameters(μ,λ), c.d.f., mean, mode, variance, skewness using mode, applications.

2.2 : Pareto distribution: P.d.f. with parameters (α, β), mean, variance, mode, skewness using mode, applications.

2.3 : Power series distribution: P.m.f. mean, mode, variance, Binomial, Poisson, Geometric and negative binomial distribution as particular cases of power series distribution.

2.4: Multinomial distribution: P.m.f, m.g.f., marginal distribution, mean, variance, covariance, variance and covariance matrix, correlation coefficient, additive property, Trinomial distribution as particular case of multinomial distribution.

Unit-3: Truncated Distributions **(8)**

3.1 : Truncated distribution as conditional distribution, truncation to the right, left and on both sides.

3.2 : Binomial distribution B(n, p) left truncated at X = 0(value zero not observable), its p.m.f mean, variance.

3.3 : Poisson distribution P(m), left truncated at X= 0(value zero not observable),its p.m.f.,mean and variance.

3.4 : Normal distribution $N(\mu,\sigma^2)$truncated

i. To the left below a
ii. To the right above b
iii. To the left below a and to the right above b, its p.d.f. And mean.

3.5 : Exponential distribution with parameter θ left truncated below a , its p.d.f. mean andvariance.

3.6 : Examples and problems.

Unit 4: Generating Functions **(10)**

Definition of generating function and probability of generating function. Expression for mean and variance in terms of generating functions.

Definitions of a convolution of two or more sequences Generating function of a convolution. Generating function of a standard discrete distributions.

Relation between: i) Bernoulli and Binomial distributions ii) Geometric and Negative Binomial distributions in terms of convolutions.

Books Recommended

1. Mathematical Methods of Statistics, Cramer H. Asia Publishing House, Mumbai. 2005
2. Introduction to Theory of Statistics: Mood, A. M., Gray bill K, Bose. D. C :(Third Edition) Mc-Graw Hiil Series. 2005
3. Statistical Theory (Third Edition), Lindgren B.W, Collier Macmillan International Edition, Macmillan Publishing Co. Inc. New York. 2004
4. Introduction to Mathematical Statistics (Third Edition), Hogg, R. V. and Craig A. T. Macmillan Publishing Company. 2000
5. New Mathematical Statistics (First Edition), Sanjay Arora and BansiLal: Satya Prakashan, ,New Market, NewDelhi, (1989).
6. Fundamentals of Mathematical Statistics, Gupta S. C and Kapoor V. K., Sultan Chand and Sons.
7. An Introduction to Probability Theory and Mathematical Statistics, Rohatgi V. K., Wiley
8. An Introduction of Probability Theory and its Applications, Feller.W, Wiley Eastern Ltd.Mumbai.

Course outcomes: Students are able to

Unit 1: Univariate Continuous Probability Distributions

1. Solve examples on Univariate Continuous Probability Distributions.
2. Understand Univariate Continuous Probability Distributions.

Unit 2: Univariate and Multinomial Probability Distributions

1. Understand Logistic distribution, Pareto distribution and Multinomial distribution.
2. Solve examples on Logistic distribution, Pareto distribution and Multinomial distribution.

Unit 3: Truncated Distributions

1. Understand Truncated Distribution.
2. Solve problem on Truncated Distribution.

Unit 4: Generating Functions

1. Understand Generating Function.
2. Solve problems on Generating Function.

Paper X : BST 502 :Statistical Inference – I

(Credits: 02)

Course Objectives: Students should to

1. Estimate an unknown parameter by point and interval.
2. Relative efficiency of unbiased estimators.
3. Sufficient statistic through (i) conditional distribution (ii) Neyman factorization criterion.
4. Method of maximum likelihood, derivation of maximum likelihood estimators

Unit - 1: Point Estimation **(15)**

1.1 : Notion of a parameter,parameter space, general problem of estimation, estimating an unknown parameter by point and interval estimation.

1.2 : Point estimation: Definition of an estimator (statistic) & its S.E., distinction between estimator and estimate, illustrative examples.

1.3 : Properties of estimator: Unbiased estimator , biased estimator, positive and negative bias, examples of unbiased and biased estimators. Proofs of the following results regarding the unbiased estimators:

(a) Two distinct unbiased estimators of $\phi(\theta)$ give rise to infinitely many unbiased estimators of $\phi(\theta)$

(b) If T is unbiased estimator of θ then $\phi(T)$ is an unbiased estimator of $\phi(\theta)$ provided $\phi(.)$ is a linear function. Sample variance is a biased estimator of the population variance. Illustration of unbiased estimator for the parameter and parametric function.

1.4 : Relative efficiency of T_1 with respect to T_2, where T_1 and T_2 are unbiased estimators. Use of mean square error to modify the above definition for biased estimator. Minimum Variance Unbiased Estimator (MVUE) and Uniformly Minimum Variance Unbiased Estimator (UMVUE), uniqueness of UMVUE whenever it exists. Illustrative examples.

1.5 : Consistency : Definition, proof of the following:

Sufficient condition for consistency, If T is consistent for θ and $\phi(.)$ is a continuous function then $\phi(T)$ is consistent for $\phi(\theta)$ Illustrative examples.

Unit - 2: Likelihood and Sufficiency (12)

2.1 : Definition of likelihood function as a function of the parameter θ for a random sample from discrete and continuous distributions. Illustrative examples.

2.2 : Sufficiency: Concept of sufficiency, definition of sufficient statistic through (i) conditional distribution (ii) Neyman factorization criterion. Pitman Koopman form and sufficient statistic. Proof of the following properties of sufficient statistic: If T is sufficient forθ then $\phi(T)$ is also sufficient for θ provided $\phi(.)$ is objective function. If T is sufficient for θ then T is sufficient for $\phi(\theta)$.

2.3 : Fisher information function: Definition of information function, amount of information contained in a sample. Statement regarding equality of the information in $(x_1, x_2,.....,x_n)$and in a sufficient statistic T, concept of minimal sufficient statistic. With illustrations to exponential family.

2.4 : Illustrative examples.

Unit - 3: Cramer-Rao Inequality (7)

Statement and proof of Cramer Rao inequality. Definition of Minimum Variance Bound Unbiased Estimator (MVBUE) of $\phi(\theta)$. Proof of the following results: If MVBUE exists for θ then MVBUE exists for $\phi(\theta)$, if ϕ (.) is a linear function .If T is MVBUE for θ then T is sufficient for θ. Examples and problems.

Unit - 4: Methods of Estimation (11)

4.1 : Method of maximum likelihood, derivation of maximum likelihood estimators for parameters of standard distributions. Use of iterative procedure to derive MLE of location parameter μ of Cauchy distribution, invariance property of MLE, relation between MLE and sufficient statistic .Illustrative examples.

4.2 : Method of moments: Derivation of moment estimators for standard distributions . Illustrations of situations where MLE and moment estimators are distinct and their comparison using mean square error (for uniform distribution). Illustrative examples.

4.3 : Method of minimum chi-square: Definition, derivation of minimum chi-square estimator for the parameter. Illustrative examples.

