PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

B.Sc. Part III (Sem. V and VI) CBCS Pattern
STATISTICS Structure (w. e. f. June 2024)

Subject/ Core Course	Name and Type of the Paper		Name of Papers/ Practical	Hours/ Week			Total Marks per Paper	UA	CA	Credits
	Type	Name		L	T	P				
Class:	**B. Sc. III Semester - V**									
Ability Enhancement Course (AECC)	English (Business English)	Paper II Part A	4	--	--	50	40	10	2.0	
Core	CC 1 A	Statistical Inference-I	Paper-IX	4	--	--	100	80	20	4.0
	CC 2 A	Probability Distributions	Paper-X	4	--	--	100	80	20	4.0
	CC 3 A	Sampling Techniques	Paper- XI	4	--	--	100	80	20	4.0
Discipline Specific Elective	DSE 4 A	Operation Research	Paper- XII	4	--	--	100	80	20	4.0
	OR									
	DSE 4 A	Regression Analysis	Paper- XII	4	--	--	100	80	20	4.0
Skill Enhancement Course	SEC 3	MS-EXCEL	4	--	--	100	80	20	4.0	
Total (Theory)				**24**	**--**	**--**	**550**	**440**	**110**	**22**

Subject/ Core Course	Name and Type of the Paper		Name of Papers/ Practical	Hours/ Week			Total Marks per Paper	*UA*	CA	Credits
	Type	Name		L	T	P				
Class:	B. Sc. III Semester - VI									
Ability Enhancement Course (AECC)	English (Business English)		Paper II Part B	4	--	--	50	40	10	2.0
Core	CC 1 B	Statistical Inference-II	Paper-XIII	4	--	--	100	80	20	4.0
	CC 2 B	Probability Theory	Paper-XIV	4	--	--	100	80	20	4.0
	CC 3 B	Design of Experiments	Paper- XV	4	--	--	100	80	20	4.0
Discipline Specific Elective	DSE 4 B	Quality Management	Paper- XVI	4	--	--	100	80	20	4.0
	OR									
	DSE 4 B	Time Series Analysis and Reliability Theory	Paper- XVI	4	--	--	100	80	20	4.0
Total (Theory)				20	--	--	450	360	90	18
Core	CC 1 A and 1 B		Practical-IV	--	--	05	100	80	20	4.0
	CC 2 A and 2 B		Practical-V	--	--	05	100	80	20	4.0
	CC 3 A and 3 B		Practical-VI	--	--	05	100	80	20	4.0
	DSE 4 A and 4 B		Practical-VII	--	--	05	100	80	20	4.0
Total (Practical)				--	--	20	400	320	80	16
Grand Total				48	--	20	1400	1120	280	56

Summary of the Structure of B.Sc. Programme
As per CBCS pattern

Class	Semester	Marks-Theory	Credits-Theory	Marks-Practical	Credits-Practical's	Total -credits
B.Sc.-I	I	450	18	--	--	18
	II	450	18	400	16	34
B.Sc.-II	III	500	20	--	--	20
	IV	500	20	600	12	32
B.Sc.-III	V	550	22	--	--	22
	VI	450	18	400	16	34
Total		2900	116	1400	44	160

B.Sc. Programme:

Total Marks   : Theory + Practical's = 2900 +1400 = 4300

Credits   : Theory + Practical's = 116+44 = 160

Numbers of Papers   Theory: Ability Enhancement Course (AECC)   04

                        Theory: Discipline Specific Elective Paper (DSE)   08

                        Theory: DSC   14

                        Skill Enhancement Courses   04

Total   : Theory Papers   30

      : Practical Papers   11

Abbreviations:

L: Lectures

T: Tutorials

P: Practical's

UA: University Assessment

CA: College Assessment CC: Core Course

AEC: Ability Enhancement Course

DSE: Discipline Specific Elective Paper

SEC: Skill Enhancement Course

GE: Generic Elective

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

CBCS Pattern B. Sc. Part III (Semester V and VI)

STATISTICS Syllabus (w. e. f. June 2024)

PRACTICAL

Practical	Paper No	Title of the Paper	U.A.				C.A.	Paper Total
			Marks	Journal	Oral	Total	Marks	
CC-1A and 1B	IV	Statistical Inference	60	5	5	70	20	90
CC-2A and 2B	V	Probability Distributions and R- Software	60	5	5	70	20	90
CC-3A and 3B	VI	Designs of Experiments and Sampling Techniques	60	5	5	70	20	90
DSE 4A and 4B	VII	Operations Research , QMR	60	5	5	70	20	90
OR								
DSE 4A and 4B	VII	Regression And Time Series Analysis	60	5	5	70	20	90
Project Report and Viva-Voce						40	-	40
Total								400

SCHEME OF TEACHING:

Sr. No.	Paper	Teaching Hours / Week		
		L	P	Total
1.	IX and XIII	3	5	8
2.	X and XIV	3	5	8
3.	XI and XV	3	5	8
4.	XII and XVI	3	5	8
Total		12	20	32

Note:

   (I) Total teaching periods for each theory papers in each semester are three per week.

