SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE, UJIRE-574240

(Autonomous)
(Re-Accredited by NAAC at 'A' Grade with CGPA 3.61 out of 4)

DEPARTMENT OF STATISTICS

Syllabus of
**Bachelor's Degree in
STATISTICS**

**(CHOICE BASED CREDIT SYSTEM SEMESTER
SCHEME)
2019-20 ONWARDS**

**Approved by the BOS meeting held on 4th June 2019
Approved by the Academic Council meeting, held on 10-10-2019**

STATISTICS AS A DISCIPLINE

Preamble

Statistics is vigorously gaining importance and recognition in today's society. For a long time, Statistics was identified solely with the displays of data and charts pertaining to the economic, demographic, and political situations prevailing in a country. However, gigantic advances during the twentieth century have enabled statistics to grow and assume its present importance as a discipline of data-based reasoning. Statistics, as a scientific discipline, stretch well beyond the confines of data display. It deals with collecting informative data, analysis interpreting these data, and drawing conclusions about a phenomenon under study. The scope of this subject naturally extends to all processes of acquiring knowledge that involve facts finding through collection and examination of data. Also, Statistics plays vital role in Big data & Analytics, which is now an emerging field in all spheres of human activity. There is a great demand for data analytics.

The board is of the view that the curriculum of B.Sc. Statistics should be flexible enough to prepare graduates to either be functioning statisticians or to go on to post-graduation studies. Accordingly, curriculum of B.Sc. Statistics is designed in such a way that it addresses the following learning goals.

Course Objectives

Upon completion of the program, students will be able to:

- Explain theoretical basis of commonly used statistical methods.
- Analyse and interpret results from standard designed experiments, sample surveys and observational studies.
- Acquiesce sufficient computing skill to implement standard statistical methods and data visualisation tools and carry out data analysis.
- Ascertain the benefits of pursuing higher education in Statistics.
- Study of optimization problems
- Application of statistics in agricultural experiments

To accomplish these course objectives, the following changes were made in the curriculum.

- Introduced Statistical computing using R software and EXCEL in practicals of various semester.
- Introduced scaling techniques which are useful in the measurements of qualitative characteristics in social science research.
- Introduced various multivariate data analysis methods (only description of methods) which are very popular in business research.
- Paper VIII of sixth semester deals with the application of statistical methods in fields such as Industrial quality control, Economics and Demography. This enables the students to understand and appreciate the applications of statistical methods in various fields.

Eligibility

1. Only those candidates who have passed Pre-University course in Science or an equivalent course with Mathematics one of the reject are eligible to take Statistics as one of the optional subjects in B.Sc. course.
2. Any student taking Statistics as one of the optional subjects in the B.Sc. course shall take Mathematics as another optional subject.

Scheme of Instruction/Examination:

The board recommends that the existing scheme of instruction and examination in theory and practical may be continued. The theory question paper in all semesters shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.

Theory question paper pattern

	No. of questions to be answered	Marks
Part A	Ten questions out of 12 questions	2 X 10 = 20
Part B	Five questions out of 8 questions	6 X 5 = 30
Part C	Three questions out of 5 questions Each question may have sub questions	10 X 3 = 30

Practical Examination:

1) Students will have to answer any four questions out of 8 questions. All questions carry equal marks.

2) Practical paper in each semester carries 50 marks and the split up of the practical marks are as given below.

a) Three hour examination carrying 30 marks with two examiners which includes at least one external examiner .

b) Ten marks for class records.

c) Ten marks to be allotted for the preparatory practical examination and continuous assessment during practical classes.

COURSE PATTERN AND SCHEME OF EXAMINATION

	Course Code	Particulars	Instruction hours/ week	Duration of the exam (hrs)	IA	Exam	Total	Credits
I SEMESTER								
Group I Core Subject	BSCSTC 131	Descriptive Statistics	4	3	20	80	100	2
	BSCSTP 132	Statistics Practical - I	3	3	10	40	50	1
Group II Elective	BSCSTCE 133	Official statistics	2	2	10	40	50	1
Total number of Credits for Core Subject in I Semester: 04								
II SEMESTER								
Group I Core Subject	BSCSTC 181	Probability Theory	4	3	20	80	100	2
	BSCSTP 182	Statistics Practical - II	3	3	10	40	50	1
Group II Elective	BSCSTCE 183	Statistical Analysis of Experimental Data.	2	2	10	40	50	1
Total number of Credits for Core Subject in II Semester: 04								
III SEMESTER								
Group I Core Subject	BSCSTC 231	Sampling Theory	4	3	20	80	100	2
	BSCSTP 232	Statistics Practical - III	3	3	10	40	50	1

Group	Code	Title						
Group II Elective	BSCSTCE 233	Introduction to Data Science and Big Data Analytics.	2	2	10	40	50	1
Total number of Credits for Core Subject in III Semester: 04								
IV SEMESTER								
Group I Core Subject	BSCSTC 281	Statistical Infernce - I	4	3	20	80	100	2
	BSCSTP 282	Statistics Practical - IV	3	3	10	40	50	1
Group II Elective	BSCSTOE 283	Basic statistics	2	2	10	40	50	1
Total number of Credits for Core Subject in IV Semester: 04								
V SEMESTER								
Group I Core Subject	BSCSTC331	Regression Analysis	3	3	20	80	100	2
	BSCSTC332	Operations Research	3	3	20	80	100	2
	BSCSTP 333	Practical based on BSCSTC 331 & BSCSTC 332	4	3	20	80	100	2
Total number of Credits for Core Subject in V Semester: 06								