Books Recommended

1. A first Course on Parametric Inference ,Kale,B.K. S. Chand New Delhi ,2004
2. Statistical Inference, Rohatgi, V. K.:, Sultan Chand and Sons.,2001
3. An introduction to Probability Theory and Mathematical Statistics ,Rohatgi,V.K.:S. Chand New Delhi ,2008
4. Statistical Inference ,SaxenaH.C.andSurenderan:2011
5. An advanced Theory of Statistics ,Kendall M.G. and StuartA.:
6. Statistical Theory, Lindgren, B. W.: Macmillan Publishing Co. Inc. New York.2000
7. Theory of Point Estimation, Lehmann, E. L.:, Macmillan Publishing Co. Inc. New York. 2002
8. Linear Statistical Inference ,Rao, C. R.,S. Chand New Delhi ,2004
9. Dudewicz C.J .and Mishra S.N.:Modern Mathematical Statistics
10. Mathematical statistics., Fergusson, T. S.

Course outcomes: Students are able to

Unit 1: Point Estimation

1. Solve Point Estimation.
2. Understand Point Estimation.

Unit 2: . Likelihood and Sufficiency

1. Understand Likelihood and Sufficiency.
2. Solve problems on Likelihood and Sufficiency.

Unit 3:: Cramer-Rao Inequality

1. Understand cramer-rao inequality.
2. Solve problems on cramer-rao inequality.

Unit 4:: Methods of Estimation

1. Understand methods of estimation.
2. Solve problems on methods of estimation.

Paper XI : BST 503 : Operation Research

Course objectives: Students should to

1) Get the basic concepts of LPP and its formulation and evaluate the examples by graphical method**.**

2) Solve the LPP by simplex method.

3) Solve T. P. Methods of obtaining initial basic feasible solution of T.P.

4) Get introduction, steps in decision theory approach and type of decision making environments

Unit-1: Linear programming **(15)**

1.1 : Basic concepts

Statement of the Linear Programming Problem (LPP), formulation of problem as. L.P. problem. Definition of (i) a slack variable, (ii) a surplus variable. L.P. problem in (i) canonical form, (ii) standard form. Definition of (i) a solution, (ii) a feasible solution, basic variable and non-basic variable, (iv) a basic feasible solution, (v) a degenerate and a non-degenerate solution, (vi) an optimal solution.

Graphical Method: Solution space, obtaining an optimal solution, unique and non-unique optimal solutions.

1.2 : Solution of L.P.P.

Simplex Method: Initial basic feasible solution (IBFS) is readily available: obtaining an IBFS, criteria for deciding whether obtained solution is optimal, criteria for unbounded solution, , more than one optimal solutions. IBFS not readily available: introduction ofartificial variable, Big-M method, modified objective function, modifications and applications of simplex method to L.P.P., criterion for no solution.

1.3 : Duality Theory

Writing dual of a primal problem, solution of L.P.P. with artificial variable.

1.4 : Examples and problems.

Unit-2:Transportation and Assignment Problems (12)

2.1: Transportation problem

Transportation problem (T. P.), statement of T. P., balanced and unbalance T. P. Methods of obtaining initial basic feasible solution of T.P. (a) North West corner rule(b)Method of matrix minima (least cost method), (c) Vogel's approximation(VAM).MODI method of obtaining Optimal solution of T. P, uniqueness and non- uniqueness of optimal solutions, degenerate solution. Examples and problems.

2.2 : Assignment Problem

Statement of an assignment problem, balanced and unbalanced assignment problem, relation with T.P, optimal solution of an assignment problem using Hungarian method. Examples and problems.

2.3 : Sequencing Problem

Introduction. Statement of problem. Procedure of processing n jobs on two machines. Procedure of processing jobs on three machines and machines .Computations of elapsed time and idle times. Examples and problems.

Unit-3: Decision Theory (8)

Introduction, steps in decision theory approach. Type of decision making environments .Decision making under uncertainty: Criteria of optimism, criteria of pessimism, equally likely decision criterion, criterion of regret. Decision making under risk: Expected monetary value, expected opportunity loss, expected value of perfect information. Examples and problems.

Unit-4: Network Analysis: (10)

Scope and definition of network model, minimal spanning tree algorithm, shortest route problem.CPM, PERT: Network Representation, critical path computation, construction of timeschedule, linear programming formulation of CPM. PERT calculations.

Books Recommended:

1. Operation research–An Introduction Taha H. A.:, Fifth Edition, Prentice Hallof India,New Delhi. 2006
2. Linear Programming, Shrinath, L. S. : Affiliated East-West Press Pvt. Ltd., Delhi. 2004
3. Mathematical Models in Operations Research, Sharma, J. K. :, Tau McGraw Hill Publishing Company Ltd., New Delhi.1998
4. Operations Research, Kapoor, V. K. ; Sultan Chand and Sons, New Delhi. 2005
5. Operations Research, Gupta, P. K. and Hira, D. S. : S. Chand and Company Ltd., 2005

Course outcomes: Students are able to

Unit 1: Linear programming

1. Solve problems on linear programming.
2. Understand linear programming.

Unit 2: Transportation problem

1. Understand Assignment problems.
2. Solve problems on Assignment problems.

Unit 3: Decision Theory

1. Understand Decision Theory.

2. Solve problems on Decision Theory.

Unit 4: Network Analysis

1. Understand Network Analysis.
2. Solve problems on Network Analysis.

Elective Paper-I

Paper XII : BST 504 : Designs of Experiments (Credits: 02)

Course Objectives: Students should to

1) Know basic concepts of design of experiment.
2) Applications of Completely Random Design and estimation of parameters.
3) Applications of Randomized Block Design and estimation of parameters.
4) Applications of Latin Square Design and estimation of parameters.
5) Find efficiency of LSD over CRD and LSD over RBD.

Unit–1: Simple Designs of Experiments **(10)**

1.1: Basic Concepts:

i. Basic terms in design of experiments: Experimental unit, treatment, layout of an experiment.
ii. Basic principles of design of experiments: Replication, randomization and local control.
iii. Choice of size and shape of a plot for uniformity trials, the empirical formula for the variance per unit area of plots.
iv. Concept and definition of efficiency of a design.

1.2: Completely Randomized Design (CRD)

i. Application of the principles of design of experiments in CRD, layout, model, assumptions and interpretations:
ii. Estimation of parameters, expected values of mean sum of squares, components of variance.
iii. Breakup of total sum of squares in to components.
iv. Technique of one-way analysis of variance (ANOVA) and its applications to CRD.
v. Testing for equality for treatment effects and its interpretation. F-test for testing H_0, test for equality of two specified treatment effects.

Unit- 2: Simple Design of Experiments II: **(15)**

2.1 : Randomized Block Design(RBD):

i. Application of the principles of design of experiments in RBD, layout, model , assumptions and interpretations:
ii. Estimation of parameters, expected values of mean sum of squares, components of variance.

iii. Breakup of total sum of squares into components.
iv. Technique of two way analysis of variance (ANOVA) and its applications to RBD.
v. Tests and their interpretations, test for equality of two specified treatment effects, comparison of treatment effects using critical difference (C.D.).
vi. Idea of missing plot technique.
vii. Situations where missing plot technique is applicable.
viii. Analysis of RBD with single missing observation.
ix. Efficiency of RBD over CRD.

