Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the S.Y.B.Sc.

Program: B.Sc. STATISTICS

Program Code: RJSUSTA

(CBCS 2021-2022)

DISTRIBUTION OF TOPICS AND CREDITS

S.Y.B.Sc. STATISTICS SEMESTER III

Course	Nomenclature	Credits	Topics
RJSUSTA301	Probability Distributions	02	1. Univariate Random Variables (Discrete and Continuous) 2. Standard Discrete Probability Distributions 3. Bivariate Probability Distributions
RJSUSTA302	Theory Of Sampling	02	4. Concepts of Sampling and Simple Random Sampling 5. Stratified Sampling 6. Ratio and Regression Estimation
RJSUSTA303	Operations Research-1	02	7. Linear Programming Problem (L.P.P) 8. Transportation problem 9. Assignment Problem
RJSUSTAP301 RJSUSTAP302 RJSUSTAP303	Practical based on RJSUSTA301, RJSUSTA302 and RJSUSTA303	03	

S.Y.B.Sc. STATISTICS SEMESTER IV

Course	Nomenclature	Credits	Topics
RJSUSTA401	Probability & Sampling Distributions	02	1. Standard Continuous Probability Distributions 2. Normal Distribution 3. Exact Sampling Distributions
RJSUSTA402	Analysis Of Variance & Design Of Experiments	02	4. Analysis of Variance 5. Design of Experiments 6. Factorial Experiment.
RJSUSTA403	Operations Research-2	02	7. CPM – PERT 8. Game Theory 9. Decision Theory
RJSUSTAP401 RJSUSTAP402 RJSUSTAP403	Practical based on RJSUSTA401, RJSUSTA402 and RJSUSTA403	03	

SEMESTER III (THEORY)		L	Cr
Paper-I: Probability Distributions	**Paper Code: RJSUSTA301**	45	2
UNIT I		15	
UNIVARIATE RANDOM VARIABLES (DISCRETE AND CONTINUOUS)			
1	Moment Generating Function(M.G.F.): Definition Properties: - Effect of change of origin and scale, - M.G.F of sum of two independent random variables X and Y - Extension of this property for n independent random variables and for i.i.d. random variables. All above properties with proof, - Uniqueness Property without proof. - Raw moments using M.G.F: using expansion method and using derivative method.		
2	Cumulant generating Function(C.G.F.): Definition Properties: - Effect of change of origin and scale, - Additive Property of C.G.F. Both properties with proof. Obtaining Cumulants using C.G.F. Derivation of relationship between moments and cumulants upto order four. Characteristic Function- Definition and properties (without Proof) Examples of obtaining raw moments and central moments up to order four using M.G.F. and C.G.F. for continuous and discrete distributions.		
3	Degenerate Distribution (One point distribution) P (X = c) = 1 Mean, Variance. Discrete Uniform distribution Mean, Variance, coefficient of skewness using m.g.f.		

	Bernoulli distribution Mean, Variance, coefficient of skewness using m.g.f. Binomial distribution Mean, Variance, Measures of skewness and Kurtosis based on moments using M.G.F. and C.G.F., Nature of probability distribution with change in the value of parameter , Mode, Additive property. Distribution of n-X where X~ Bin(n,p). Recurrence relation for moments with proof: $\mu'_{r+1} = npq\,\mu'_r + pq\,\frac{d}{dp}\,\mu'_r$ $\mu_{r+1} = pq\,[\,nr\,\mu_r + \frac{d}{dp}\,\mu_r\,]$ Fitting of Binomial Distribution. Relation between Bernoulli and Binomial using m.g.f.		
	UNIT II	15	
	STANDARD DISCRETE PROBABILITY DISTRIBUTIONS		
1	Poisson distribution Mean, Variance, Measures of skewness and Kurtosis based on moments using M.G.F.and C.G.F., Nature of probability distribution with change in the value of parameter, Mode, Additive property. Recurrence relation for moments with proof for μ'_{r+1} & μ_{r+1} If X and Y are two independent Poisson variables Conditional distribution of X given X+Y (with proof). Poisson distribution as limiting distribution of Binomial (with proof) Real life examples of Binomial, Poisson distribution. Fitting of Poisson Distribution.		
2	Geometric Distribution Definition in terms of No. of failures and No. of trials. Mean, Variance. M.G.F., Mean and Variance using M.G.F., C.G.F., Mean, Variance, μ_3, μ_4 using C.G.F. Coefficients of skewness and Kurtosis and Nature of probability distribution with change in the value of parameter. Property of Lack of Memory (with proof). If X and Y are two i.i.d. Geometric variables; Conditional distribution of X given X+Y(with proof).		