   (II) Teaching periods for practical paper-IV to paper-VII are five periods per paper per week per batch 12 students.

   (III) **Scheme of evaluation:**

As per the norms of the grading system of evaluation, out of 100 Marks, the candidate has to appear for College internal assessment of 20 marks and external evaluation (University Assessment) of 80 marks. Assessment scheme is given below.

Semester – V and VI:

Theory: (100 marks)

    University Examination (80 Marks):

    No. of Theory papers: 4 Papers/Subject and

    Compulsory English (Total 5 Papers)

  Continuous Internal Assessment (20 Marks):

  Scheme of Marking:

  10 Marks: Internal Test

  10 Marks: Home assignment/Tutorials/Seminars/ Group discussion/ Viva/ Field visit/Industrial visit.

  (IV) **Duration of University Examinations:**

   1) For each theory paper, duration is of three hours.

   2) For practical paper-IV to paper-VII, three hours for a batch of 12 students annually.

  (V) **Nature of Project**

     (i)   Identification of problem where statistical techniques can be used.

     (ii)   Planning and execution of data collection.

     (iii)   The Marking system for the project work is as follows:

         • Data Collection   : 10 Marks

         •Analysis of Data   : 10 Marks

         •Conclusion   : 10 Marks

         •Viva on Project   : 10 Marks

     (iv)   Project in B. Sc. III will be conducted in a group of 5 to 6 students.

Objectives -The main objective of this course is to develop the advanced statistical skills to the students, which covers concepts of statistical inference, design of experiment, sampling techniques, distribution theory, operation research, S.Q.C., regression analysis, time series analysis and R programming. Also the students are expected to conduct a project work which includes data collection and analysis of data using various statistical tools. By the end of course students are expect to-

Course outcomes
1. Distinguish between point estimation and interval estimation
2. Understand and solve testing of hypothesis problems
3. Work out the design of experiments.
4. Utilize various sampling techniques.
5. Know various probability distributions, concept of truncation and their applications to real life situations.
6. Understand the concepts of stochastic process, queuing theory, and reliability theory.
7. Understand concept of operation research, SQC, sampling plans.
8. Use of R software
9. Know the utility of time series analysis and regression analysis.
10. To conduct project work to understand data collection methods, analysis and interpretation

Nature of practical papers:
(i) Each Practical Question paper must contain **Six** questions of 15 marks each.
(ii) Student should attempt any **Four** questions.
(iii) Each question to be distributed according to following Points:

(a) Aim of the Experiment	2 Marks
(b) Statistical formulae	2 Marks
(c) Observation Tables	5 Marks
(d) Calculations	4 Marks
(e) Conclusion/result of the experiment	2 Marks.

(v) **Ten** marks are reserved for Viva and **Ten** marks are reserved for journal.

Instructions:
1. While attempting questions based on R-software, students have to write the commands of R-software on their Answer-book. Final result should be shown to the examiner online or the printout may be attached.
2. Duration of each practical paper should be of three hours.
3. Student can use MS-Excel or electronic calculators for other practical.

Requirements:
1. There should be two subject experts at the time of practical examination.
2. Laboratory should be well equipped with 20 computers/Laptops, 2printers with sufficient backup facility (UPS/Inverter/Generator).

CBCS Pattern Syllabus: CC - 1A
B. Sc. III Statistics Semester-V Paper-IX
Statistical Inference-I

Course Outcomes: The students will able to understand

a) Importance and application of inferential aspect of point estimation.

b) Concept of various important properties of estimator.

c) Concept and application of Fisher information and CR inequality.

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 $\varphi(\theta)$ give rise to infinitely many unbiased estimators of $\varphi(\theta)$.
(b) If T is unbiased estimator of θ then $\varphi(T)$ is an unbiased estimator of $\varphi(\theta)$ provided $\varphi(.)$ is a linear function.
(c) 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 T1 with respect to T2, where T1 and T2 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:

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

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 conditional distribution and Neyman factorization criterion. Pitman - Koopman form and sufficient statistic.

Proof of the following properties of sufficient statistic:

(a) If T is sufficient for θ then $\varphi(T)$ is also sufficient for θ provided $\varphi(.)$ is a one-to-one and on-to function.
(b) If T is sufficient for θ then T is sufficient for $\varphi(\theta)$.