	Course Code	Particulars	Instruction hours/ week	Duration of the exam (hrs)	IA	Exam	Total	Credits
		VI SEMESTER						
Group I Core Subject	BSCSTC381	Statistical Inference II & Design and Analysis of experiments	3	3	20	80	100	2
	BSCSTC382	Applied Statistics	3	3	20	80	100	2
	BSCSTP 383	Practical based on BSCSTC 381 & BSCSTC 382	4	3	20	80	100	2
Total number of Credits for Core Subject in VI Semester: 06								
Total number of Credits for Core Subject in I-VI Semesters: 28								

B.Sc. Degree – First Semester
BSCSTC 131 - DESCRIPTIVE STATISTICS
(48 Lecture hours) (2 Credits)

Rationale/ Learning Objectives:

- To identify the relevant population, sample, study units (subjects), variables, attributes.
- To know various types of data, methods of collection and presentation of the data.
- To Identify the different types of averages suitable to different situations.
- To study various measures of variation
- To understand measures of skewness and kurtosis
- Introduction of statistical computing using R software.

<u>OUTCOMES</u>

- Students are familiar with type of data identification and preparation of datasets.
- Students are able to Know the various graphical presentation of data
- Able to understand the various types of averages and measures of variation used for different types of data by the students
- Learners are Familiar with measures of skewness and kurtosis.

UNIT I: Organisation, Presentation of Data and Statistical computing (R- Software) (12L)

Meaning of Statistics as a Science, Importance of Statistics

Types of characteristics: Attributes - Nominal scale, ordinal scale, Variables - Interval scale, ratio scale, discrete and continuous variables,

Types of data: (a) Primary data, Secondary data. (b) Cross-sectional data, time series data,

Classification and Tabulation, Construction of frequency distribution, Graphical representation- Histogram, Frequency polygon, Frequency curve, Ogives

Notion of a statistical population - Finite population, Infinite population, Homogeneous population and Heterogeneous population

Notion of sample - Random sample and Non-random sample

Introduction to R, R as a calculator, statistical software and a programming language, R preliminaries, getting help, data inputting methods(direct and importing from other spread sheet applications like Excel), data accessing, and indexing, packages, Graphics in R, built in functions, saving, storing and retrieving work.

UNIT II – Univariate data analysis - Measures of central tendency (12L)

Concept of central tendency of statistical data: Statistical average, characteristics of a good statistical average ,Arithmetic Mean (A.M.), properties with proof, Trimmed arithmetic mean- definition only.

Median - Definition, Formula for computation (with derivation), Graphical method of determination of median, merits and demerits, Mode - Definition, formula for computation, (with derivation) Graphical method of determination of mode, merits and demerits

 Empirical relation between mean, median and mode

Partition Values - Quartiles, Deciles and Percentiles

Means of transformed data - Geometric Mean (G.M.) -Definition, merits and demerits, Harmonic Mean (H.M.) - Definition, merits and demerits. Order relation between arithmetic mean, geometric mean, harmonic mean (proof for n = 2). Weighted Mean - Weighted A.M., Situations where one kind of average is preferred to others. Examples

UNIT III - Univariate data analysis - Measures of Dispersion (12L)

Measures of Dispersion - Concept of dispersion, characteristics of good measure of dispersion. Range- Definition, merits and demerits. Semi-inter quartile range (Quartile deviation), Mean deviation- Definition, merits and demerits, minimal property (without proof). Mean square deviation, Variance and standard deviation: Definition, merits and demerits, properties. Measures of dispersion for comparison: coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.) Examples

UNIT IV – Moments, skewness and kurtosis(12L)

Moments- Raw moments for grouped and ungrouped data, Moments about an arbitrary constant for grouped and ungrouped data, Central moments for grouped and ungrouped data, Effect of change of origin and scale, Relations between central moments and raw moments

Skewness and Kurtosis - Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution, Interpretation with examples, Bowley's coefficient of skewness, Karl Pearson's coefficient of skewness. Measures of skewness based on moments. Kurtosis- leptokurtic, mesokurtic and platykurtic frequency distributions. Measures of kurtosis based on moments, Examples.

References

1) Goon, A. M., Gupta, M. K., & Das Gupta, B. (1991). *Fundamentals of Statistics, Vol. 1.* World Press, Calcutta.

2) Gupta, S. C., & Kapoor, V. K. (2002). *Fundamental of Mathematical Statistics.* Sultan Chand & sons.

3) Medhi, J. (2006). *Statistical Methods: An Introductory Text.* New Age International(P) Limited, New Delhi.

4) Robert Kabacoff, I. (2015). *R in Action - Data Analysis and Graphics with R, second edition.* dreamtech Press.

5) Sudha Purohit, G., Sharad Gore, D., & Shailaja Deshmukh, R. (2008). *Statistics Using R.* Narosa Publishing House.

6) Mathematical Statistics by Irvin Millon Maryless Miler, 7th Ed. Pearson Publication.

B.Sc. Degree – First Semester

BSCSTP 132– Statistics Practical – I -Descriptive Statistics (1 credit)

List of Practical Assignments

1) Graphical presentation of Statistical Data (Manual and using MS-Excel)
2) Measures of central tendency-I
3) Measures of central tendency –II (Using R-Software)
4) Measures of central tendency-III
5) Measures of central tendency-IV (Using R-Software)
6) Measures of dispersion-I
7) Measures of dispersion-II(Using R-Software)
8) Measures of dispersion-III
9) Measures of dispersion-IV(Using R-Software)
10) Computation of central moments, Measure of skewness and Kurtosis

B.Sc. Degree – Second Semester
BSCSTC 181 – PROBABILITY THEORY
(48 Lecture hours) (2 Credits)

Rationale /Learning Objectives:

- To understand the concept of Probability and its applications
- To understand the concept of random variables, pmf, pdf,mgf,cgf etc.
- Study of standard discrete probability distributions and their relationship, applications.
- To know various standard continuous probability distributions and their relationship.
- To study the properties of the normal curve.