	Distribution of k i.i.d. Geometric variables. Negative Binomial Distribution Definition, Mean, Variance. M.G.F., Mean and Variance using M.G.F. , C.G.F., Mean, Variance, μ_3, μ_4 using C.G.F., Coefficients of skewness and Kurtosis and Nature of probability distribution with change in the value of parameter. Recurrence relation for probabilities, Fitting of distribution Limiting distribution of Negative Binomial distribution (with proof).		
3	Hypergeometric distribution Definition, Mean, Variance, Limiting distribution of Hypergeometric distribution. If X and Y are two independent Binomial variables Conditional distribution of X given X+Y. Truncated distribution Definition: Truncated Binomial and Truncated Poisson Distribution: (truncated at 0), probability mass function, mean and variance. Real life situations of Geometric, Negative Binomial, Hypergeometric distributions.		
	UNIT III	15	
	BIVARIATE PROBABILITY DISTRIBUTIONS		
1	Two dimensional Discrete random variables -Joint Probability mass function and its properties. -Distribution function of (X, Y) and its properties. -Definition of raw and central moments, covariance, correlation coefficient, Independence and correlation between two variables -Marginal and conditional probability distributions -Conditional expectation, conditional variance.		
2	Continuous bivariate random variables -Joint Probability density function and its properties - Distribution function of (X, Y) and its properties -Definition of raw and central moments, covariance, correlation coefficient, Independence and correlation between two variables -Marginal and conditional probability distributions -Conditional expectation, conditional variance -Regression Function.		

S.Y.B.SC	Semester III Theory
RJSUSTA301 Paper I Probability Distributions	Course Outcomes3.1: Students will acquire 1. knowledge to obtain raw moments and central moments using m.g.f and c.g.f. 2. knowledge related to concept of discrete random variable and its probability distribution including expectation and moments. 3. knowledge of the importance of discrete distributions such as Binomial, Poisson, Geometric, Negative Binomial and Hypergeometric and their interrelations if any. Learning outcomes: This course will provide the students with a knowledge of ➢ understanding the patterns in the of data of large populations. ➢ central location and dispersion of the data. ➢ the relationship between various distributions.

SEMESTER III (THEORY)		**L**	**Cr**
Paper-II: Theory Of Sampling	**Paper Code: RJSUSTA302**	45	2
UNIT I		15	
CONCEPTS OF SAMPLING AND SIMPLE RANDOM SAMPLING			
1	Concept of sampling: Population, Population unit, Sample, Sample unit, Parameter, Statistic, Estimator, Bias, Unbiased Estimator, Mean square error & Standard error. Census Survey, Sample Survey. Steps in conducting sample surveys with examples on designing appropriate Questionnaires. Concepts of Sampling and Non-sampling errors. NSSO, CSO and their functions. Concepts and methods of Probability and Non-Probability Sampling.		
2	Simple Random Sampling (SRS): Definition, Sampling with & without replacement (WR/WOR). Lottery method & use of Random numbers to select simple random samples. Estimation of population mean & total. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators.(WR/WOR). Estimation of population proportion. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators (WR/WOR). Estimation of sample size based on a desired accuracy in case of SRS for variables & attributes (WR/WOR).		
UNIT II		15	
STRATIFIED SAMPLING			
1	Concepts : Need for Stratification of population with suitable examples. Definition of Stratified Sample. Advantages of Stratified Sampling.		
2	Stratified Random Sampling : Estimation of population Mean and Total in case of Stratified Random Sampling (WOR within each strata). Expectation and		

	Variance of the unbiased estimators, Unbiased estimators of variances of these estimators. Proportional allocation, Optimum allocation with and without varying costs. Comparison of Simple Random Sampling, Stratified Random Sampling using Proportional allocation and Neyman allocation.		
	UNIT III	15	
	RATIO AND REGRESSION ESTIMATION		
1	Ratio & Regression Estimation Method assuming SRSWOR: Ratio Estimators for population Ratio, Mean and Total. Expectation & MSE of the Estimators. Estimators of MSE. Uses of Ratio Estimator. Regression Estimators for population Mean and Total. Expectation and Variance of the Estimators assuming known value of regression coefficient 'b'. Estimation of 'b'. Resulting variance of the estimators. Uses of regression Estimator. Comparison of Ratio, Regression & mean per unit estimators.		
2	Introduction to different methods of sampling: Introduction to Systematic sampling, Cluster sampling and Two stage sampling with suitable illustrations.		