2.3: Fisher information function: Definition of information function, amount of information contained in a sample. Statement regarding equality of the information in $(x_1, x_2, \ldots, x_n)$ 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 $\varphi(\theta)$. Proof of the following results:

(i) If MVBUE exists for θ then MVBUE exists for $\varphi(\theta)$, if $\varphi(.)$ is a linear function.
(ii) If T is MVBUE for θ then T is sufficient for θ.
(iii) 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. Kale, B. K.: A first Course on Parametric Inference
2. Rohatgi, V. K.: Statistical Inference
3. Rohatgi, V. K.: An introduction to Probability Theory and Mathematical Statistics
4. Saxena H. C. and Surenderan: Statistical Inference
5. Kendall M. G. and Stuart A.: An advanced Theory of Statistics
6. Lindgren, B. W.: Statistical Theory
7. Lehmann, E. L.: Theory of Point Estimation
8. Rao C.R.: Linear Statistical Inference
9. Dudewicz C.J. and Mishra S.N.: Modern Mathematical Statistics
10. Fergusson T.S.: Mathematical statistics.
11. Zacks S.: Theory of Statistical Inference.
12. Cramer H.: Mathematical Methods of Statistics.
13. Cassela G. and Berger R.L.: Statistical Inference.
14. Siegel, S.: Non-parametric Methods for the Behavioral Sciences.
15. Dr. P. G. Dixit, Dr. (Mrs.) V. R. Prayag, S. M. Patil, N. J. Subandh: Statistical Inference: Estimation, Nirali Prakashan, Pune

Probability Distributions

Course Outcomes: The students will able to understand

a) Importance and application of univariate distributions such as Laplace, Cauchy, Lognormal, Weibull, Logistic, Pareto, Power Series Distribution.

b) Concept of Bivariate Normal Distribution.

c) Concept and application of Truncated Distributions.

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,β_1, β_2, γ_1 and γ_2, Laplace distribution as the distribution of the difference of two i.i.d. exponential variables 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, β_1, β_2, γ_1 and γ_2 coefficients, Relation with $N(\mu,\sigma^2)$, 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 variables (statement only), statement of distribution of the sample mean, relationship with uniform and Students 't' distribution, distribution of $\frac{X}{Y}$ where X and Y are i. i. d. N(0,1), examples and problems.

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

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

2.1 Logistic distribution: p.d.f. with parameters (μ, σ), 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.

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 and variance.

3.6 Examples and problems.

Unit-4: Bivariate Normal Distribution (10)

4.1 P.d.f. of a bivariate normal distribution, $BN(\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \rho)$, Marginal and conditional distributions, identification of parameters, conditional expectation and conditional variance, regression of Y on X and of X on Y., independence and uncorrelatedness imply each other, m.g.f and moments. Distribution of aX+bY+c, where a,b and c are real numbers.

4.2 Cauchy distribution as the distribution of Z=X/Y where, $(X,Y) \sim BN(0,0,\sigma_1^2,\sigma_2^2,\rho)$

4.3 Examples and problems.

Books Recommended:

1. Cramer H.: Mathematical Methods of Statistics, Asia Publishing House, Mumbai.

2. Mood A.M., GraybillK, Bose.D.C.: Introduction to Theory of Statistics.(Third edition) Mc-Graw Hiil Series.

3. Lindgren B. W.: Statistical Theory (Third Edition), Collier Macmillan International Edition, Macmillan Publishing Co. Inc. New York.

4. Hogg, R.V. and Craig A.T.: Introduction to Mathematical Statistics(Third Edition), Macmillan Publishing Company,Inc.866,34dAvenue,NewYork,10022.

5. Sanjay Arora and Bansi Lal: New Mathematical Statistics (First Edition), Satya Prakashan, 16/17698,New Market,NewDelhi,5(1989).

6. Gupta S.C and Kapoor V.K .:Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 88, Daryaganj, New Delhi.

7. Rohatgi V.K.: An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd. ,NewDelhi.

8. Feller.W.: An Introduction of Probability Theory and its Applications, Wiley Eastern Ltd. Mumbai.

9. Jhonson and Kotz: Continuous Univariate Distributions I and II: Discrete Distributions: Multivariate Distributions

10. Bhat B.R.: Modern Probability Theory. New Age International.

CBCS Pattern Syllabus: CC – 3A

B. Sc. III (Statistics) Semester-V Paper-XI

Sampling Techniques

Course Outcomes: The students will able to understand

a) An idea of conducting sample surveys and selecting appropriate sampling techniques.

b) Concept of comparing various sampling techniques and its use for various situations.

c) Use of auxiliary information to conduct sample survey.

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- response cases.

1.2: Simple random sampling for attributes:

i. 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.
ii. Np as an estimator of total number of units in the population possessing the attribute of interest, derivation of its expectation, standard error and estimator of standard error.

1.3: Determination of the sample size:

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

i. Margin of error and confidence coefficient
ii. Coefficient of variation of the estimator 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 stratum using SRSWOR method.
iii. (a) $\bar{y}_{st}$ as an estimator of population mean $\bar{Y}$,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 optimum allocation, 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. Comparison of systematic sampling with SRSWOR and stratified sampling in the presence of linear trend.

v. Idea of Circular Systematic Sampling.

3.2: Cluster Sampling

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

ii. Estimation of population mean and population total (with equal size clusters), standard error 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 multi stage 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.

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

iii. 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. Cochran, W.G: Sampling Techniques, Wiley Eastern Ltd., New Delhi.