2.2 Latin Square Design (LSD)

i. Application of the principles of design of experiments in LSD, layout, model, assumptions and interpretations:
ii. Breakup of total sum squares into components.
iii. Estimation of parameters, expected values of mean sum of squares, components ofvariance. Preparation of analysis of variance (ANOVA) table.
iv. Tests and their interpretations, test for equality of two specified treatment effects, comparison of treatment effects using critical difference(C.D.).
v. Analysis of LSD with single missing observation.
vi. Identification of real life situations where CRD, RBD AND LSD are used.
vii. Efficiency of LSD over CRD and LSD over RBD.

Unit – 3 : Split Plot Design and ANOCOVA (10)

3.1. Split Plot Design:

i. Application of the principles of design of experiments in layout, model, assumptions and interpretations:
ii. Estimation of parameters, expected values of mean sum of squares, components of variance.

3.2 Strip Plot Design:

i. Application of the principles of design of experiments, layout, model, assumptions and interpretations:
ii. Estimation of parameters, expected values of mean sum of squares, components of variance.

3.2 Analysis of Covariance (ANOCOVA) with one concomitant variable

i. Purpose of analysis of covariance.

ii. Practical situations where analysis of covariance is applicable.

iii. Model for analysis of covariance in CRD and RBD. Estimation of parameters (derivationsare not expected).

iv. Preparation of analysis of covariance (ANOCOVA) table, test for $\hat{a} = 0$, test for equality of treatment effects (computational technique only).

Note :- For given data, irrespective of the outcome of the test of regression coefficient (β),ANOCOVA should be carried out.

Unit – 4 : Factorial Experiments **(10)**

i. General description of factorial experiments, 2^2 and 2^3 factorial experiments arranged in RBD.

ii. Definitions of main effects and interaction effects in2^2 and 2^3factorial experiments.

iii. Model, assumptions and its interpretation.

iv. Preparation of ANOVA table by Yate's procedure, test for main effects and interactioneffects.

v. General idea and purpose of confounding in factorial experiments.

vi. Total confounding (Confounding only one interaction) : ANOVA table, testing maineffects and interaction effects.

vii. Partial Confounding (Confounding only one interaction per replicate): ANOVA table, testing main effects and interaction effects.

viii. Construction of layout in total confounding and partial confounding in 2^3factorial experiment.

Books Recommended

1. Experimental Design ,Federer, W.T. :, Oxford and IBH publishing Company, New Delhi.2005

2. Experimental Design ,Cochran, W.G. and Cox, G.M. :, John Wiley and Sons, Inc., New York.

3. Design and Analysis of Experiments Montgomery, D.C.:, Wiley Eastern Ltd., New Delhi. 2012

4. Design and Analysis of Experiments Das, M.N. and Giri, N.C. :, Wiley Eastern Ltd., New Delhi.
5. Methods of Statistical Analysis Goulden, G.H.:,Asia Publishing House, Mumbai. 1999
6. : Design and Analysis of Experiments Kempthrone, O., Wiley Eastern Ltd., New Delhi.2003
7. Snedecor, G.W. and Cochran, W.G. : Statistical Methods, Affiliated East-West Press, Delhi.
8. Fundamental of Statistics, Goon, Gupta, Dasgupta : Vol. I and II, The World Press. Kolkata.2013
9. Fundamentals of Applied Statistics, Gupta, S.C. and Kapoor, V.K. :, S. Chand & Sons, Delhi.

Course outcomes: Students are able to

Unit 1 Simple Designs of Experiments

1. Solve problems on CRD.
2. Understand CRD.

Unit 2: Simple Design of Experiments II

1. Understand RBD.
2. Solve problems on RBD.

Unit 3: Split **P**lot **Design and ANOCOVA**

1. Understand Split plot techniques.
2. Solve problems on Split plot techniques.

Unit IV: Factorial Experiments

1. Understand Factorial experiments.
2. Solve problems on Factorial experiments.

Elective :II

Paper- XII: BST 505 : Demography and Vital Statistics

(Credits: 02)

Course objectives: Students should to

1) Understand the demographic data and use of balancing data and population composition.
2) Get the knowledge for errors in census and registration data.
3) Measure the mortality and fertility rate.
4) Measure population growth.

Unit1: Population Theories **(10)**

Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekaran- Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

Unit 2: Sources of data on vital statistics **(15)**

Introduction: Sources of data on vital statistics, errors in census and registration data. Measurement of population, Rates and ratios of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Standardized Death Rate, Cause of Death Rate, Case Fatality Rate, Infant Mortality Rate (IMR), Maternal Mortality Rate (MMR), Neonatal and Perinatal Mortality Rates.

Unit 3: Life (Mortality) Tables **(10)**

Life (Mortality) Tables: Assumption, descriptions of Complete and Abridged Life Tables, Cohort vs. Current Life Tables, Stationary and Stable population, Construction of CompleteLife Table from population and death statistics, Central Mortality Rates and Force of Mortality, Uses of Life Tables. Measurements of Morbidity: Morbidity Incidence and Morbidity Prevalence Rates. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).

Unit 4: Measurement of Population Growth (10)

Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate(GRR)and Net Reproduction Rate (NRR).Population Estimation, Projection and Forecasting: Use of A.P. and G.P. methods for population estimates, Use of component method for population projection, Fitting of Logistic curve for population forecasting using Rhode's method.

Books Recommended

1. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol.II, 9th Edition, World Press.
3. Biswas, S. (1988): Stochastic Processes in Demography &Application, Wiley Eastern Ltd.
4. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
5. Keyfitz N., Beckman John A.: Demogrphy through Problems S-Verlag New york

Course outcomes: Students are able to

Unit 1: Population Theories

1. Solve problems on Population Theories.
2. Understand Population Theories.

Unit 2: Sources of data on vital statistics

1. Understand Sources of data on vital Statistics.
2. Solve problems on Sources of data on vital statistics.

Unit 3: Life (Mortality) Tables:

1. Understand Life (Mortality) Tables.
2. Solve problems on Life (Mortality) Tables.

Unit 4: Measurement of Population Growth:

1. Understand Measurement of Population Growth.
2. Solve problems on Measurement of Population Growth.

Elective: III:

Paper- XII: BST 506: Data Mining

(Credits: 02)

Course Objectives: Students should to

1) Data understanding , data cleaning and classification techniques.
2) Get knowledge for metrics for evaluating Classifier Performance and test of significant for model selection.
3) Get techniques to Improve Classification Accuracy

Unit-1: Data understanding and data cleaning (10)

Concept of supervised and unsupervised learning. Problem of classification, classification techniques: k-nearest neighbor, decision tree, Naïve Bayesian, classification based on logistic regression, Bayesian belief Network., CART(classification and regression trees)

Unit-2: Model evaluation and selection: (15)

Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost–Benefit and ROC Curves.

Unit 3: Techniques to Improve Classification Accuracy: (8)

Introduction to Ensemble Methods, Bagging, Boosting and Ada Boost, Random Forests, Improving Classification Accuracy of Class-Imbalanced Data.

Unit-4: Unsupervised learning: (12)

Clustering: k-mediods, CLARA, DENCLUE, DBSCAN, Probabilistic model based clustering. Market Basket Analysis: Association rules and prediction, Apriori Algorithm, data attributes, applications to electronic commerce

Books Recommended

1. Data Mining-Concept and Techniques :Jiawei Han. Micheline Kamber and Jian Pei.
2. Data Mining- Introductory and Advanced Topics : Margret.H and Dunham
3. Introduction to Data Mining with case studies:G.K.Gupta
4. Data Mining Application with R: Zhao.