S.Y.B.SC	Semester III Theory
RJSUSTA302 Paper II Theory of Sampling	Course Outcomes 3.2 : The students shall get 1. basic knowledge of complete enumeration and sample, sampling frame, sampling distribution, sampling and non-sampling errors, principal steps in sample surveys, limitations of sampling etc. 2. an idea of conducting the sample surveys and selecting appropriate sampling techniques. 3. introduced to various statistical sampling schemes such as simple, stratified, systematic and cluster sampling, two stage sampling. 4. knowledge about comparing various sampling techniques. Learning outcomes: This course will help the students ➢ to understand various sampling techniques. ➢ to apply these techniques in real life situations. ➢ to compare various sampling techniques.

SEMESTER III (THEORY)		L	Cr
Paper-III: Operations Research-1	**Paper Code: RJSUSTA303**	45	2
UNIT I		15	
LINEAR PROGRAMMING PROBLEM (L.P.P)			
1	Mathematical Formulation: Maximization & Minimization. Concepts of Solution, Feasible Solution, Basic Feasible Solution, Optimal Solution.		
2	Graphical Solution for problems with two variables. Simplex method of solving problems with two or more variables. Big M method. Concept of duality. Its use in solving L.P.P. Relationship between optimum solutions to Primal and dual. Economic interpretation of Dual.		
UNIT II		15	
TRANSPORTATION PROBLEM			
1	Concept, Mathematical Formulation. Concepts of Solution, Feasible Solution. Initial Basic Feasible Solution by North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method.		
2	Optimal solution by MODI Method. Optimality test, Improvement procedure. Variants in Transportation Problem: Unbalanced, Maximization type.		
UNIT III		15	
ASSIGNMENT PROBLEM			
1	Concept. Mathematical Formulation. Solution by: Complete Enumeration Method and Hungarian method. Variants in Assignment Problem: Unbalanced, Maximization type. Travelling Salesman Problem.		
2	Introduction to different methods of sampling. Sequencing: Processing n Jobs through 2 and 3 Machines & 2 Jobs through m Machines.		

S.Y.B.SC	Semester III Theory
RJSUSTA303 Paper III Operations Research-1	Course Outcomes3.3: Students are able 1. to convert the word problem with mathematical form. 2. to explain and solve Linear programming problems using graphical, simplex method, dual simplex method for finding degenerate, unbounded, alternate and infeasible solutions. 3. to understand basic concepts of Complete Enumeration Method, IBFS by NWCM, MMM and VAM, and MODI method for solving problems. 4. to use Hungarian method to solve Assignment to obtain optimum solution. To understand and solve the Travelling Salesman Problem. 5. to understand and solve the Sequencing Problem to complete n jobs on 2 machines or 3 machines and also 2 jobs on n machines. Learning outcomes: This course will help the students ➢ to learn mathematical formulation of real life situations. ➢ to solve the formulated problems and to reach optimum solutions. ➢ to learn the applications of Operations research in industry.