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

3. DesRaj: Sampling Theory.

4. Daroga Singh and Choudhary F.S. : Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi.

5. Murthy, M.N: Sampling Methods, Indian Statistical Institute, Kolkata.

6. Mukhopadhay Parimal: Theory and Methods of Survey Sampling, Prentice Hall.

CBCS Pattern Syllabus: DSE 4A

B. Sc. III (Statistics) Semester-V Paper-XII

Operations Research

Course Outcomes: The students will able to understand

a) Concept of Linear programming problem and its application to real life problems.

b) Importance of Transportation, Assignment and Sequencing problems.

c) Use of decision theory in solving complex problems.

d) Importance of simulation techniques in every aspects of Statistical theory.

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, (iii)basic variable and non-basic variable,(iv) a basic feasible solution, (v)a degenerate and a non-degenerate solution, (vi)an optimal solution.

1.2: Solution of L.P.P.:

  i. Graphical Method: Solution space, obtaining an optimal solution, unique and non- unique optimal solutions.
  ii. Simplex Method:
  (a)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.
  (b) IBFS not readily available: introduction of artificial variable, Big-M method, modified objective function, modifications and applications of simplex method to L.P.P., criterion for no solution.
  iii. Examples and problems.

1.3: Duality Theory:

  i. Writing dual of a primal problem, solution of L.P.P. with artificial variable.
  ii. Examples and problems.

Unit-2: Transportation and Assignment Problems (12)

2.1: Transportation problem:

  i. Transportation problem (T.P.), statement of T.P., balanced and unbalanced T.P.
  ii. 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).
  iii. MODI method of obtaining Optimal solution of T.P, uniqueness and non-uniqueness of optimal solutions, degenerate solution.
  iv. Examples and problems.

2.2: Assignment Problem:

  i. Statement of an assignment problem, balanced and unbalanced assignment problem, relation

with T.P, optimal solution of an assignment problem using Hungarian method.

ii. Examples and problems.

2.3: Sequencing Problem:

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

Unit-3: Decision Theory (8)

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

Unit.4: Simulation Techniques (10)

Meaning of simulation, Monte Carlo simulation, advantages and disadvantages of simulation, definition and properties of random numbers, generation of pseudo random numbers, Techniques of generating random numbers from uniform distribution, Tests for randomness and uniformity, random variate generation using inverse c. d. f. method, random Variate generation from Bernoulli, Binomial, Poisson, Geometric, Exponential and Normal distributions.

Book Recommended

1. Gass E.: Linear Programming Method and Applications, Narosa Publishing House, New Delhi.

2. Shrinath L.S.: Linear Programming.

3. Taha H.A.: Operation research–An Introduction, Fifth Edition, Prentice Hall of India, New Delhi.

4. Saceini, Yaspan, Friedman: Operations Research Method and Problems, Wiley International Edition.

5. Shrinath, L.S.: Linear Programming, Affiliated East-West Press Pvt. Ltd., New Delhi.

6. Phillips, D.T., Ravindra, A., Solberg, J.: Operations Research Principles and Practice, John Wiley and Sons Inc.

7. Sharma, J.K.: Mathematical Models in Operations Research, Tau McGraw Hill Publishing Company Ltd., New Delhi.

8. Kapoor, V.K.: Operations Research, Sultan Chand and Sons, New Delhi.

9. Gupta, P.K. and Hira D.S.: Operations Research, S. Chand and Company Ltd., New Delhi.

10. Luc Devroye: Non-Uniform Random Variate Generation, Springer–Verlag, New York.

11. Gentle, J.E.: Random Number Generation and Monte Carlo Methods, Springer- Verlag.

12. Robert, C.P. and Casella, G.: Monte Carlo Statistical methods, Springer-Verlag.

13. Rubinstien, R.Y.: Simulation and Monte Carlo Method, John Wiley, New York

CBCS Pattern Syllabus: DSE 4A
B. Sc. III (Statistics) Semester-V Paper-XII
Regression Analysis

Course Outcomes: The students will able to understand

a) Concept and application of regression analysis.

b) Real life application of logistic regression.

c) Importance of least square techniques in the context of regression analysis.

Unit.1: Simple linear regression model (16)

i. Review of simple linear regression model : $Y = \beta_0 + \beta_1 X + \epsilon$, where ϵ is a continuous random variable with $E(\epsilon) = 0$ and $V(\epsilon) = \sigma^2$.

ii. Estimation of β_0 and β_1, by the method of least squares. Properties of the estimators β_0 and β_1, Properties of estimators of β_0 and β_1. Estimation of σ^2, Assumption of normality of ϵ . Tests of hypothesis of β_1. Interval estimation in simple regression model, Coefficient of determination.

iii. Residual analysis. Standardized residuals, Studentized residuals, residual plot, Detection and treatment of outliers.

