(Bachelor of Science in Statistics) (Bachelor of Science)
(B. Sc.) (Statistics) Semester (VI)

Course Code	US06CSTA51	Title of the Course	SAMPLING DISTRIBUTIONS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To understand the concepts of sampling distributions and their applications in statistical inference 2. To learn bivariate normal distribution and its applications 3. To learn the concepts of order statistics applicable in understanding the concepts of non - parametric tests

Course Content		
Unit	Description	Weightage* (%)
1.	Sampling distributions: Distribution of function of one and two random variables. Distribution function technique, change of variable techniques, m.g.f and characteristic function techniques.	25
2.	Exact sampling distribution - I Chi – square distribution: Definition and derivation of pdf of χ^2 with n d.f. using m.g.f technique, nature of pdf curve for different degrees of freedom, mean, variance, m.g.f ,c.g.f., additive property and limiting form of χ^2 distribution.	25
3.	Exact sampling distribution – II: t – distribution: Student's t and Fisher's t – distribution, derivation of its pdf, nature of pdf curve with different degrees of freedom, mean, variance, moments and limiting form of t – distribution. F – distribution: Snedecor's F – distribution, derivation of pdf, nature of curve with different degrees of freedom, mean, variance. Distribution of ratio of F – distribution.	25

4.	Bivariate Normal distribution: Bivariate normal distribution as a particular case of multivariate normal distribution. Distribution of sample correlation coefficient r. Order statistics: Definition: distribution of r^{th} order statistics. Joint pdf of $r^{th}$and k^{th} order statistics. Distribution of sample range and sample median (for continuous distribution only)	25

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	derive probability distributions of functions of one and two variables using various techniques like m.g.f, distribution function and change of variable.
2.	derive probability distributions of various sampling distributions like chi square, t and F distributions applicable in understanding the concept of testing of hypotheses

Suggested References:	
Sr.	References

No.	
1.	Dudewic and Misra: Modern Mathematical Statistics, John Wiley & Sons.
2.	Gupta, S.C. and Kapoor, V.K.: Fundamentals of Mathematical Statistics, Sultan Chand and Sons
3	Mukhopadhyay, P.(2006): Mathematical Statistics, 3ed., Books abd Allied(P) Ltd.
4	Rohatgi, V.K. & A.K. Md.E. Saleh (2001): An Introduction to Probability and Statistics, John Wiley (2nd Edition)

On-line resources to be used if available as reference material
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(Bachelor of Science in Statistics) (Bachelor of Science)
(B. Sc.) (Statistics) Semester (VI)

Course Code	US06CSTA52	Title of the Course	TESTING OF HYPOTHESIS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	Hypothesis testing methods, including likelihood ratio tests, the Neyman – Pearson lemma and uniformly most powerful tests, power calculations, Bayesian approaches and non – parametric approaches.

Course Content		
Unit	Description	Weightage* (%)
1.	Principles of Test of significance: Null and alternative hypotheses (Simple and composite), Type – I and Type – II errors, critical region, level of significance, size and power, Best critical region, Most powerful (MP) test, Uniformly Most Powerful (UMP) Test, Neyman Pearson lemma (Statement and applications to construct most powerful test).	25
2.	Likelihood Ratio (LR) test, Properties of LR test (without proof). Applications of LR test (i) mean and variance of normal distribution (ii) equality of variances of two independent normal distributions	25
3.	Sequential Analysis: Sequential Probability Ratio Test (SPRT) for simple v/s simple hypotheses. Determination of stopping bounds B and A. OC and ASN functions of SPRT.	25
4.	Non - Parametric Tests: One sample and two sample sign test. Wald – Wolfwitz run test, Run test for randomness, Median test, Wilcoxon – Mann – Whitney test.	25

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	demonstrate the plausibility of pre – specified ideas about the parameters of the models by examining the area of hypothesis testing
2.	explain in detail and demonstrate the use of non – parametric statistical methods.

Suggested References:	
Sr. No.	References
1.	Ross, S.M.: Introduction to Probability and Statistics for Engineers and Scientists, Elsevier
2.	Dudewic and Misra: Modern Mathematical Statistics, John Wiley & Sons.
3	Hogg, R.V. and Craig, A.T. (1972): Introduction to Mathematical Statistics, Amerind Publishing Co.
4	Gupta, S.C. and Kapoor, V.K.: Fundamentals of Mathematical Statistics, Sultan

	Chand and Sons
5	Robert V. Hogg and Elliot Tanis : Probability and Statistical Inference, 8th edition

On-line resources to be used if available as reference material
On-line Resources

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(Bachelor of Science in Statistics) (Bachelor of Science)
(B. Sc.) (Statistics) Semester (VI)

Course Code	US06CSTA53	Title of the Course	DESIGN OF EXPERIMENTS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To learn how to plan, design and conduct experiments efficiently and effectively and analyze the data to obtain objective conclusions 2. Understanding the process of designing an experiments

Course Content		
Unit	Description	Weightage* (%)
1.	One Way Analysis of Variance and Completely Randomized Design (CRD) For fixed effect model one way classification – Purpose and Analysis with equal number of observations per cell using ANOVA technique. Concept of treatment, plot, block, yield, shapes and sizes of plots and blocks. Principles of experimental design: Randomization, Replication and Local Control. Complete Randomized Design (CRD) – Introduction, Layout, Statistical analysis and its merits and demerits.	25
2.	Two way Analysis of Variance and Randomized Block Design (RBD) Two way classification – Purpose and Analysis with equal number of observations per cell using ANOVA technique – Expected values of sum of squares for both one way and two way classifications. Randomized Block Design (RBD) – Introduction, layout, Statistical analysis and its merits and demerits. Estimation of one and two missing yields. Efficiency of RBD over CRD.	25
3.	Latin Square Design (LSD) : Introduction, layout, Statistical analysis and its merits and demerits.	25

	Estimation of one and two missing yields. Efficiency of LSD over RBD and CRD.	
4.	Factorial Experiments: Factorial experiments upto four factors each at two levels. Concept of confounding and their types. Confounding upto two interactions. Analysis of confounded factorial experiments.	25

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	appreciate the advantages and disadvantages of a design for a particular experiment
2.	construct optimal or good designs for a range of practical experiments
3.	understanding the potential practical problems in its implementation describe how the analysis of the data from the experiment should be carried out.