Course outcomes: Students are able to

Unit 1: Data understanding and data cleaning

1. Solve problems on supervised and unsupervised learning.
2. Understand supervised and unsupervised learning.

Unit II: Model evaluation and selection::

1. Understand Model evaluation and selection
2. Solve problems on Model evaluation and selection.

Unit III: Techniques to Improve Classification Accuracy

1. Understand Techniques to Improve Classification Accuracy.
2. Solve problems on Techniques to Improve Classification Accuracy.

Unit IV: Unsupervised learning:

1. Understand unsupervised learning.
2. Solve problems on unsupervised learning.

Paper XIII:

SECCST-507: Basic Numerical Skills in computational Statistics

(Statistical Computing using C-Programming -I)

Course Objectives: Students should to

1. Learn C language structure, types of constants, library functions
2. Use of control statement and loop control statement in programming.

Unit-1: Introduction of 'C' **(10)**

History of C, importance of C, general language structure, character set, key words, identifiers, constants, types of constants, variables, data type(character, integer, floating point, long int, double, exponential) , declaration of variables, assignment statement, assigning values to variables. ii Operators and expressions: Arithmetic operators, relational operators,relational expression, logical operators, increment operator, decrement operator, arithmetic expressions,, library functions: cos(x), sin(x), tan(x), exp(x), abs(x), floor(x), mod(x, y), log(x), log10(x), pow(x, y), sqrt(x), random( ), randomize( ). iii Input and output operators:getchar(),putchar(),scanf(),printf(),Conversion specification-%c %d, %f, %s, %e, %u. Escape sequences : \n, \t.

Unit-2: Decision Making **(12)**

1.1. Decision Control statement: if, if ... else statement, switch statement, simple illustrative examples.

2.2 Loop control statements: Concept and use of looping, while, do. while, for, compound assignment operators, break, continue, exit, goto, nested loops, programs using control statements.

Books Recommended

1. Let Us C: Yashavant P. Kanetkar, BPB Publications, Thirteenth Edition
2. Proramming in ANSI C: E. Balgurusamy, Tata McGraw Hill Education Private Limited, Fifth edition

Course outcomes: Students are able to

Unit-1: Introduction of 'C'

1. Understand basic of C-programming.
2. Write C code using Operators and expression.

Unit-2: Decision Making

1. Understand decision control statements such as if, if else.
2. Use of loop control statement such as while, do while and for loop in C code.

Semester V

BSP-508 - Practical Paper –V

Course Objectives: Students should to

1. Learn applications of probability distributions like Laplace, Cauchy and Pareto distribution.
2. Understand fitting of distribution procedure for truncated distribution.
3. Estimate an unknown parameter by point and interval.
4. Method of maximum likelihood, derivation of maximum likelihood estimators

Practical Paper –V (A)
Probability Distributions-I

1. Model sampling from Laplace and Cauchy distributions
2. Model sampling from Pareto distribution.
3. Model sampling from truncated binomial and poison distributions.
4. Model sampling from truncated normal and exponential distributions.
5. Fitting of Weibull distribution.
6. Fitting of truncated Binomial distribution.
7. Fitting of truncated Poisson distribution.
8. Applications of multinomial distribution.
9. Applications of Weibull, Laplace and Pareto distribution.

Practical Paper –V(B)

Statistical Inference-I

1. Point estimation by method of moments for discrete distributions.
2. Point estimation by method of moment for continuous distributions.
3. Point estimation by method of maximum likelihood(one parameter).
4. Point estimation by method of maximum likelihood (two parameters).
5. Point estimation by method of minimum chi-square.
6. Interval estimation of location and scale parameters of normal distribution (single sample).
7. Interval estimation of difference of location and ratio of scale parameters of normaldistribution (two samples).
8. Interval estimation for population proportion and difference between two population proportions.
9. Interval estimation for population median using order statistics.

Books Recommended

1. Mathematical Methods of Statistics, Cramer H. Asia Publishing House, Mumbai.2005
2. Introduction to Theory of Statistics: Mood, A. M., Gray bill K, Bose. D. C :(Third Edition) Mc-Graw Hiil Series. 2005
3. Statistical Theory (Third Edition), Lindgren B.W, Collier Macmillan International Edition, Macmillan Publishing Co. Inc. New York. 2004
4. A first Course on Parametric Inference ,Kale,B.K. S. Chand New Delhi ,2004
5. Statistical Inference, Rohatgi, V. K.:, Sultan Chand and Sons.,2001

Course outcomes: Students are able to

Practical Paper –V(A): Probability Distributions-I

1. Understand application of distributions in real life
2. Fit appropriate distributions to provided data

Practical Paper -V(B): Statistical Inference-I

1. Estimate population parameter for given sample data
2. Compute interval estimation for different population parameters.

BSP-509: Practical Paper –VI

Course objectives: Students should to

1. Learn basic idea of LPP and its formulation.
2. Solve the LPP by different method.
3. Learn different methods of design of designs of experiment
4. Application of designs of experiment in various domains

Practical Paper –VI(A) : Operations Research

1. L.P.P. by simplex method I (Slack variable)
2. L.P.P.by simplex method II (Big Method)
3. Transformation problem-I.
4. Transformation problem-II.(Degeneracy)
5. Assignment problem.
6. Sequencing Problem.
7. Decision Theory.
8. Construction of CPM and PERT.
9. Minimal Path and cut.

Practical Paper -VI(B): Design of Experiments

1. Analysis of CRD and RBD.
2. Analysis of Latin Square Design (LSD).
3. Missing Plot Technique for RBD and LSD with one missing observation.
4. Efficiency of RBD over CRD and ii) LSD over CRD and RBD.
5. Analysis of Split plot and strip plot design.
6. Analysis of Covariance in CRD
7. Analysis of Covariance in RBD
8. Analysis of 2^2 and 2^3 Factorial Experiment
9. Total and partial Confounding

Books Recommended:

1. Operation research–An Introduction Taha H. A.:, Fifth Edition, Prentice Hallof India,New Delhi. 2006
2. Linear Programming, Shrinath, L. S.: Affiliated East-West Press Pvt. Ltd., Delhi. 2004
3. Experimental Design ,Federer, W.T. , Oxford and IBH publishing Company, New Delhi.2005
4. Experimental Design , Cochran, W.G. and Cox, G.M. :, John Wiley and Sons, Inc.,New York.

Course outcomes: Students are able to

Practical Paper –VI (A): Operations Research

1. Solve the LPP using different methods
2. Solve the problem on the network Analysis

Practical Paper –VI (B): Design of Experiments

1. Solve problems on the different techniques of design of experiment

2. Understand applications of the factorial experiments

PRACTICAL PAPER VII

BSP-510: Basic Numerical Skills in computational Statistics

Course objectives: Students should to

1. Get the basic knowledge about computer programming
2. Develop problem solving ability using c- programming

List of Experiments

1. Control statement –I : if and if ... else statement
2. Control statement –II : Switch statement
3. Loop control statement – I : while and do ...while statement
4. Loop control statement – II : for statement
5. Loop control statement – III : nested loops

Books Recommended

1. Let Us C: Yashavant P. Kanetkar, BPB Publications, Thirteenth Edition
2. Proramming in ANSI C: E. Balgurusamy, Tata McGraw Hill Education Private Limited, Fifth edition

Course Outcomes: Students are able to

1. Write basic C- programs to solve statistical problems
2. Write C- programs using decision control and loop control statements.