Unit.2: Review of multiple Regression Model (20)

i. Review of multiple linear regression model : $Y = \beta_0 + \beta_1 X_1 + \ldots + \beta_p Xp + \epsilon$, where ϵ is a continuous random variable with $E(\epsilon) = 0$ and $V(\epsilon) = \sigma^2$.

ii. Estimation of regression parameters $\beta_0, \beta_1, \ldots, \beta_p$ by method of least square, obtaining normal equations, Estimation of σ^2, Assumption of normality of ϵ .Tests of hypothesis of regression parameters.

iii. Variable selection and model building, Residual diagnostics and corrective measures such as transformation of response variable, weighted least squares method.

Unit.3: Logistic Regression Model (9)

Binary response variable, logit transform estimation and interpretation of parameters.

Tests of hypotheses of model parameters, model deviance, LR test.

Book Recommended

1. Montgomery D.C., Peak E.A., and Vining G.G. (2003). Introduction to Linear Regression Analysis (Wiley)

2. Hosmer D.W. And Lemeshow, S. (1989). Applied Logistic Regression (Wiley)

3. Manisha Sane, Regression Analysis: Nirali Prakashan

CBCS Pattern Syllabus: SEC 3

B.Sc. III (Statistics) Semester-V

MS-EXCEL

Course outcomes:

1. To enable student to understand importance of MS-Excel in day-to-day life.
2. To motivate student to judiciously use MS-Excel for facilitation for their own development and development of the society.
3. To help student to construct knowledge using MS-Excel and become a lifelong learner.
4. To empower student to become responsible citizens of the modern technology-based world.

Unit -1 Microsoft Excel: Introduction to MS-EXCEL.   (05)

Unit-2 Data manipulation using EXCEL: sort and filter, find and replace, text to columns.   (06)

Unit-3 Charts and Diagrams   (10)

Unit-4 Built-in mathematical and statistical functions for obtaining descriptive statistics, computing PMF/PDF, CDF and quantiles of the well-known distributions, rand function   (10)

Unit-5 Logical functions: if, true, false, and, or, not etc.   (06)

Unit-6 Excel add-ins: analysis tool pack. Pivot tables and charts.   (08)

References:

1. Help manual of EXCEL.

CBCS Pattern Syllabus: CC - 1B

B.Sc. III (Statistics) Semester –VI Paper -XIII

Statistical Inference-II

Course Outcomes: The students will able to understand

a) Concept and application of interval estimation.

b) Difference between parametric and non-parametric tests.

c) Importance of sequential test procedure.

Unit-1: Interval Estimation   **(11)**

  1.1: Notion of interval estimation, definition of confidence interval, length of confidence interval, confidence bounds. Definition of Pivotal quantity and its use in obtaining confidence intervals and bounds.

  1.2: Interval estimation for the following cases:

i. Mean μ of normal distribution (σ^2 known and σ^2 unknown).
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. Illustrative examples.

Unit-2: Parametric Tests (13)

2.1: 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.

2.2: 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 α.

2.3: Power function of a test, power curve, definition of uniformly most powerful (UMP) level α test. Use of NP lemma for constructing UMP level α test for one-sided alternative. Illustrative examples.

2.4: Likelihood Ratio Test: Procedure of likelihood ratio test, statement and 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 (α,β), 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. Kale, B.K.: A first Course on Parametric Inference

2. Rohatgi, V.K.: Statistical Inference

3. Rohatgi, V.K.: An introduction to Probability Theory and Mathematical Statistics

4. Saxena H.C. and Surenderan: Statistical Inference

5. Kendall M.G. and Stuart A.: An Advanced Theory of Statistics

6. Lindgren, B.W.: Statistical Theory

7. Cassela G. and Berger R. L.: Statistical Inference

8. Lehmann, E.L: Testing of Statistical Hypothesis

9. Rao, C. R.: Linear Statistical Inference

10. Dudewicz C.J. and Mishra S. N.: Modern Mathematical Statistics

11. Fergusson, T.S.: Mathematical Statistics.

12. Zacks, S.: Theory of Statistical Inference.

13. Cramer, H.: Mathematical Methods of Statistics.

14. Gibbons, J.D.: Non-parametric Statistical Inference.

15. Doniel: Applied Non-parametric Statistics

16. Siegel,S.: Non-parametric Methods for the behavioral sciences.

17. Kunte,S.; Purophit, S.G. and Wanjale, S.K.: Lecture notes on Non-parametricTests.

CBCS Pattern Syllabus: CC -2B

B.Sc. III (Statistics) Semester-VI Paper -XIV

Probability Theory

Course Outcomes: The students will able to understand

a) Idea behind order statistics and its use.

b) Concept of different modes of convergence of random variables.

c) Concept and real life application of Markov chain.

Unit-1: Order Statistics (10)

i. Order statistics for a random sample of size n from a continuous distribution, Joint distribution, definition, derivation of distribution function and density function of the ith order statistic, particular cases for i=1 and i=n.

ii. Derivation of joint p.d.f. of ith and j^{th} order statistics, statement of distribution of the sample range.

iii. Distribution of the sample median when n is odd.

iv. Examples and Problems

Unit-2: Convergence and Limit Theorem (12)

2.1: Convergence:

i. Definition of convergence of sequence of random variables (a) in probability, (b)in distribution, (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.