OUTCOMES

- Students are able to understand the concept of probability and its applications
- Able to understand the concept of random variables, pmf, pdf, mgf, cgf etc.
- Able to understand the standard discrete probability distributions and their relationship, applications.

UNIT I – Probability (12 L)

Random Experiments, Sample space (Discreet and continuous), Elementary events and compound events, Classical definition of probability and its limitations, relative frequency approach. Axioms of probability, limitations of classical definition of probability. Addition theorem, Conditional Probability and Independence, Multiplication theorem, Bayes' Theorem (with proof) and its applications

UNIT II - Random Variables (12L)

Random variables (discrete and continuous), probability mass function, probability density function – their properties, Distribution function – Properties, Bivariate p.m.f.'s and p.d.f.'s , marginal and conditional probability distributions for two r.v.'s, Independence of random variables. Expectation of random variables – Rules of expectation, Addition and

Multiplication theorems of expectation, Variance , Covariance and Correlation coefficient. Mean and variance of linear combination of random variables, Moments, Expectation of functions of random variables, M.G.F. and its properties, Cumulant generating function, Cumulants.

UNIT III – Standard Probability distributions
Discrete distributions (12L)

Bernoulli, Binomial, Poisson, discreet uniform, Geometric, Negative Binomial, Hyper geometric distributions........

– Mean, Variance, MGF, CGF, Mode for Binomial ,Poisson, Negative binomial distributions.Recurrence relation for central moments for Binomial, Poisson, Negative binomial distributions, Applications, Limiting Distributions

UNIT -IV
Continuous univariate distributions (12L)

Uniform, exponential, Gamma with single parameter, Normal Distributions, Beta-I and Beta-II distributions, Cauchy – definition through p.d.f – Distribution function – computation of moments, Median, Mode.

References

1) Goon, A. M., Gupta, M. K., & Das Gupta, B. (1991). *Fundamentals of Statistics, Vol. 1.* World Press, Calcutta.

2) Gupta, S. C., & Kapoor, V. K. (2002). *Fundamental of Mathematical Statistics.* Sultan Chand & sons.

3) Hogg, R. V., & Craig, A. T. (1995). *Introduction to Mathematical Statistics.* 5/e, Prentice Hall, New Jersy, USA.

4) Levin, R. (2013). *Statistics for Management.* Prentice Hall India.

5) Medhi, J. (2006). *Statistical Methods: An Introductory Text.* New Age International(P) Limited, New delhi.

6) Robert Kabacoff, I. (2015). *R in Action - Data Analysis and Graphics with R, second edition.* dreamtech Press.

7) Rohatgi, V. K. (2002). *An Introduction to Probability theory and Mathematical Statistics.* Wiley Eastern Limited.

8) Ross, S. M. (2003). *Introduction to Probability Models.* 10e, Academic Press, UK.

9) Sudha Purohit, G., Sharad Gore, D., & Shailaja Deshmukh, R. (2008). *Statistics Using R.* Narosa Publishing House.

10) Mathematical Statistics by Irvin Millon Maryless Miler, 7th Ed. Pearson Publication.

B.Sc. Degree – Second Semester
BSCSTP 182 – Statistics Practical – II – Probability Theory (1 credit)
List of Practical Assignments

1) Probability- Addition theorem, multiplication theorem and conditional probability

2) Probability- Baye's theorem.

3) Random variables (Univariate and Bivariate- manual & using MS-Excel), pmf ,pdf and Distribution functions, mean and variance

4) Exercises on Discrete Probability Distributions-I

5) Exercises on Discrete Probability Distributions-II

6) Fitting of Binomial, Poisson, Negative Binomial Distributions(Manual)

7) Fitting of Binomial, Poisson, Negative Binomial Distributions(using R)

8) Exercise on Normal Distributions-I

9) Exercise on Normal Distributions-II

10) Fitting of Normal distributions

B.Sc. Degree – Third Semester

BSCSTC 231 – SAMPLING THEORY

(48 Lecture hours) (2 Credits)

Rationale /Learning Objectives:

- To know about sample and census surveys
- To study of principles of sample surveys
- To study basic sampling schemes (simple random sampling, stratified sampling, systematic sampling ,), their merits and demerits.
- To study the different types of sampling distributions and their applications in the real life.
- To understand the relationship between different distributions using Jacobean of transformation technique
- To understand Limit theorems and their applications

OUTCOMES

- Learners are able to distinguish between census and sample survey
- Students are familiar with SRSWR, SRSWOR, Stratified sampling Systematic sampling and Cluster sampling Techniques
- Familiar with finding mean, variance of sampled distributions and estimation by various sampling techniques.
- Able to understand the relationship between distributions using Jcobian of transformation technique.
- Familiar with applications of WLLN and CLT.

UNIT I – Statistical Investigation(6 L)   Population and Sample.

Complete enumeration v/s sample surveys - merits and demerits, need for random and non-random sampling, limitations of non-random sampling and judgment sampling, Principles of sample surveys. Principal steps in a sample survey, Errors in sampling, parameter and statistic, Unbiasedness, variance and precision of estimators, pilot survey, determination of

sample size, Selection of sample using random numbers. Drawing samples from finite population with and without replacement. Sampling from frequency distribution and contingency tables.

UNIT II - Simple random sample(10L)

Simple random sampling with replacement(SRSWR) and simple random sampling without replacement (SRSWOR), Unbiased estimators of mean, variance and population total, Sampling variances , standard errors and their estimation, comparison of SRSWR with SRSWOR.

Sampling of attributes - Sampling for proportions, Estimation of population proportion and its Standard Error(SE).