SEMESTER IV (THEORY)		**L**	**Cr**
Paper-I: Probability And Sampling Distributions	**Paper Code: RJSUSTA401**	45	2
UNIT I		15	
STANDARD CONTINUOUS PROBABILITY DISTRIBUTIONS			
1	Rectangular or Continuous Uniform over (a,b). Mean, Median Standard deviation, C.D.F., M.G.F., Mean, variance, μ_3 using M.G.F., skewness of distribution. For X following U (0,1), distribution of i) $\frac{X}{1+X}$, ii) $\frac{X}{1-X}$ Triangular distribution over(a,b) with peak at c -M.G.F. Exponential Distribution (Single parameter) Definition, M.G.F.,C.G.F. raw moments and central moments upto order four using M.G.F..and C.G.F. - Measures of Skewness and Kurtosis ,Nature of Probability curve - Median and Quartiles, -Forgetfulness Property with proof and examples based on it. -Distribution of ratio of two i.i.d. Exponential variables. -Distribution of X+Y and $\frac{X}{X+Y}$,for two independent Exponential variables X and Y with mean(1). (All with proof.)		
2	Cauchy (with location and scale parameter) -Properties without proof Gamma (with scale and shape parameter) Expression for r th raw moment. Mean, Mode & Standard deviation. M.G.F., Additive property, C.G.F. raw moments and central moments upto order four using M.G.F. and C.G.F. Coefficient of skewness and kurtosis and nature of probability curve. Distribution of sum of independent Exponential variables. Beta Distribution: Type I & Type II Expression for r th raw moment, Mean, Mode Standard deviation. If a r.v. X follows Beta of type 1, distribution of 1- X.		

	If a r.v. X follows Beta of type 2, distribution of i) $\frac{1}{1+X}$, ii)$\frac{X}{1+X}$ (with proof). For two independent Gamma variables X and Y with parameters m and n respectively, distribution of U = $\frac{X}{Y}$ and V= $\frac{X}{X+Y}$ (with proof).		
	UNIT II	15	
	NORMAL DISTRIBUTION		
1	Definition, Derivation of Mean, Median, Mode, Standard deviation, M.G.F , C.G.F., Moments & Cumulants (up to fourth order). skewness & kurtosis, Nature of Normal curve, Mean absolute deviation. Properties of Normal Distribution. Expression for even order central moments and to show that odd order central moments zero.		
2	Distribution of Standard Normal Variable Distribution of linear function of independent Normal variables (i) aX, (ii) X+b, (iii) aX+bY in particular X+Y and X-Y, (iv) aX+bY+c (all with proof) Fitting of Normal Distribution. Central Limit theorem for i.i.d. random variables.(only statement) Log Normal Distribution: Derivation of mean & variance.		
	UNIT III	15	
	EXACT SAMPLING DISTRIBUTION		
1	<u>Chi-Square Distribution:</u> Derivation of p.d.f. Mean, Mode & Standard deviation. M.G.F.,C.G.F., Measures of skewness and kurtosis, Additive property Distribution of ratio two independent Chi-square variables Distribution of $\frac{X}{X+Y}$ if X and Y two independent Chi-square variables (All with proof). Distribution of the sum of squares of independent Standard Normal variables. Sampling distributions of sample mean and sample		

	variance and their independence for a sample drawn from Normal distribution (without proof). Applications of Chi-Square: Development of decision criterion with test procedures of (i)Test of significance for specified value of variance of a Normal population (ii)Test for goodness of fit		
2	Test Procedure for independence of attributes. (i) rxc contingency table, (ii) 2x2 contingency table, Derivation of test statistic, Yates' correction with proof Derivation of Confidence interval for the variance of a Normal population when (i) mean is known, (ii) mean is unknown. Student t-distribution: Derivation of p.d.f., Mean, variance, r^{th} order raw moment, Mean Deviation, Measures of skewness and Kurtosis and Additive property. Limiting distribution of t distribution with proof.		
3	Applications of t distribution: Development of decision criterion with test procedure of Test of significance for specified value of mean of Normal population. Test procedure of test of significance for difference between means of (i) two independent Normal populations with equal variances (ii) dependent samples (Paired t test) Derivation of Confidence intervals for (i) mean of Normal population, (ii) difference between means of two independent Normal populations having the same variance. Snedecor's F-distribution: Derivation of p.d.f. , Expression for r^{th} raw moment, Mean, Mode & Standard deviation Distribution of Reciprocal of F variable with proof. Applications of F distribution:		

	Test procedure for testing equality of variances of two independent Normal populations i. Mean is known ii. Mean is unknown Derivation of confidence interval for ratio of variances of two independent Normal populations.		

S.Y.B.SC	Semester IV Theory
RJSUSTA401 Probability and Sampling distributions	Course Outcomes 4.1 : This is a course designed to provide the students 1. the knowledge to obtain the raw moments and central moments using m.g.f and c.g.f. 2. the ability to handle transformed random variables and derive associated distributions. 3. the knowledge of important continuous distributions such as Uniform, Normal, Exponential and Gamma and relations with some other distributions. Learning outcomes: The course will provide the students with knowledge of ➢ understanding the patterns in the data of large populations. ➢ important continuous distributions such as Uniform, Normal, Exponential and Gamma and relations with some other distributions. ➢ ability to understand how t- test and Chi square test are used in real life situations.