2.2: Weak Law of Large Numbers

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

ii. Simple examples based on Bernoulli, binomial, Poisson , chi-square etc distributions

Unit-3: Finite Markov Chains (12)

3.1: Basic concepts:

Definition and examples of stochastic process, classification of general stochastic process into discrete–continuous time, discrete –continuous state space, type of stochastic process, Examples and problems.

3.2: Markov chain:

Definition and examples of Markov chain, stochastic matrix, transition probability matrix, Chapman-Kolmogorov equation (statement only), n step transition probability matrix, classification of states, simple problems. Stationary probability distribution, applications. Examples and problems.

3.3: Continuous Markov chain:

i. Pure birth process, Poisson process, birth and death process (Derivations not expected).

ii. Examples and problems.

Unit-4: Queuing Theory (11)

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

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

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

iv. Types of queuing models.

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

vi. Examples and problems.

Books Recommended

1. Cramer H.: Mathematical Methods of Statistics, Asia Publishing House, Mumbai.

2. Lindgren B.W.: Statistical Theory (Third Edition), Collier Macmillan International Edition, Macmillan Publishing Co. Inc. New York.

3. Hogg, R.V. and Craig A.T.: Introduction to Mathematical Statistics (Third Edition), Macmillan Publishing Company, Inc. 866,34d Avenue, New York, 10022.

4. Sanjay Arora and Bansi Lal: New Mathematical Statistics (First Edition), Satya Prakashan 16/17698,New Market, New Delhi, 5(1989).

5. Gupta S.C and Kapoor V. K.: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 88, Daryaganj, New Delhi 2.

6. Rohatgi V.K.: An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi.

7. Medhi J: Stochastic Processes. Wiley Eastern Ltd. New Delhi.

8. Hoel, Port and Stone: Introduction to Stochastic Processes, Houghton Mifflin.

9. Feller. W.: An Introduction to Probability Theory and its Applications. Wiley Eastern Ltd. Mumbai.

10. Bhat B.R.: Modern Probability Theory.

11. Karlin and Taylor: Stochastic Process.

12. Ross S: Probability Theory

13. Bhat B. R.: Stochastic Models: Analysis and Applications. New Age International.

14. Zacks S.: Introduction to Reliability Analysis, Probability Models and Statistical Methods, Springer Verlag.

15. Taha H.A.: Operation research–An Introduction, Fifth edition, Prentice Hall of India, New Delhi.

16. Barlow R. E. and Proschan Frank: Statistical Theory of Reliability and Life Testing. Holt .Rinebart and Winston Inc., New York

17. Sinha S. K.: Reliability and Life Testing, Second Edition, Wiley Eastern Publishers, New Delhi.

18. Trivedi R. S.: Probability and Statistics with Reliability and Computer Science Application, Prentice–Hall of India Pvt .Ltd., New Delhi.

19. Parimal Mukhopadhyaya: An Introduction to the Theory of Probability. World Scientific Publishing.

CBCS Pattern Syllabus: CC – 3B

B. Sc. III (Statistics) Semester -V Paper -XV

Designs of Experiments

Course Outcomes: The students will able to understand

a) Basic terminology involved in designing of experiment.

b) Concept and use of different experimental designs.

c) Concept and real life application of factorial experiment.

Unit–1: Simple Designs of Experiments I: (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.

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. Break up of total sum of squares into components.
   iv. Technique of one way analysis of variance (ANOVA) and it's applications to CRD.
   v. Testing for equality for treatment effects and it's 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.

2.2 Latin Square Design (LSD):

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

Unit–3: Efficiency of design and ANOCOVA (10)

3.1 Efficiency of design:

  i.   Concept and definition of efficiency of a design.
  ii. Efficiency of RBD over CRD.
  iii. Efficiency of LSD over CRD and LSD over RBD.

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 (derivations are not expected).
  iv. Preparation of analysis of covariance (ANOCOVA) table, test for $\beta=0$, 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 in 2^2 and 2^3 factorial experiments.
  iii. Model, assumptions and its interpretation.
  iv. Preparation of ANOVA table by Yate's procedure, test for main effects and interaction effects.
  v.   General idea and purpose of confounding in factorial experiments.
  vi. Total confounding (Confounding only one interaction): ANOVA table, testing main effects 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 2^3 factorial experiment.