UNIT III - Stratified random sampling(12L)

Need for stratification, Stratified sampling under SRSWOR, Unbiased estimators of mean and total, Variances of these estimators and their estimation. Allocation of sample size - proportional and optimum allocation (w.r.t. SRSWOR stratification only), Neyman's allocation, allocation with cost functions, Comparison of SRSWOR and stratified sampling. Gain in efficiency due to stratification.

Linear systematic sampling

Estimation of mean, Variance of the estimator of mean in terms of intra-class correlation, Comparison of SRSWOR and linear systematic sampling.

UNIT IV – Transformation of random variables , Sampling Distributions and Limit theorems (20L)

Definition and derivation of students' t, Chi-square and F- distributions –mean, variance and MGF. Mode of Chi-square and F distributions. Distribution of sample mean, sample variance under normality assumption,. Interrelationship between the distributions, Distribution of minimum and maximum.

Statement and proof of Chebyschev's inequality, sequence of random variables, convergence in probability : basic results(without proof), Weak law of large numbers, central limit theorem for i. i. d. random variables and its application

References

1) Cochran, W. G., & Cos. (1977). *Sampling Techniques, 3rd Edition.* Wiley Eastern.

2) Goon, A. M., Gupta, M. K., & Das Gupta, B. (1991). *Fundamentals of Statistics, Vol. 1.* World Press, Calcutta.

3) Gupta, S. C., & Kapoor, V. K. (2002). *Fundamental of Mathematical Statistics.* Sultan Chand & sons.

4) Guptha, S. C., & Kapoor, V. K. (1984). *Fundamentals of Applied Statistics.* Sulthan Chand and Sons.

5) Hogg, R. V., & Craig, A. T. (1995). *Introduction to Mathematical Statistics.* 5/e, Prentice Hall, New Jersy, USA.

6) Rohatgi, V. K. (2002). *An Introduction to Probability theory and Mathematical Statistics.* Wiley Eastern Limited.

7) Sampath, S. (2006). *Sampling Theory and Methods.* 2/e, Narosa, New Delhi.

8) Parimal Mukhyopadhya() Theory of Sampling.

9) Mathematical Statistics by Irvin Millon Maryless Miler, 7th Ed. Pearson Publication.

B.Sc. Degree – Third Semester

BSCSTP 232 – Statistics Practical – III – Sampling Theory(1 credit)

List of Practical Assignments

1) Drawing simple random samples using random numbers and from a frequency distribution and contingency table

2) Exercise on SRSWR

3) Exercise on SRSWOR and sampling of attributes

4) Exercise on Stratified random sampling.

5) Exercise on Allocation of samples in Stratified sampling.

6) Linear systematic sampling.

7) Exercise on Chebyschev's inequality.

8) Exercise on Central limit theorems.

B.Sc. Degree – Fourth Semester
BSCSTC 281 – STATISTICAL INFERENCE – I
(48 Lecture hours) (2 Credits)

Rationale /Learning Objectives:

- To understand Point estimation and interval estimation, their applications in real life.

- Construction of confidence intervals

- To familiar with the basic concepts of hypothesis testing and performing hypothesis tests for means and proportions

- To find the BCR for testing H_0 against H_1

- To study Likelihood Ratio tests, Large sample tests, chisquare tests.

OUTCOMES

- Learners are familiar with the problem of estimation and able to distinguish between the point and interval estimation

- Able to understand the basic concepts of hypothesis testing and computation of size and power of the test.

- Able to select the type of test to be used for the problem of concern in large samples.

- Able to use Likelihood ratio tests, chi-square tests

UNIT I - Point Estimation (12 L)

Estimator and estimate, Unbiasedness, and consistency of estimators, Sufficient condition for consistency, Relative efficiency, Sufficient statistics. Factorization theorem and its applications, Maximum likelihood and moment methods of estimation-properties of these methods (without proof)- (discussion of examples to be restricted to Bernoulli, Binomial, Poisson, Negative Binomial distributions, Normal, Beta and Gamma distributions.)

UNIT II - Interval estimation(6L)

Confidence coefficient, confidence interval using Pivotal Quantity method with examples. Confidence interval for mean, difference between means, variance and ratio of variances

under normality. Large sample confidence interval for mean, difference of means.Proportion and difference between proportions.

UNIT III - Testing of Hypotheses (12 L)

Statistical Hypotheses -Null and alternative, Simple and composite hypotheses. Critical region. Concepts of type I and type II errors, level of significance and p-value, power of test. Power function -power curve.Relationship between testing of hypothesis and interval estimation.Most powerful test for continuous case only and best critical region. Statement of Neyman and Pearson Lemma and its use.

UNIT IV - Likelihood ratio tests, Small and large sample tests (LRT) (10 L)

-Derivation of tests for normal distribution with testing for mean ,variance, equality of means and ratio of variances (two sided alternatives only). Paired t test. Test for significance of correlation coefficient, properties of LRT(without proof). Large Sample test, small sample tests and Chi-square tests- goodness of fit, test for independence of attributes in rxs, 2xk, 2x2 contingency table and Yates correction for continuity.

References

1) Gupta, S. C., & Kapoor, V. K. (2002). *Fundamental of Mathematical Statistics.* Sultan Chand & sons.

2) Hogg, R. V., & Craig, A. T. (1995). *Introduction to Mathematical Statistics.* 5/e, Prentice Hall, New Jersy, USA.

3) John freund, E. (2001). *Mathematical statistics.* Prentice hall of India, New Delhi.

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5) Mood, A. M., Graybill, A., & Boes, C. (2001). *Introduction to the theory of Statistics.* Tata McGraw-Hill Publishing company Limited.

6) Robert Kabacoff, I. (2015). *R in Action - Data Analysis and Graphics with R, second edition.* dreamtech Press.

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9) Mathematical Statistics by Irvin Millon Maryless Miler, 7th Ed. Pearson Publication.