B. Sc. III Statistics: Semester VI

Paper XIV : BST 601 : Probability Distribution – II

Course Objectives: Students should to Know

1. Various application of probability in daily life.
2. Basic of Stochastics Process, Markov chain, Queueing theory with some proof andtheir real life examples.
3. Mathematical proof of Central limit theorem and weak law of large number

Unit-1: Convergence and Central Limit Theorem (10)

1.1: Convergence

i. Definition of convergence of sequence of random variables(a) in probability,(b)indistribution, (c) in quadratic mean.

ii. If $X_n \xrightarrow{p} X$ then $g(X_n) \xrightarrow{p} g(X)$ where g is continuous function without proof.

iii. Examples and problems.

1.2: Weak Law of Large Numbers and Central Limit Theorem

i. Weak law of large numbers (WLLN) statement and proof for i. i. d. random variables with finite variance.

ii. Central limit theorem: Statement and proof for i. i. d. random variables with finite variance, proof based on m.g.f..

iii. Simple examples based on Bernoulli, binomial, Poisson and chi- square distribution.

Unit-2: Markov Chain (12)

a) Definition of Stochastic process, state space ,parameter space, types of stochastic

processes ,first order Markov property, Markov chains (MC), finite MC, time homogeneous M.C. one step transition probabilities, and transition probability matrix (t.p.m.),stochastic matrix, Chapman Kolmogorov equation, n step transition probability matrix , n-step tpm of two state M.C. and some typical t. p. m .initial distribution, finite dimensional distribution functions , partial sum(and functions of independent and identically distributed random variables as Markov chain, illustrations such as random walk, Gambler's run problem, Ehren fest chain)

b) Communicating states, first return probability, probability of ever return Classification of states , as persistent and transient states , irreducible MC.

Unit 3: Stochastic Processes **(12)**

a) Definition of stochastic process.

b) Postulates and difference differential equations for :

i) Pure birth process

ii) Poisson process with initially 'a' members, for a =0 and a>0

iii) Yule Furry process

iv) Pure death process

v) Death process with $\mu_n = \mu$

vi) Death process with $\mu_n = n\mu$

vii) Birth and death process

Unit-4: Queuing Theory **(11)**

Introduction, essential features of queuing system, input source, queue configuration, queuediscipline, service mechanism.

i. Operating characteristics of queuing system, transient- state and steady state, queue length, general relationship among system characteristics.

ii. Probability distribution in queuing system: Distribution of arrival, distribution of inter arrival time, distribution of departure and distribution of service time (Derivations are not expected).

iii. Types of queuing models:

iv. Solution of queuing Model: M/M/1,using FCFS queue discipline.

v. Problems and examples.

Books Recommended

1. Mathematical Methods of Statistics, Cramer H.: Asia Publishing House, Mumbai. 2005
2. Statistical Theory (Third Edition), Lindgren B. W.: Collier Macmillan International Edition, Macmillan Publishing Co.Inc. New York. ... 1997
3. Introduction to Mathematical Statistics (Third Edition), Hogg, R. V. and Craig A. T. : MacmillanPublishingCompany,Inc.866,34dAvenue,NewYork,10022. 2009
4. New Mathematical Statistics (First Edition), SanjayArora and Bansi Lal : Satya Prakashan,16/17698, New Market, New Delhi, 5 (1989).
5. Fundamentals of Mathematical Statistics, Gupta S. C and Kapoor V. K. : Sultan Chandand Sons, 88, Daryaganj, New Delhi 2000
6. An Introduction to Probability Theory and Mathematical Statistics, Rohatgi V. K.: Wiley
7. Stochastic Processes. Medhi J : Wiley Eastern Ltd. New Delhi. 2009
8. Introduction to Stochastic Processes, Houghton Mifflin. 2005
9. An Introduction of Probability Theory and its Applications. Feller. W. : Wiley Eastern 2002
10. Modern Probability Theory. Bhat B. R.: Sultan Chandand Sons, 88, Daryaganj, NewDelhi 1997
11. Stochastic Models : Bhat B. R.: Analysis and Applications. New Age International. 2003
12. Introduction to Reliability Analysis, Probability Models and Statistical Methods,Springer Verlag.
13. Operation research – An Introduction, Taha H. A, Fifth edition, Prentice Hall of India,

Course outcomes: Students are able to

Unit 1: Convergence and Central Limit Theorem

1. Solve Convergence and Central Limit Theorem.
2. Understand Convergence and Central Limit Theorem.

Unit 2: Markov Chain

1. Understand Markov Chain
2. Solve partial on Markov Chain.

Unit 3: Stochastic Processes

1. Understand Stochastic Processes.
2. Solve partial on Stochastic Processes.

Unit 4: Queuing Theory

1) Understand Queuing Theory.
2. Solve partial on Queuing Theory.

Paper XV : BST 602 : Statistical Inference – II

Course Objectives: Students should

1. Understand different cases of interval estimation.
2. Different parametric and Non-parametric tests with their applications.
3. Analyze sequential tests with different sample procedure.

Unit - 1: Interval Estimation (11)

Notion of interval estimation, definition of confidence interval, length of confidenceinterval, confidence bounds. Definition of Pivotal quantity and its us in obtaining confidence intervals and bounds.

Interval estimation for the following cases:

(i) Mean μ of normal distribution (σ^2known and σ^2unknown).
(ii) Variance σ^2 of normal distribution (μ known and μ unknown).
(iii) Difference between two means (μ_1-μ_2),
(a) for a sample from bivariate normal population,
(b) For samples from two independent normal populations.
(iv) Ratio of variances for samples from two independent normal populations.
(v) Mean of exponential distribution.
(vi) Population proportion and difference of two population proportions of two independent large samples.
(vii) Population median using order statistics.

Unit - 2: Parametric Tests (13)

Statistical hypothesis, problems of testing of hypothesis, definitions and illustrations of (i) simple hypothesis (ii) composite hypothesis, critical region, type I and type II error, probabilities of type I & type II errors. Power of a test, p-value, size of a test, level of significance, problem of controlling probabilities of type I & type II errors. Definition of Most Powerful (MP) test. Statement and proof (sufficient part) of Neyman-Pearson(NP) lemma for simple null hypothesis against simple alternative hypothesis for construction of MP test. Examples of construction of MP test of level$\propto$.Power function of a test, power curve, definition of uniformly most powerful (UMP)level $\propto$ test. Use of NP

lemma for constructing UMP level α test for one-sided alternative. Illustrative examples. Likelihood Ratio Test: Procedure of likelihood ratio test, statement of its properties,Likelihood Ratio test involving mean and variance of normal population.

Unit - 3: Sequential Tests **(9)**

General theory of sequential analysis and its comparison with fixed sample procedure. Wald's SPRT of strength $(\propto,\beta)$, for simple null hypothesis against simple alternative hypothesis.Illustrations for standard distributions like binomial, Poisson, exponential and normal.Graphical and tabular procedure for carrying out the test. Illustrative examples.