SEMESTER IV (THEORY)		L	Cr
Paper-II: Analysis Of Variance & Design Of Experiments	**Paper Code: RJSUSTA402**	45	2
UNIT I		15	
ANALYSIS OF VARIANCE			
1	Introduction, Uses, Cochran's Theorem (Statement only). One way classification with equal & unequal observations per class, Two-way classification with one observation per cell.		
2	Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard Error and Confidence limits for elementary treatment contrasts.		
UNIT II		15	
DESIGNS OF EXPERIMENTS			
1	Introduction: Concepts of Experiments, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision. Principles of Designs of Experiments: Replication, Randomization & Local Control. Efficiency of design D1 with respect to design D2. Choice of size, shape of plots and blocks in agricultural & non agricultural experiments.		
2	Completely Randomized Design (CRD) and Randomized Block Design (RBD) Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of RBD relative to CRD.		

UNIT III		15	
FACTORIAL EXPERIMENTS			
1	Latin Square Design Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of the design relative to RBD, CRD. Missing plot technique for one missing observation in case of CRD, RBD and LSD.		
2	Factorial Experiments Definition, Purpose & Advantages. 2^2, 2^3 Experiments. Calculation of Main & interaction Effects. Definition of contrast and orthogonal contrast, Yates' method. Analysis of 2^2 & 2^3 factorial Experiments.		

S.Y.B.SC	Semester IV Theory
RJSUSTA402 Paper II Analysis of Variance and Design of Experiments	Course Outcomes4.2 : The students shall get exposed to 1. carry out one way and two- way Analysis of Variance with real life data. 2. understand the basic terms used in the design of experiments. 3. use appropriate experimental designs to analyze the experimental data. 4. analyze 2^2 and 2^3 factorial experiments. Learning outcomes: Students will acquire knowledge ➢ to apply the techniques and methodology available to design and analyze the data. ➢ to compare one way ANOVA and Two way ANOVA.

	➢ to interpret the conclusion based on ANOVA table.

SEMESTER IV (THEORY)		**L**	**Cr**
Paper-III: Operations Research-2	**Paper Code: RJSUSTA403**	45	2
UNIT I		15	
CPM AND PERT			
1	Objective and Outline of the techniques. Diagrammatic representation of activities in a project: Gantt Chart and Network Diagram. Slack time and Float times. Determination of Critical path.		
2	Probability consideration in project scheduling. Project cost analysis. Updating.		
UNIT II		15	
GAME THEORY			
1	Definitions of Two persons Zero Sum Game, Saddle Point, Value of the Game, Pure and Mixed strategy, Maximin principle, Minimax principle, Optimal solution of two person zero sum games. Dominance property.		
2	Derivation of formulae for (2×2) game. Graphical solution of (2×n) and (m×2) games, Reduction of game theory to LPP.		
UNIT III		15	
DECISION THEORY			
1	Decision making under uncertainty: Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwitz α criterion, Minimax Regret criterion.		
2	Decision making under risk: Expected Monetary Value criterion, Expected Opportunity Loss criterion, EPPI, EVPI. Bayesian Decision rule for Posterior analysis. Decision tree analysis along with Posterior probabilities.		

S.Y.B.SC	Semester IV Theory
RJSUSTA403 Paper III Operations Research-2	Course Outcomes 4.3: The students shall get exposed 1. to diagrammatic representation of activities in a project, to calculate Slack time and Float times and obtain Critical path. 2. to know about the probability associated with project schedule, project cost and updating the project. 3. to game theory, minimax-maximin rules, graphical solution of mx2 or 2xn rectangular game and mixed strategy. 4. to decision making problems under uncertainty as well as under risk. Also to solve these problems with the help of various criteria of optimality. Learning outcomes: Students will acquire knowledge ➢ to plan, schedule and control projects, analyse project cost and update the project. ➢ to convert a competitive situation in real life into a game and obtain the best strategies to optimise results. ➢ to make the decisions under certainty or at the risk and optimise outcomes of the business. ➢ to learn the applications of Operations research in industry.