B.Sc. Degree – Fourth Semester
BSCSTP 282– Statistics Practical – IV – Statistical Inference – I(1 credit)
List of Practical Assignments

1) Point Estimation
2) Exercise on size and power
3) Large sample tests and confidence intervals-1
4) Large sample tests and confidence intervals-2
5) 't' test for testing mean, difference of means, paired t test
6) Small sample confidence interval for mean and difference of means.
7) Testing variance of a normal population, confidence interval for variance,
8) Testing goodness of fit
9) Testing the independence of attributes.
10) F test for testing the ratio of variances of normal population and confidence interval for the ratio of variances

Fifth semester B.Sc. (Paper V)
BSCSTC 331 – REGRESSION ANALYSIS
(48 Lecture Hours) (2 Credits)

Rationale /Learning Objectives:

- To understand scaling techniques
- To know the concept of correlation, measurement and testing of correlation
- To understand the concept of regression, testing significance of regression coefficients
- To study trivariate regression, partial and multiple correlation
- To fit second degree and exponential curves using least square method
- To study multivariate data analysis

OUTCOMES

- Students are able to understand scaling techniques
- Learners are familiar with the concept of correlation, measurement and testing of correlation
- Able to understand the concept of regression, testing significance of regression coefficients
- Able to compute multiple regression equations, partial and multiple correlation coefficients.
- Students are able to fit second degree and exponential curves using least square method
- Learners are familiar with multivariate data analysis

UNIT I -Scaling Techniques (7 L)

Measurement statistical survey, Sources of error in measurement, Tests of measurement

Scaling – Meaning of scaling, important scaling techniques, Scale construction techniques

Guttman scale--Likert scale, selection of appropriate scale- limitations of scaling techniques

UNIT II- Bivariate Data analysis (12 L)

Correlation

Bivariate data, bivariate frequency distribution , Concept of correlation between two variables, types of correlation, Scatter diagram, Covariance between two variables - Definition, computation, effect of change of origin and scale. Karl Pearson's coefficient of correlation, Spearman's rank correlation coefficient, derivation of rank correlation coefficient with and without ties Testing the significance of correlation coefficient.

UNIT III -Regression analysis(14 L)- Concept of errors in functional relationship , simple linear regression model. least squares method, Interpretation of Regression coefficient properties, residuals, Mean residual sum of squares, estimation of error variance, Residual plot and its interpretation, Explained and unexplained variation, coefficient of determination, testing the significance of regression coefficients, Fitting of second degree curve, exponential curve by the method of least squares after logarithmic transformation

UNIT IV - Multivariate data analysis (15L)

Multiple linear regression (3 variables only), Assumption, Estimation of Regression by least squares method. Estimation of regression coefficients. Partial, multiple correlation coefficients. Coefficient of Determination (R_2)

Multivariate Data Analysis - (Description of various multivariate methods to be given)

Logistic regression, Factor Analysis, Structural Equation Modelling, Cluster Analysis, Discriminant Analysis, conjoint analysis, Correspondence Analysis

References

1) Gupta, S. C., & Kapoor, V. K. (2002). *Fundamental of Mathematical Statistics.* Sultan Chand & sons.

2) Joseph Hair, F., Willium Black, C., Barry Babin, J., & Rolph Anderson, E. (2010). *Multivariate Data Analysis, Seventh edition.* Pearson Prentice Hall.

3) Kothari, C. R. (2004). *Research methodology.* New Age International Publishers.

4) Levin, R. (2013). *Statistics for Management.* Prentice Hall India.

5) Medhi, J. (2006). *Statistical Methods: An Introductory Text.* New Age International(P) Limited, New delhi.

6) Montgomery, D. C. (2007). *Introduction to Linear Regression analysis.* John Willey & sons.

7) Mukhopadhyay, P. (2000). *Mathematical Statistics.* Books & Allied Pvt. Ltd.

8) Robert Kabacoff, I. (2015). *R in Action - Data Analysis and Graphics with R, second edition.* dreamtech Press.

9) Sudha Purohit, G., Sharad Gore, D., & Shailaja Deshmukh, R. (2008). *Statistics Using R.* Narosa Publishing House.

10) Mathematical Statistics by Irvin Millon Maryless Miler, 7th Ed. Pearson Publication.

B.Sc. Degree – Fourth Semester
BSCSTP 333 – Statistics Practical – V – Regression Analysis (1 credit)
List of Practical Assignments

1) Exercise on Correlation -1

2) Exercise on Correlation -2 (using MS-Excel)

3) Spearman's rank correlation coefficient.

4) Simple linear regression-1

5) Simple linear regression-2 (using MS-Excel),

6) Multiple linear regression -1

7) Multiple regression -2

8) Testing the significance of correlation coefficient and equality of correlation coefficients.

9) Testing the significance of regression coefficients. Coefficient of determination, Standard Error of Regression.

10) Fitting of quadratic curve and exponential curve by the method of least squares

Fifth semester B.Sc. (Paper VI)

BSCSTC 332 – OPERATIONS RESEARCH

(48 Lecture Hours)(2 Credits)

Rationale /Learning Objectives:

- Able to understand the concept of OR, phases of OR, LPP.
- Able to understand the concept of T.P. and A.P
- To understand the applications of different EOQ models
- To study the different types of replacement policies

<u>OUTCOMES</u>

- Students are able to construct LPP and solving through graphical, simplex method, big M method and Twophase method
- Able to understand the concept of Transportation problem and Assignment problems
- Learners are Familiar with Deterministic and problematic inventory models
- Students are able to use different EOQ models
- Learners are able to find the individual and group replacement policies

UNIT I   (14L)

Operations Research (OR): Origin, definition, phases of OR- types of models.