Unit - 4: Non- parametric Test **(12)**

Notion of non-parametric statistical inference (test) and its comparison with parametric Statistical inference. Concept of distribution free statistic. Test procedure of:

(i) Run test for one sample (i.e. test for randomness) and run test for two independent sample problems.

(ii) Sign test for one sample and two sample paired observations

(iii) Wilcoxon's signed rank test for one sample and two sample paired observations.

(iv) Mann-Whitney U - test (two independent samples)

(v) Median test

(vi) Kolmogorov Smirnov test for one and for two independent samples.

Books Recommended

1. A first Course on Parametric Inference Kale, B. K.: Sultan Chand New Delhi ,2006
2. Statistical Inference Rohatgi, V. K.: Wiley Eastern Ltd. New Delhi.,2000
3. An introduction to Probability Theory and Mathematical Statistics Rohatgi,V.K.: 1996
4. Statistical Inference Saxena H.C .and Surenderan :Wiley Eastern Ltd. New Delhi. 2010
5. An advanced Theory of Statistics Kendall M.G. and Stuart A.: International Publication2009
6. Statistical Theory ,Lindgren, B. W.:

7. Statistical Inference Cassela G. And Berger R.L.: Wiley Eastern Ltd. New Delhi.2010
8. Testing of Statistical Hypothesis Lehmann, E. L: 1999
9. Linear Statistical Inference Rao, C. R.: Wiley Eastern Ltd. New Delhi.1997
10. Dudewicz C.J. and Mishra S.N.: Modern Mathematical Statistics 2000
11. Fergusson, T. S.: Mathematical statistics, S. Chand 2003
12. Theory of Statistical Inference,.Zacks, S. Chand 2005:
13. Cramer, H.: Mathematical Methods of Statistics. Wiley Eastern Ltd. New Delhi.
14. Non-parametric Statistical Inference. Gibbons, J. D.:
15. Applied Non-parametric Statistics Doniel: Wiley Eastern Ltd. New Delhi.

Course outcomes: Students are able to

Unit1: Interval Estimation

1. Solve Interval Estimation.
2. Understand Interval Estimation.

Unit 2: Parametric Tests

1. Understand Parametric Tests
2. Solve partial on Parametric Tests.

Unit 3: Sequential Tests

1. Understand Sequential Tests.
2. Solve partial on Sequential Tests.

Unit 4: Non- parametric Test

1. Understand Non- parametric Test.
2. Solve partial on Non- parametric Test.

Paper XVI : BST 603 : Industrial Statistics

Course objectives: Students should to

1. Use of the Quality tools in industrial sectors.
2. Use of Six Sigma methodology for improving ongoing process, by implementing smallchanges.
3. Introduce the technique of process control and product control.
4. Use of Sampling plans.

Unit.1: Quality Tools **(10)**

Meaning and dimensions of quality, quality philosophy, Magnificent tools of quality: Histogram, Check sheet, Pareto diagram, cause and effect diagram, scatter diagram, control chart, flow chart. Deming's PDCA cycle for continuous improvements and its applications.

Unit 2: Process Control **(12)**

CUSUM chart, tabular form, use of these charts for monitoring process mean.
Moving average and exponentially weighted moving average charts. Introduction to six-sigma methodology, DMAIC cycle and case studies.

Unit 3: Product Control **(13)**

Sampling Inspection plans for attribute inspection: Concept of AQL, LTPD ,Consumer's risk, producer's risk, AOQ, AOQL, OC, ASN and ATI. Description of Single and double sampling plans with determination of above constants.

Unit 4: Lean and Six Sigma **(10)**

Overview of Lean and Six Sigma with principles. Methodologies– Introduction to SCORE, DMAIC, Six Sigma Roles and Responsibilities. Tools used in Define Phase. Tools used in Measure Phase. Spaghetti diagram. Tools used in Analyze Phase. Various Statistical Techniques used in analyze Phase (Revision), Tools used in Improve/Design Phase. Toolsused in Control/Verify Phase.

Books Recommended

1. Introduction to quality Control–Montgomery D. C. Wiley Eastern Ltd., New Delhi.
2. Quality Control and Industrial statistics Duncan A J,
3. Statistical Quality Control by E L Grant, International Publication 2003
4. Data Mining-Concept and Techniques :Jiawei Han. Micheline Kamber and JianPei.
5. Data Mining- Introduction and Advanced Topics: Margret. Hand Dunham, 2007
   Introduction to Data Mining with case studies: G. K. Gupta Wiley Eastern Ltd., New Delhi.
6. Data Mining Application with R:Zhao., International Publication 2003

Course outcomes: Students are able to

Unit 1: Quality Tools

1. Understand the various Quality Tools.
2. Apply SPC tools and DMIC cycle.

Unit 2: Process Control

1. Understand Process Control, small shift control charts.
2. Solve Problems on Process Control.

Unit 3: Product Control

1. Understand the OC curve, ASN, AOQ, AOQL and other definitions.
2. Construct OC curve and ASN value for Sampling plan .

Unit 4: Lean and Six Sigma

1. Understand Six Sigma methodology.
2. Construct the Six Sigma control chart

Elective Paper –I :
Paper- XVII: BST 604: Sampling Theory

Course Objectives: Students Should to Know

1. The basic terminology of sampling techniques.
2. Learn the systematic and cluster sampling with their applications.
3. Analyze the sampling methods using auxiliary variables.

Unit–1: Basic Terminology and Simple Random Sampling (15)

1.1: Basic Terminology

Concept of distinguishable elementary units, sampling units, sampling frame, random sampling and non-random sampling. Advantages of sampling method over census method, objectives of a sample survey, Designing a questionnaire, Characteristics of a good questionnaire, Concept of sampling and non-sampling errors. Handling of non-responsecases.

1.2 : Simple random sampling

i. Simple random sampling from finite population of size N with replacement(SRSWR) and without replacement (SRSWOR): Definitions, population mean and population total as parameters, inclusion probabilities.

ii. Sample mean $\bar{y}$ as an estimator of population mean, derivation of its expectation, standard error and estimation of standard error.

iii. $N\bar{y}_n$ as an estimator of population total, derivation of its expectation, standard error and estimator of standard error.

iv. Sampling for dichotomous attributes. Estimation of population proportion Sample proportion (p) as an estimator of population proportion (P), derivation of its expectation, standard error and estimator of standard error using SRSWOR. N_p as an estimator of total number of units in the population possessing the attribute of interest, derivationof its expectation, standard error and estimator of standard error.

1.3 Determination of the samples size.

Determination of the sample size (n) for the given:

i. Margin of error and confidence coefficient.

ii. Coefficient of variation of the estimate and confidence coefficient.

Unit – 2: Stratified Sampling (15)

i. Real life situations where stratification can be used.

ii. Description of stratified sampling method where sample is drawn from individual stratumusing SRSWOR method.

iii. (a) $\bar{y}_{st}$ as an estimator of population mean Y , derivation of its expectation, standard error and estimator of standard error.