Books Recommended

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

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

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

4. Das, M. N. and Giri, N. C.: Design and Analysis of Experiments, Wiley Eastern Ltd., New Delhi.

5. Goulden, G.H.: Methods of Statistical Analysis, Asia Publishing House, Mumbai.

6. Kempthrone, O.: Design and Analysis of Experiments, Wiley Eastern Ltd., New Delhi.

7. Snedecor, G.W. and Cochran, W.G.: Statistical Methods, Affiliated East-West Press, New Delhi.

8. Goon, Gupta, Dasgupta: Fundamental of Statistics, Vol. I and II, The World Press Pvt. Ltd. Kolkata.

9. Gupta, S.C. and Kapoor, V. K.: Fundamentals of Applied Statistics, S. Chand &Sons, New Delhi.

10. C.F. Jeff Wu, Michael Hamada: Experiments, Planning Analysis and Parameter Design Optimization.

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CBCS Pattern Syllabus: DSE 4B

B.Sc. III (Statistics) Semester VI Paper XVI

Quality Management

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Course Outcomes: The students will able to understand

a) Meaning and dimensions of quality and its importance in real life and in manufacturing industry.

b) Different tools and techniques involved in process and product control.

c) Concept and real life application of reliability theory.

Unit 1: Statistical Quality Control (SQC): (10)

Meaning and purpose of SQC, quality of product, process control, product control, SPC tools: assignable causes, chance causes. Shewhart's control chart: construction, working, theoretical basis, 3σ –control limits and lack of control situation.

Control charts for variables: Control chart for process average ($\overline{X}$), control chart for process variation (R), Construction and working of and R chart for known and unknown standards, revised control limits, estimate of process s. d.

Control charts for attributes: Defects, defectives, fraction defective, control chart for fraction defectives (P-chart) for fixed sample size and unknown standards, construction, working of chart, revised control limits.

Control chart for number of defects(C-chart): for standards are not given, construction and working of the chart, revised control limits.

Unit.2: 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 3: 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 4: 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.

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Books Recommended

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1. Introduction to quality Control–Montgomery D. C.

2. Quality Control and Industrial statistics- Duncan A J

3. Statistical Quality Control- E L Grant

8. Dr. B.G. Kore and Dr. P. G. Dixit: Statistical Methods-II, 4thEdition, December, 2017, Nirali Prakashan, Pune.

CBCS Pattern Syllabus: DSE 4B

B.Sc. III (Statistics) Semester VI Paper XVI

Time Series Analysis and Reliability Theory

Course Outcomes: The students will able to understand

a) Concept behind features of time series data.

b) Tools and techniques involved to understand trend in time series analysis.

c) Impact of trend, seasonality on time series data.

Unit 1: Time series data, estimation and smoothing   (15)

Studying a given series by plots and Historigrams. Test of randomness of a series against trend and seasonality. Progressive average method, Exponential smoothing, Forecasting based on smoothing, Double exponential smoothing, Choosing parameters for smoothing and forecasting, Estimating mean square error of forecasting, Prediction intervals based on normality assumption. Ratio to trend method, Link Relative Method. Measurement of cyclic variation- Harmonic analysis.

Unit 2: Detailed study of stationary process   (10)

Definition of Stationary Time Series, Auto-Covariance, Auto-Correlation. Properties of Auto-covariance function (Statement only). Illustrative examples. MA(q) Process: Auto-covariance function, Auto-correlation function. Estimation of parameters (For MA(1) and MA(2) process only). Illustrative examples. AR(p) Process: Auto-covariance function, Auto-correlation function. Estimation of parameters (For AR(1) and AR(2) process only). Illustrative examples.

Unit 3: Reliability Theory   (10)

Binary system: Block diagram, definition of binary coherent structure and illustrations. Coherent system of component (at most three)- a) Series b) Parallel c) 2 out of 3 system.
Minimal cut, minimal path representation of system. Reliability of binary system: reliability of above systems h(p),when components are independent and identically distributed with common probability p of operating. 'S' shaped ness property of h (p) without proof.

Unit 4: Ageing Properties of components   (10)

Ageing Properties: Definitions, Hazard rate, hazard function, survival function, concept of distributions with increasing and decreasing failure rate (IFR, DFR). Relationship between survival function and hazard function, density function and hazard rate, derivations of the results a) Hazard rate of a series system of components having independent lifetimes is summation of component hazard rates. b) Lifetime of series system of independent components with independent IFR life times is IFR. Examples on exponential and Weibull distributions.

Books Recommended

1. Montgomery, D.C. and Johnson L.A. (1976): Forecasting and Time series Analysis, McGraw Hill.

2. The Analysis of Time Series an Introduction Sixth Edition: Chris Chatfield CRC press Taylor and Francis Group, A Chapman And Hall Book

3. Farmum, N. R. and Stantorr, L.W. (1989). Quantitative Forecasting Methods, PWS-Kent Publishing Company, Boston.

4. Dr. B.G. Kore and Dr. P. G. Dixit: Statistical Methods-I, Nirali Prakashan, Pune.

5. Zacks S.: Introduction to Reliability Analysis, Probability Models

6. Barlow, R.E. and Proschan Frank: Statistical Theory of Reliability and Life Testing, Holt Rinebart and Winston Inc., New York.

7. Sinha S.K.: Reliability and Life Testing, Second Edition, Wiley Eastern Ltd. New Delhi.

8. Trivedi R.S.: Probability and Statistics with Reliability and Computer Science Application, Prentice – Hall of India Pvt. Ltd., New Delhi.