Linear Programming Problem (LPP): General model, formulation , graphical solution, and standard form of LPP. Simplex algorithm (without proof), Charne's big M method , Two phase method ,indication of unique solution, multiple solution, unbounded solution, no solution, dual LPP and its properties.

UNIT II   (6 L)

Transportation Problem: General description and Statement of T.P. , Balanced and unbalanced T.P. - initial solution by north west corner rule , matrix minima and Vogel's method, MODI method of optimization (without proof), degeneracy.

UNIT III (10 L)

Assignment Problem: General description and Statement of assignment problem , Hungarian method, maximization and minimization problems.

UNIT IV (15 L)

Inventory Theory: Basic concepts, deterministic models with instantaneous / finite production with / without shortages (derivations for continuous case), Models with one and two price breaks, stochastic model -single period problem. Newspaper boy problem

Replacement Model- Replacement of items which deteriorate with time (with and without cash discount), Individual Replacement and group replacement models.

References

1) Kalavathy, S. K.(2013). *Operations Research.* Vikas Publishing House Pvt. Ltd.
2) Kanthiswarup, Manmohan, & Guptha, P. K. (2002). *Operations Research.* Sulthan Chand & Co.
3) Sharma, S. D. (2009). *Operations Research.* Kedar Nath Ram Nath.
4) Taha, H. A. (2002). *Operations Research, An Introduction.* Mac Millan.

B.Sc. Degree – Fifth Semester
BSCSTP 334 – Statistics Practical – VI – Operations Research (1 credit)
List of Practical Assignments

1) Formulation of linear programming problem and its solution for two variables
2) Simplex method of solving linear programming problems.
3) Charne's Big M method of solving linear programming problems and Two phase method of solving.
4) Transportation problems.
5) Assignment problems.
6) Inventory problems(deterministic models)
7) Inventory problems (Stochastic model)
8) Replacement problems-1
9) Replacement problems-2

Sixth semester B.Sc. (Paper VII)

BSCSTC 381 – STATISTICAL INFERENCE II & DESIGN AND ANALYSIS OF EXPERIMENTS

(48 Lecture Hours)(2 Credits)

Rationale /Learning Objectives:

- To understand the concept of sequential testing and to test H_0 against H_1 using SPRTP.
- To study Nonparametric tests for various situations.
- To understand the analysis of different types of designs of experiment
- To describe the impact of randomization in the study of designs of experiment
- To Study the application of these designs in agricultural experiments.
- To study the different types of Factorial experiments and their applications.

OUTCOMES

- Students are able to use chi-square tests Nonparametric tests for various situations.
- Able to understand the concept of sequential testing and to test H_0 against H_1 using SPRTP.
- Learners are able to test the homogeneity of several means**,** treatment effects and effect of varieties
- Students gain knowledge on basics, principles of design of experiment
- Learners are able to prepare the lay out and carry out the analysis of CRD**,** RBD and LSD
- Able to carry out the analysis and compute main and interaction effects in 2^2 and 2^3
- factorial expt.

UNIT I (12 L)

Sequential testing: Need for sequential test. Wald's sequential probability ratio test (SPRT) Strength of sequential tests. Wald's SPRT applied to Bernoulli, Poisson and Normal distributions. Expressions to constants to be given without proof

Non-parametric tests: Advantages and limitations. Sign test for one sample problem and for pairs of observations. Two sample median test. Run test for randomness. Two sample run test. Null distribution of test statistic to be derived in each case, Large sample approximation to these tests.

UNIT II (12 L)

Analysis of variance: Meaning, basic assumptions, fixed effect model. Analysis of one way, two way and three way classified data with one observation per cell -mathematical model. Least square estimates, splitting of total sum of squares, expectation of sums of squares and mean sums of squares (under appropriate hypotheses) and ANOVA table**.**

UNIT III (12L)

Designs of experiments - Meaning and terminology - experiment, 'treatment, experimental unit, experimental error and precision. Basic Principles of experimental design, Randomisation, Replication, Local Control

CRD, RBD and LSD: Layout of model, splitting of Total variation into different components. least square estimates of effects, ANOVA tables, Multiple comparisons:, critical difference, advantages and limitations of each design

UNIT IV12 L)

Missing plot technique: Estimation of one or two missing observations in RBD and LSD (least square estimates). ANOVA in case of missing observations.

Factorial experiments: Meaning and advantages. 2^2 and, 2^3 factorial experiments in RBD and LSD, main and interaction effects. Yates' method of computing factorial effect totals, ANOVA table and inferences. Contrasts and orthogonal contrasts

References

1) Cochran, W. G., & Cox, G. M. (1959). *Experimental Designs.* Wiley Eastern.

2) Federer, W. T. (1963). *Experimental Designs.* Oxfotd & IBH Publishing Co. Giri & Das

3) Goon, A. M., Gupta, M. K., & Das Gupta, B. (1983). *Fundamentals of Statistics, Vol. II.* World Press, Calcutta.

4) Guptha, S. C., & Kapoor, V. K. (1984). *Fundamentals of Applied Statistics.* Sulthan Chand and Sons.

5) Mukhopadhyaya, P. (1999). *Applied Statistics.* Books and Allied Pvt. Ltd.

B.Sc. Degree Sixth Semester

BSCSTP 383– Statistics Practical – VII – Statistical Inference II & Design and Analysis of Experiments (1 credit)

List of Practical Assignments

1. Sequential probability ratio test.

2. Non-parametric inference

3. Exercise on Completely Randomised Design

4. Exercise on Randomised Block Design.

5. Exercise on Latin square Design.

6. Exercise on Missing observations

7. 2^2 Factorial experiment.

8. 2^3 Factorial experiment.