Suggested References:	
Sr. No.	References

1.	Das, M.N. & Giri, N.: Design of experiments (Wiley Eastern Ltd)
2.	Montogomery D.C. (1976): Design and Analysis of Experiments, John Wiley
3	Cochran W.G. & Cox G.M.: Experimental Designs, John Wiley
4	Mukhopadhyay P. (1999): Applied Statistics
5	Federer W.T. (1975): Experimental Designs – Theory and Application, Oxford & IBH.

On-line resources to be used if available as reference material
On-line Resources

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(Bachelor of Science in Statistics) (Bachelor of Science)
(B. Sc.) (Statistics) Semester (VI)

Course Code	US06CSTA54	Title of the Course	OPERATIONS RESEARCH
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To impart knowledge in concepts and tools of Operations Research 2. To formulate verbal problem into mathematical form 3. To understand mathematical tools that are needed to solve optimization problems used in Operations Research 4. To apply techniques constructively to make effective business decisions.

Course Content		
Unit	Description	Weightage* (%)
1.	Linear Programming Problem (LPP), Mathematical formulation of LPP, Graphical solutions of a LPP. Simplex method for solving LPP. Special cases of LPP. Concept of duality in LPP, Dual simplex method.	25
2.	Transportation Problem (TP): Initial solution by North – West corner rule, Least cost method and Vogel's approximation method (VAM), Modi's method to find the optimum solution, special cases of transportation problem. Assignment Problem: Hungarian method to find optimal assignment, special cases of assignment problem.	25
3.	Game Theory: Rectangular game, minimax – maximin principle, solutions to rectangular game using graphical method, dominance property to reduce the game matrix and solution to rectangular game with mixed strategy.	25
4.	PERT and CPM: Project planning with PERT and CPM: Drawing of Project network, critical path identification, slack time and float. Calculation of probability of completing project within a specified	25

	time.	

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	solve Linear Programming problems
2.	solve Transportation and Assignment Problems
3.	understand the usage of game theory and network analysis.

Suggested References:	
Sr. No.	References
1.	KantiSwarup, Gupta R.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.
2.	Taha, H.A. (2007): Operations Research: An Introduction, Prentice Hall of India.

3	Heardly, G. (1962): Linear Programming

On-line resources to be used if available as reference material
On-line Resources

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((Bachelor of Science in Statistics) (Bachelor of Science)
(B. Sc.) (Statistics) Semester (VI)

Course Code	US06DSTA55	Title of the Course	PRACTICAL: STATISTICAL DATA ANALYSIS USING R PROGRAMMING
Total Credits of the Course	08	Hours per Week	16

Course Objectives:	This course introduces the statistical computing language R (open source and free software) for under graduate students with no prior background in R or programming. At the end of the course, a student should acquire ability to write codes in R to perform univariate and bivariate data analysis according to statistical methods.

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction to R: R as a Statistical Software and language, R preliminaries, methods of data input, Data accessing or indexing, Data frames and lists, Functions, Graphics with R, Saving, storing and retrieving work, work space and files, using scripts, using packages. Descriptive Statistics Using R: Diagrammatic and graphical representation of data, Measures of central tendency, dispersion, skewness and kurtosis, selection of representative samples.	25
2.	Probability and Probability distributions using R: Probability : definition and properties, probability distributions, some special discrete distributions (Binomial, Poisson), Continuous probability distributions, some special distributions (Normal, Exponential) Methods for generating random variables: Introduction, Random generation of common probability distribution in R, the inverse method, the acceptance and rejection methods, transformation methods	25
3.	Correlation and Regression analysis using R: Correlation, correlation coefficient, Linear Regression, inference procedure for simple linear model, validation of linear regression model. Monte Carlo estimation	25

	and standard error. Estimation of MSE, estimating a confidence interval, Monte Carlo methods for hypothesis test, Empirical type – I error, Power of a test, Comparison of powers of two tests	
4.	Statistical Inference using R: Sampling distribution of the sample mean, Estimation of parameters, plots to check normality, Hypothesis testing, Goodness of fit, One way and Two way ANOVA.	25

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	understand the basic concepts such as data type and index and use them in their work
2.	demonstrate the use of basic functions
3.	create their own customized functions
4	construct tables and graphs for descriptive statistics
5	import, review, manipulate and summarize data sets in R
6	explore data sets to create testable hypotheses and identify appropriate statistical tests

7	perform appropriate statistical test using R
8	create and edit visualization with R.

Suggested References:	
Sr. No.	References
1.	Chambers J.M. (1998) : Programming with Data: A guide to S language, Springer
2.	Statistics Using R – Purohit, S.G., et al. (2008), Narosa Publishing House
3	Statistical Computing with R – Rizzo, M.L. (2007), Chapman & Hall / CRC

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