(b) $N\bar{y}_{st}$ as an estimator of population total, derivation of its expectation, standard error and estimator of standard error.

iv. Problem of allocation: Proportional allocation, Neyman's allocation and optimumallocation, derivation of the expressions for the standard errors of the above estimators when these allocations are used.

v. Comparison amongst SRSWOR, stratification with proportional allocation and stratification with optimum allocation.

vi. Cost and variance analysis in stratified random sampling, minimization of variance for fixed cost, minimization of cost for fixed variance, optimum allocation as a particular case of optimization in cost and variance analysis.

Unit-3 Other Sampling Methods (10)

3.1 : Systematic Sampling

i. Real life situations where systematic sampling is appropriate. Technique of drawing a sample using systematic sampling.

ii. Estimation of population mean and population total, standard error of these estimators.

iii. Comparison of systematic sampling with SRSWOR.

iv. Comparisonofsystematicsamplingwith SRSWORandstratifiedsamplinginthepresence oflinear trend.

v. Idea of Circular Systematic Sampling.

3.2 : Cluster Sampling

i. Real life situations where cluster sampling is appropriate. Technique of drawing a sample using cluster sampling.

ii. Estimation of population mean and population total (with equal size clusters), standarderror of these estimators

iii. Systematic sampling as a particular case of cluster sampling.

3.3 Two Stage and Multi Stage Sampling

Idea of two-stage and multistage sampling.

Unit - 4: Sampling Methods using Auxiliary variables (5)

4.1: Ratio Method

i. Concept of auxiliary variable and its use in estimation

ii. Situations where Ratio method is appropriate.

iii. Ratio estimators of the population mean and population total and their standard errors (without derivations), estimators of the standard errors.

iv. Relative efficiency of ratio estimators with that of SRSWOR

4.2: Regression Method

i. Situations where Regression method is appropriate.

ii. Regression estimators of the population mean and population total and their standard errors (without derivations), estimators of these standard errors.

iii. Comments regarding bias in estimation

iv. Relative efficiency of regression estimators with that of a) SRSWOR b) Ratio estimator.

Books Recommended

1. Sampling Techniques, Cochran,W.G: Wiley Eastern Ltd., NewDelhi.2012

2. Sampling Theory of Surveys with Applications Sukhatme, P.V. and Sukhatme, B.V. :,Indian Society of Agricultural Statistics, New Delhi.1989

3. Sampling Theory .Des Raj : S. Chand 2017

4. Theory and Analysis of Sample Survey Designs, Daroga Singh and Choudhary F.S.; Wiley Eastern Ltd., New Delhi.
5. Sampling Methods, Murthy, M.N: Indian Statistical Institute, Kolkata. 1998
6. Theory and Methods of Survey Sampling, Mukhopadhay, Parimal: PrenticeHall. 2003

Course outcomes: Students are able to

Unit 1: Basic Terminology and Simple Random Sampling

1. Solve Simple Random Sampling.
2. Understand Simple Random Sampling.

Unit 2: Stratified Sampling

1. Understand Stratified Sampling
2. Solve Problems on Stratified Sampling.

Unit 3: Other Sampling Methods

1. Understand Cluster Sampling.
2. Solve Problems on Cluster Sampling.

Unit 4: Sampling Methods using Auxiliary variables

1. Understand Ratio and regression Method.
2. Solve Problems on Ratio and regression Method.

Elective II:

Paper- XVII: BST 605: Survey Sampling and Official Statistics

Course objectives: Students should to

1. Know about survey sampling framework.
2. Know the how to collect the survey and use of different sampling methods in survey.
3. Know role of statistics in Government sector.

Unit 1: Population and sample **(10)**

Concept of population and sample, complete enumeration verses sampling, sampling and non-sampling error, Types of sampling: Non-Probability and Probability sampling, basic principle of sample survey, Simple Random Sampling With and Without Replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

Unit 2: Sampling Methods **(10)**

Stratified Random Sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocation and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision, post stratification and its performance. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=n\times k$). Comparison of systematic sampling with SRS and Stratified Sampling in the presence of linear trend and corrections

Unit 3: Estimation **(10)**

Introduction to Ratio and Regression method of estimation, first approximation to the population mean and total(for SRS of large size), MSE of these estimates and estimates of these variances, MSE in term of correlation coefficient for regression method of estimation and their comparison with SRS. Cluster sampling (Equal clusters only) estimation of population mean and variance, comparison (with and without randomly formed clusters). Concept of subsampling, Two-stage sampling. Estimation of Population mean and variance of the estimate.

Unit 4: Statistical Organizations **(15)**

An outline of present official statistical system in India, Methods of collection of official statistics, their reliability and limitation. Role of Ministry of Statistics and Problem Implementation (MOSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), Registered General Office and National Statistical Commission, Government of India's Principal publications containing data on topics such as Agriculture, price, population, industry, finance and employment

Consumer price index, Wholesale price Index number and Index of industrial production National Income: Basic idea and a brief description of income, expenditure and production approaches

Books Recommended

1. SamplingTechniques,Cochran,W.G:WileyEasternLtd.,NewDelhi.2012
2. Sampling Theory of Surveys with Applications Sukhatme, P.V. and Sukhatme, B.V. :,Indian Society of Agricultural Statistics, New Delhi.1989
3. Sampling Theory. Des Raj : S. Chand 2017
4. Theory and Analysis of Sample Survey Designs, Daroga Singh and Choudhary F.S.; Wiley Eastern Ltd., New Delhi.

Course outcomes: Students are able to

Unit 1: Population and sample

1. Solve population and sample.
2. Understand population and sample.

Unit 2: Sampling Methods

1. Understand Stratified Sampling
2. Solve partial on Stratified Sampling.

Unit 3: Estimation

1. Understand Cluster Sampling.
2. Solve Problems on Cluster Sampling.

Unit 4: Statistical Organizations

1. Understand Ratio and regression Method.
2. Solve Problems on Ratio and regression Method.

Elective III:
Paper- XVII: BST 606 : Reliability Theory

Course Objectives: Students should know

1) The basic of reliability use in daily life.
2) The different distributions used in life and survival function.
3) The computation of hazard rate, survival function, reliability of any product and interpret them.

Unit-1: Binary System and Structure function **(12)**

Structure function, dual of a structure, cuts and paths, components & systems, coherent systems, redundancy, Pivotal decomposition, Associated random variables and their properties. Birnbaum's measure of structural importance. Reliability concepts and measures, reliability of coherent systems, bounds on system reliability, Modular composition.

Unit-2: Reliability and Life time distributions **(10)**

Life time distributions, survival functions, failure rate function, cumulative hazard function, residual life time, survival function of residual life time, mean residual life time, Computation of these functions for Common life time distributions: exponential, Weibull, Gamma, Makeham, Pareto, Rayleigh.

Unit-3: Aging properties **(13)**

Notion of ageing: IFR, DFR, IFRA, DFRA, DMRL, NBU, NWU, NBUE, NWUE classes, ageing properties of common life time distributions, closure properties under formation of coherent structures, convolutions and mixtures of these classes. Damage model, cumulative damage model, univariate shock models and life distributions arising from shock models, bivariate exponential distribution.