BSCSTC 382– APPLIED STATISTICS
(48 Lecture Hours) (2 Credits)

Rationale /Learning Objectives:

- To understand the concept of statistical quality control, the different types of charts.
- Study of different types of control limits, concepts of rational subgroups.
- Study of control chart for variables and attributes.
- To know the concept of Index numbers, methods of computation of Index numbers
- Study of vital statistics – methods of fertility and mortality
- To understand the Methods of measuring trend and seasonal variation.

OUTCOMES

- Able to construct control charts for variables and attributes
- Able to understand acceptance sampling plan.
- Able to understand the concept of Index numbers, methods of computation of Index numbers
- Able to compute measures of fertility and mortality
- Familiar with the methods of measuring trend and seasonal variations

UNIT I – Statistical Quality Control(11L)

Meaning of quality, quality characteristics - variables and attributes.Causes of variation - Assjgnable and Chance Causes, process control and product control. Control limits, specification limits, Natural tolerance limits, action limits, warning limits,Probability limits. General theory of control charts, Criteria for lack of Control, Selection of rational subgroups.

UNIT II (11L)

Control chart for variables: $\bar{x}$ - R charts, $\bar{x}$ - s charts, control limits with and without standard

values. Revised control charts. Construction and working of these charts,

Control chart for attributes: Need for attribute charts p, np, C and U charts, analysis and interpretation.

UNIT   III (11L)

Acceptance sampling   Plans: Single sample plan by attributes, P.R, C.R, AQL, LTPD. Derivation of AOQ, O.C. ATI functions and their graphs, AOQL and indiffence Quality. Construction of SSP. Given AQL, LTPD, P.R.C.R. -Double sampling plan,

 SSP by variables single specification, σ known and unknown plans. O.C. function Construction of these plans

UNIT IV - Index numbers(5L)

Introduction , Definition and Meaning, Points to be considered in construction of Index numbers, Simple and weighted price index numbers, Laspeyre's, Passche's and Fisher's Index numbers. Description of following index numbers - CPI, BSE, SENSEX

Demography (5 L)

Vital Statistics- Sources of vital statistics in India, functions of vital Statistics, rates and ratios, - Mortality rates- Crude, Age Specific and Standard Death rates - Fertility and reproduction rates, Crude birth rates general and specific fertility rates, gross and net reproductive rates, life – tables

Time Series(5 L)

Time Series: Meaning and Components of time series. Additive and multiplicative models. Methods of estimating trend : moving average method, least squares method and exponential smoothing method Elimination of trend using additive and multiplicative models Measurement and estimation of seasonal variations using Link Relative method and Ratio to trend method and ratio to moving average method

References

1) Douglas Montgomery, C. (2001). *Introduction to Statistical Quality Control.* Wiely & Sons.

2) Goon, A. M., Gupta, M. K., & Das Gupta, B. (1991). *Fundamentals of Statistics, Vol. 1.* World Press, Calcutta.

3) Grant, E. L., & Richard, S. L. (2001). *Statistical Quality Control.* Tata McGraw Ltd.

4) Gupta, S. C., & Kapoor, V. K. (2002). *Fundamental of Mathematical Statistics.* Sultan Chand & sons.

5) Guptha, S. C., & Kapoor, V. K. (1984). *Fundamentals of Applied Statistics.* Sulthan Chand and Sons.

6) Levin, R. (2013). *Statistics for Management.* Prentice Hall India.

7) Medhi, J. (2006). *Statistical Methods: An Introductory Text.* New Age International(P) Limited, New Delhi.

8) Mitra, A. (2001). *Fundamentals of Quality Control and Improvement.* Pearson education, Asia.

9) Mukhopadhyaya, P. (1999). *Applied Statistics.* Books and Allied Pvt. Ltd.

B.Sc. Degree Sixth Semester

BSCSTP 384– Statistics Practical – VIII – Applied Statistics(1 credit)

List of Practical Assignments

1) Exercise on $\bar{X}$ –R chart

2) Exercise on $\bar{X}$ –s chart

3) Control chart for attributes- p chart and np chart.

4) Control chart for attributes c chart and U chart.

5) Single sampling plan for attributes

6) Single sampling plan for variables.

7) Exercise on Index numbers

8) Exercise on vital statistics.

9) Exercise on Time Series. Graph of Time series data:

BSCSTCE 133: OFFICIAL STATISTICS   (24 L) (1 Credit)

Rationale /Learning Objectives:

- To know about CSO, SSO, NSSO
- To study Population Statistics, Income Statistics and Agricultural Statistics

OUTCOMES:

- Learners have knowledge on CSO, SSO, NSCO
- Students are familiar with Population Statistics, Income statistics and Agricultural statistics

UNIT I (08L)

Introduction: Introduction to Indian and International Statistical system. Role, function and activities of Central and State Statistical organization. National Sample Survey Organization (NSSO) - functions. Ministry of programe implementation and Statistics.

UNIT II (08L)

Population Statistics: Scope and content of Population census of India. Vital Statistics, methods of collecting population census, economic census.

Income Statistics: Uses, Methods of national income estimation, problems in the estimation of national income.

UNIT III (08L)

Agricultural Statistics: System of collection of Agricultural Statistics. . Crop yield, Random sampling method. Production Statistics, Traditional Method, Crop estimation and forecasting. Statistics related to industries, foreign trade, balance of payment, cost of living, inflation, educational and other social statistics.