CBCS Pattern Syllabus: B.Sc. III (Statistics)

Practical Paper IV

Statistical Inference

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 normal distribution (Two samples).

8. Interval estimation for population proportion and difference between two population proportions.

9. Interval estimation for population median using order statistics.

10. Construction of MP test.

11. Construction of UMP test.

12. Construction of SPRT for Binomial, Poisson distributions, Graphical representation of procedure.

13. Construction of SPRT for exponential and normal distribution, graphical representation of procedure.

14. NP test—Run test (for one and two independent samples).

15. NP test–Sign test and Wilcoxon's signed rank test (for one and two samples paired observation).

16 NP test-Mann-whitney U-test (for two independent samples).

17. NP test–Median test (for two large independent samples)

18. NP test—Kolmogorov-smirnov test (for one and two independent samples).

CBCS Pattern Syllabus: B.Sc. III (Statistics)
Practical Paper V
Probability Distributions and R-Software

1. Model sampling from Laplace distribution.

2. Model sampling from Pareto distribution

3. Model Sampling from Cauchy distribution

4. Model sampling from truncated Binomial and Poison distributions.

5. Model sampling from truncated Normal and Exponential distributions.

6. Model sampling from Bivariate Normal distribution.

7. Fitting of truncated Binomial distribution.

8. Fitting of truncated Poisson distribution.

9. Application of Bivariate Normal distribution-I.

10. Application of Bivariate Normal distribution-II.

11. Data input/output, diagrammatic and graphical representation of data using R-Software.

12. Computation of probabilities of type I and type II errors and power of a test using R- Software.

13. Model sampling from log-normal and Weibull distributions using R-Software.

14. Model sampling from logistic distribution using R-Software.

15. Fitting of Binomial and Poisson distributions using R-Software.

16. Fitting of Normal distribution using R-Software.

17. Fitting of Log-Normal distribution using R-Software.

18. Analysis of Completely Randomized Design (CRD) using R-Software. Analysis of Randomized Block Design (RBD) using R-Software.

CBCS Pattern Syllabus: B.Sc. III (Statistics)
Practical Paper VI
Design of Experiments and Sampling Techniques

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 i) RBD over CRD and ii) LSD over CRD and RBD.

5. Analysis of Covariance in CRD.

6. Analysis of Covariance in RBD.

7. Analysis of 2^2 and 2^3 Factorial Experiment.

8. Total Confounding.

9. Partial Confounding.

10. Simple Random Sampling for Attributes.

11. Determination of Sample Size in SRS for Variables and Attributes.

12. Stratified Random Sampling–I

13. Stratified Random Sampling–II

14. Ratio Method of Estimation.

15. Regression Method of Estimation.

16. Systematic Sampling.

17. Cluster Sampling.

18. Two Stage and Multi Stage Sampling.

CBCS Pattern Syllabus: B.Sc. III (Statistics)
Practical Paper-VII
Operations Research and Quality Management

1. L.P.P. by simplex method I (Slack variable)

2. L.P.P. by simplex method II (Big M method)

3. Transformation problem- I.

4. Transformation problem- II (Degeneracy)

5. Assignment problem.

6. Sequencing Problem.

7. Decision Theory.

8. Simulation I (Discrete distribution)

9. Simulation II (Continuous distribution)

10. Construction of $\overline{X}$ and R chart.

11. Construction of P and C chart.

12. EWMA-Chart.

13. CUSUM chart.

14. Six sigma limits for mean.

15. Single sampling plan (Small sample and large sample).

16. Double sampling plan (Small sample and large sample).

17. Reliability Theory- I (Block diagram, Structure function, Minimal cut, Minimal path, Reliability)

18. Reliability Theory- II (Hazard rate, Hazard function, Survival function, IFR, DFR, Examples on Exponential and Weibull distributions)

CBCS Pattern Syllabus: B.Sc. III (Statistics)

Practical Paper VII

Regression Analysis, Time Series Analysis and Reliability Theory

1. Estimation of β_0 and β_1, by the method of least squares in simple regression model.

2. Estimation of σ^2 in simple regression model

3. Tests of hypothesis of β_1 under Assumption of normality of ϵ, in simple regression model

4. Interval estimation in simple regression model

5. Residual Analysis. Standardised residuals, Studentized residuals, residual plot in simple regression model

6. Estimation of regression parameters $\beta_0, \beta_1, \ldots, \beta_p$ by method of least square, obtaining normal equations, in multiple regression model

7. Estimation of σ^2 in multiple regression model

8. Tests of hypothesis of regression parameters, in multiple regression model.

9. Tests of hypotheses of model parameters, model deviance, and LR test in multiple regression model.

10. Study of time series: plots and histogram

11. Test of randomness of a series against trend and seasonality

12. Trend estimation using moving average

13. Curve fitting by least square method

14. Trend estimation using smoothing

15. Measurement of seasonal variation by Simple average method

16. Measurement of seasonal variation by ratio to moving average method.

17. Fitting of trend by AR (1) mode

18. Fitting of trend by AR (2) model

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