Semester III (PRACTICALS)			L	Cr
Practical-I: Probability Distributions		**Paper Code: RJSUSTAP301**		1
1	Moment Generating Function, Moments			
2	Cumulant generating Function, Cumulants, Characteristic function			
3	Standard Discrete Distributions			
4	Fitting Standard Discrete Distributions			
5	Bivariate Probability Distributions, Marginal & Conditional distributions, Conditional Mean, Conditional Variance, Correlation			
6	Transformation of discrete & continuous random variables			
Practical-II: Theory Of Sampling		**Paper Code: RJSUSTAP302**		1
1	Designing a Questionnaire			
2	Simple Random Sampling for Variables			
3	Simple Random Sampling for Attributes			
4	Estimation of Sample Size in Simple Random Sampling			
5	Stratified Random Sampling			
6	Ratio and Regression Estimation			
Practical-III: Operations Research-1		**Paper Code: RJSUSTAP303**		1
1	Formulation and Graphical Solution of L.P.P			
2	Simplex Method			

3	Duality		
4	Transportation Problems		
5	Assignment Problems		
6	Sequencing Problems		

S.Y.B.Sc	Semester III (Practical)
RJSUSTAP301 Practical - I Probability Distributions	Course Outcomes Students will acquire 1. ability to distinguish between random and non-random experiments. 2. knowledge related to the concept of discrete random variable and its probability distribution including expectation and moments. 3. knowledge of important discrete distributions such as Binomial, Poisson, Geometric, Negative Binomial and Hypergeometric and their interrelations if any. Learning outcomes: Students will acquire knowledge ➢ to understand the patterns in the of data of large populations ➢ to obtain the central location and dispersion of the data ➢ to know the relationship between various distributions

S.Y.B.Sc	Semester III (Practical)
RJSUSTAP302 Practical II Theory Of Sampling	Course Outcomes 3.2: The students are able to 1. estimate the mean, variance, population mean square , etc. with real life data under SRSWR and SRSWOR for variable and attribute. 2. estimation of sample size in case of variable and attribute. 3. estimate the population mean, population total and also find the estimate of standard error. Also compute 95% confidence interval for population mean and population total in case of stratified random sampling. 4. estimate the population total and its estimate of standard error. Learning outcomes: Students will acquire knowledge ➢ to understand various sampling techniques ➢ to apply these techniques in real life situations. ➢ comparison of sampling techniques

S.Y.B.Sc	Semester III (Practical)
RJSUSTAP303 Practical III Operations Research-1	Course Outcomes 3.3 : Students are able to 1. solve Linear programming problem using simplex method, dual simplex method 2. solve Assignment and transportation problems to obtain optimum solution. 3. understand basic concepts of Complete Enumeration Method and Hungarian method and methods of solving game problems. Learning outcomes: Students will acquire knowledge ➢ to convert real life situations into mathematical formulation. ➢ to study methods to solve the formulated problems. ➢ to learn the application of Operations research in industry.

Semester IV (PRACTICALS)			L	Cr
Practical-I: Probability And Sampling Distributions		**Paper Code: RJSUSTAP401**		1
1	Standard Continuous distribution			
2	Normal distribution			
3	Central Limit Theorem			
4	Chi Square Distribution			
5	t Distribution			
6	F Distribution			
Practical-II: Analysis Of Variance & Design Of Experiments		**Paper Code: RJSUSTAP402**		1
1	Analysis Of Variance- One Way Classification			
2	Analysis Of Variance- Two Way Classification			
3	Completely Randomized Design			
4	Randomized Block Design			
5	Latin Square Design			
6	Missing Observation in CRD, RBD, and LSD			
7	Factorial Experiment			
Practical-III: Operations Research-2		**Paper Code: RJSUSTAP403**		1
1	CPM-PERT : 1			
2	CPM-PERT : 2			

3	CPM-PERT : 3		
4	Game Theory		
5	Decision Theory : 1		
6	Decision Theory : 2		

S.Y.B.Sc	Practicals Semester IV
RJSUSTAP401 Practical I Probability And Sampling Distributions	Course Outcomes: This is a course designed to provide the students 1. ability to handle transformed random variables and derive associated distributions. 2. knowledge of important continuous distributions such as Uniform, Normal, Exponential and Gamma and relations with some other distributions. Learning outcomes: Students will acquire ➢ knowledge of understanding the patterns in the data of large populations ➢ knowledge to obtain the central location and dispersion of the data ➢ knowledge of the relationship between various distributions.