References:

1. B. L. Agarwal (2003), Basic statistics, New age International Publishers

2. Guide to Official Statistics,Central Statistical Organisation, Department of Statistics, Ministry of Planning, Government of India, 1985 - India

3. Indian official statistical systems, M. R. Saluja, Statistical Pub. Society, 1972 - India

BSCSTCE 183: STATISTICAL ANALYSIS OF EXPERIMENTAL DATA

(24L) (1 Credit)

Rationale /Learning Objectives:

- To understand basic description of error analysis
- To study Normal distribution and its applications
- To study Regression analysis and examples
- To know about Monte Carlo techniques

OUTCOMES

- Students are able to understand basic description of error analysis
- Students have knowledge about Normal distribution and its applications
- Learners are familiar with Regression analysis, examples and Monte Carlo techniques

UNIT I - Preliminary description of error analysis (06L)

Introduction to measurements, measurement categories - Direct and derived quantities, errors in measurement, propagation of errors – sums and differences; products and quotients, independent errors in a sum, Nature of measurement errors-Systematic errors and random errors, Statistical analysis of random errors

UNIT II - Normal Distribution (06L)

Histograms and distributions, The normal distribution, confidence interval, justification of mean as the best estimate, standard deviation of mean, The problem of combining separate measurements, weighted average and examples

UNIT III - Regression Analysis (12L)

Bi-variate and Multivariate data, Correlation, Concept of Errors, Simple linear regression, interpretation of Regression coefficients, Principles of least squares, goodness of fit, multiple regression, non-linear regression, Examples using Excel

Monte Carlo techniques

Introduction, Random numbers, random number generation from probability distributions, specific distributions, Efficient Monte Carlo generation

References

1) John R Taylor (1996); An introduction to error analysis – The study of uncertainties in physical measurements, , University Science books, Sausalito, California

2) R Bevington, D Keith Robinson (2003): Data reduction and error analysis for the Physical sciences, Philip Third edition, Mc Graw Hill publications

3) Mechanical Measurement and Metrology, NPTEL online courses (https://nptel.ac.in/courses/112106138/8), course coordinated by IIT MADRAS

BSCSTCE 233: INTRODUCTION TO DATA SCIENCE AND BIG DATA ANALYTICS
(24L) (1 Credit)

Rationale /Learning Objectives:

- To expose the students to analyse the statistical data.

- Ability to understand, interpret, scale and transform data to extract more meaningful insights

OUTCOMES

- Students have ability to understand the data patterns

- Learners have ability to understand data collection and data wrangling methods,

- Able to implement statistical and machine learning techniques for variety of signals and industrial applications.

UNIT I - Introduction to Big data and Data Analytics (08L)

Business Intelligence, Decision Support Systems, Data Warehousing; Definition of Big Data, Big data characteristics & considerations.

Data Analytics Lifecycle

Need of Data analytic lifecycle, Key roles for successful analytic projects, various phases of Data analytic lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalization.

UNIT II - Exploring Data in R and Machine Learning (10L)

Basic features of R, Exploring R GUI, Data Frames & Lists, Handling Data in R Workspace, Reading Data Sets & Exporting Data from R, Manipulating & Processing Data in R

Machine Learning: Supervised Learning

What is Machine Learning? Applications of Machine Learning; Supervised Learning: Structure of Regression Model, Linear Regression, Logistics Regression

UNIT III - Classification & Unsupervised Learning (06L)

Classification: Classification Problem, Classification Models, Classification Trees, Bayesian Method; Association Rule: Structure of Association Rule, Apriori Algorithm, General Association; Clustering: Clustering Methods, Partition Methods, Hierarchical Methods.

References

1) Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (2015)

2) Shmueli, G., Patel, N. R., & Bruce, P. C. (2010): Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XL Miner

3) Y Lakshmi Prasad(2016) , Big Data Analytics made easy, Notion Press, Chennai

4) Seema Acharya & Subhashini Chellappan (2015): Big Data & Analytics , Wiley Publications

5) Carlo Vercellis (2009), Business Intelligence – Data Mining and Optimization for Decision Making - Wiley Publications

BSCSTOE 283: BASIC STATISTICS

Rationale /Learning Objectives:

- To understand types of data, measurement scales and classification of data
- To study Basic Probability Theory
- To know measures of location and variation
- To understand correlation and association of attributes

OUTCOMES

- Learners are able to understand types of data, measurement scales and classification of data
- Familiar with Basic Probability Theory
- Able to know measures of location and variation
- Able to understand correlation and association of attributes

UNIT I (08L)

Meaning and definition of Statistics. Collection of data, types of data – Primary data, Secondary data, Cross sectional data, longitudinal data. Measurement scales- nominal, interval and ratio. Types of data – qualitative and quantitative data - Classification of data

Elements of Probability Theory: Random experiments, Uncertainty, sample space, events, types of events, probability of an event, conditional probability, Bayes' Theorem.

UNIT II - Analysis of Univariate data: (08L)

Measures of location- Mean, Median, Mode, Geometric mean and Harmonic mean and partition values, Measures of variation- Range, Quartile deviation, Mean deviation Standard deviation Coefficient of variation – Skewness and kurtosis, Stem and leaf diagram, Box plot – its interpretation.

UNIT III (08L)

Analysis of Bivariate data: Correlation, types of correlation- Scatter diagram, Karl Pearson's method of computing correlation and its interpretation.

Association of Attributes: Class frequency, Inconsistency of data, consistency of data, coefficient of association and its interpretation.

References:

1. B. L. Agarwal (2003), Basic statistics, New age International Publishers
2. J Medhi (2006), Statistical Methods, New age International Publishers
3. S. C. Guptha (2016), Fundamentals of Statistics - Business statistics, Himalaya Publishing House
4. Levin R (2013), Statistics for Management, Prentice hall India

QUESTION PAPER PATTERN
DEPARTMENT OF STATISTICS
(Elective Paper)

Marks	No. of questions to be set	No. of questions to be answered	Total Marks
2	7	5	10
6	7	5	30
		Total:	**40**

<u>NOTE:</u>

1. At least two – two mark questions should be asked from each unit.
2. At least two – six mark questions should be asked from each unit.