Unit-4: Stochastic Ordering **(10)**

Stochastic ordering: usual stochastic ordering, hazarad rate ordering, reverse hazard rate ordering, dispersive ordering, mean residual life ordering and their implications. Availability, interval reliability, availability of a system with a single spare and a repair facility

Books Recommended

1. Barlow R. E. and Proschan Frank: Statistical Theory of Reliability and Life Testing. Holt Rinebart and Winston Inc., New Yark.
2. Sinha S. K.: Reliability and Life Testing, Second Edition, Wiley Eastern Publishers, New Delhi.
3. Trivedi R. S.: Probability and Statistics with Reliability and Computer Science Application, Prentice – Hall of India Pvt. Ltd., New Delhi.
4. Parimal Mukhopadhyaya: An Introduction to the Theory of Probability. World ScientificPublishing.
5. Hogg R.V. and Criag A.T.: Introduction to Mathematical Statistics (Third edition),Macmillan Publishing, New York.

Course outcomes: Students are able to: Unit 1: Binary System and Structure function

1. Understand Structure function.
2. Solve the examples on reliability functions

Unit 2: Reliability and Life time distributions

1. Understand Life time distributions
2. Solve Problems on Lifetime distributions.

Unit 3: Aging properties

1. Understand ageing properties of components.
2. Solve Problems on ageing.

Unit 4: Stochastic Ordering

1. Understand stochastic process
2. Life ordering and their implications

Paper- XVIII:

SECCPT-607 : Entrepreneurship development in Statistics

(Statistical Computing using C-Programming -II)

Course Objectives: Students should know

1. Use of arrays and user defined functions in C language.
2. Concept of strings and pointers in C language.

Unit-1: Arrays and User Defined Functions (12)

Arrays Concept of arrays, one-dimensional array, declaration of one-dimensional array, initialization of one-dimensional array. Two-dimensional array, declaration of two- dimensional array, initialization of two dimensional array. Programs using arrays.

User defined function Definition of function, use of function, declaration, passing values between functions, local and global variables, scope of function, Passing array elements to a function, calling function by value, by reference ,recursion,.

Unit-2 : Strings and Pointers (10)

Strings String of characters input/output functions for using gets( ), puts( ). Use of standardstring library function sstrlen, strwr, strupr, strrev, strchr, strcmp, strcpy and strcat. Programsusing string. Pointers Introduction to pointers, Pointer notation, passing pointers as parameters of function arrays and pointers .Simple programs.

Books Recommended

1. Let Us C: Yashavant P. Kanetkar, BPB Publications, Thirteenth Edition
2. Proramming in ANSI C: E. Balgurusamy, Tata McGraw Hill Education Private Limited, Fifth edition

Course outcomes: Students are able to

1. Write C programs using array and user defined function
2. Write C programs using string functions and pointers.

B.Sc. III (Statistics) : Semester VI : Practical

BSP- 608 Practical Paper- VIII (A)

Course Objectives: Students should to

1. Various application of probability distribution in daily life.
2. Use of R – Software to solve statistical software
3. Know different parametric and non-parametric tests with their applications
4. Analyze sequential tests with different sample procedure.

Practical Paper- VIII (A): Probability Distributions and R – Software

1. Model sampling from Log-normal and Weibull distributions using R-Software.
2. Model sampling from Logistic distribution using R-Software.
3. Fitting of Binomial and Poisson distributions using R-Software.
4. Fitting of Normal distribution using R-Software.
5. Fitting of Log-normal distribution using R-Software.
6. Analysis of Completely Randomized Design (CRD) using R.
7. Analysis of Randomized Block Design (RBD) using R.
8. Classification of TPM, States and computation of higher transition probabilities.
9. Applications of Queueing Systems.

Practical Paper- VIII (B): Statistical Inference-II

1. Construction of MP test.
2. Construction of UMP test.
3. Construction of SPRT for binomial, Poisson distributions, graphical representation
4. Construction of SPRT for exponential and normal distribution, graphical representationof procedure.
5. NP test—Run test (for one and two independent samples).
6. NP test –Sign test and Wilcoxon's signed rank test (for one and two samples pairedobservation).
7 NP test— Mann-whitney U- test (for two independent samples).
8. NP test–Median test(for two large independent samples)
9. NP test—Kolmogorov - Smirnov test (for one and two independent samples).

Books Recommended

1. Mathematical Methods of Statistics, Cramer H.: Asia Publishing House, Mumbai. 2005
2. Statistical Theory (Third Edition), Lindgren B. W.: Collier Macmillan International Edition, Macmillan Publishing Co.Inc. New York. 1997
3. Testing of Statistical Hypothesis Lehmann, E. L: 1999
4. Non-parametric Statistical Inference. Gibbons, J. D.

Course outcomes: Students are able to

Practical Paper- VIII (A): Probability Distributions and R – Software

1. Fit different statistical distributions for the given data using R-Software
2. Solve example of the design of experiments using R - software

Practical Paper- VIII (B): Statistical Inference-II

1. Understand use of arametric and non-parametric test.
2. Solve example on MP,UMP and SPRT test

BSP-609 : Practical Paper –IX

Course Objective: Students Should to

1. Use of Six Sigma methodology for improving ongoing process, by implementing small changes.
2. Introduce the technique of process control and product control
3. The basic terminology of sampling techniques.
4. Learn the systematic and cluster sampling with their applications

Practical Paper-IX(A) : Industrial Statistics

1. EWMA-Chart.
2. CUSUM chart.
3. Six sigma limits for mean.
4. Single sampling plan-I (Small sample).
5. Single sampling plan-II (Large sample).
6. Double sampling plan-I (Small sample.
7. Double sampling plan-II (Large sample).

8. k-nearest neighbor technique for classification.
9. k-means technique for clustering.

Practical Paper- IX (B) : Sampling Methods

1. Simple Random Sampling for Variables.
2. Simple Random Sampling for Attributes.
3. Determination of Sample Size in SRS for Variables and Attributes.
4. Stratified Random Sampling–I
5. Stratified Random Sampling –II
6. Ratio Method of Estimation.
7. Regression Method of Estimation.
8. Systematic Sampling.
9. Cluster Sampling.

Books Recommended

1. Introduction to quality Control–Montgomery D. C. Wiley Eastern Ltd., New Delhi.
2. Quality Control and Industrial statistics Duncan A J
3. Sampling Techniques, Cochran,W.G: Wiley Eastern Ltd., NewDelhi.2012
4. Sampling Theory of Surveys with Applications Sukhatme, P.V. and Sukhatme, B.V. :, Indian Society of Agricultural Statistics, New Delhi.1989

Course outcomes: Students are able to

Practical Paper-IX(A) : Industrial Statistics

1. Understand the various Quality Control Tools
2. Understand Process Control, small shift control charts.

Practical Paper- IX (B) : Sampling Methods

1. Solve Problems on Cluster Sampling
2. Solve Problems on Ratio and regression Method.

Practical Paper- X

SECCSP-610: Entrepreneurship Development in Statistics

Course Objectives : Students Should to

1. Know use of Array in C – Programs
2. Know use of String function and Pointer in C – programs

List of Experiments

1. One-dimensional Array
2. Two-dimensional Array-I
3. Two-dimensional Array-II
4. User defined unction
5. Strings and Pointers

Books Recommended

1. Let Us C: Yashavant P. Kanetkar, BPB Publications, Thirteenth Edition
2. Proramming in ANSI C: E. Balgurusamy, Tata McGraw Hill Education Private Limited, Fifth edition

Course outcomes: Students are able to

1. Write C programs using array and user defined function
2. Write C programs using string functions and pointers

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