S.Y.B.SC	Practicals Semester IV
RJSUSTAP402 Practical II Analysis Of Variance & Design Of Experiments	Course Outcomes : The students will be in a position to 1. carry out one way and two way Analysis of Variance. 2. understand the basic terms used in the design of experiments. 3. use appropriate experimental designs to analyze the experimental data. 4. perform and analyze 2^2 and 2^3 factorial experiments. Learning outcomes: Students will acquire ➢ To introduce and apply the techniques and methodology available for designing and analysis of experiments. ➢ To emphasize the need for sound and unambiguous interpretation of experimentation.

S.Y.B.SC	Practicals Semester IV
RJSUSTAP403 Practical III Operations Research- 2	Course Outcomes: The students shall get exposed to 1. graphical and simplex method of solving linear programming problem (LPP) for finding degenerate, unbounded, alternate and infeasible solutions. Use of duality to solve a LPP. 2. obtaining solution of a transportation problem by North West corner method, Matrix Minima method, Vogel's method. 3. Hungarian Method for solving assignment problems. 4. game theory, minimax-maximin rules, graphical solution of mx2 or 2xn rectangular game and mixed strategy. Learning outcomes: Students will acquire knowledge ➢ to plan, schedule and control the given projects, analyze project cost and update the project. ➢ to convert a given competitive situation in real life into a game and obtain the best strategies to optimize results. ➢ to make the decisions under certainty or at the risk and optimize outcomes of given problems. ➢ to learn the applications of Operations research in industry.

References

1. Introduction to the theory of statistics: A. M. Mood, F.A. Graybill, D. C. Boyes, Third Edition; McGraw-Hill Book Company.
2. Introduction to Mathematical Statistics: R.V.Hogg, A.T. Craig; Fourth Edition; Collier McMillan Publishers.
3. Probability and Statistical Inference: R.V.Hogg, E. A.Tannis, Third Edition; Collier McMillan Publishers.
4. John E. Freund's Mathematical Statistics: I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.
5. Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.
6. Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.
7. Mathematical Statistics: J.N. Kapur, H.C. Saxena; Fifteenth Edition; S. Chand & Company Ltd.
8. Statistical Methods: An Introductory Text: J. Medhi; Second edition; Wiley Eastern Ltd.
9. An outline of statistical theory Vol. I: A.M Goon, M. K. Gupta, B. Das Gupta: Third Edition: The World Press Pvt. Ltd.
10. Sampling Techniques: W.G. Cochran; 3rd Edition; Wiley(1978)
11. Sampling Theory and methods: M.N. Murthy; Statistical Publishing Society. (1967)
12. Sampling Theory: Des Raj; McGraw Hill Series in Probability and Statistics. (1968).
13. Sampling Theory of Surveys with Applications: P.V. Sukhatme and B.V. Sukhatme; 3rd Edition; Iowa State University Press (1984).
14. Fundamentals of Applied Statistics: S. C. Gupta and V.K. Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
15. Theory and Analysis of Sample Survey Designs: Daroga Singh, F.S.Chaudhary, Wiley Eastern Ltd. (1986).
16. Sampling Theory and Methods: S. Sampath, Second Edition (2005),Narosa.
17. Theory and Methods of Survey Sampling: Parimal Mukhopadhyay, (1998), Prentice Hall Of India Pvt. Ltd.
18. Operations Research: Kantiswaroop and Manmohan Gupta. 4th Edition; S Chand & Sons.
19. Schaum Series book in O.R. Richard Broson. 2nd edition Tata Mcgraw Hill Publishing Company Ltd.
20. Operations Research: Methods and Problems: Maurice Sasieni, Arthur Yaspan and Lawrence Friedman, (1959), John Wiley & Sons.
21. Mathematical Models in Operations Research : J K Sharma, (1989), Tata McGraw Hill Publishing Company Ltd.
22. Operations Research: S.D.Sharma.11th edition, Kedar Nath Ram Nath & Company.

23. Operations Research: H. A.Taha.6th edition, Prentice Hall of India.
24. Quantitative Techniques For Managerial Decisions: J.K.Sharma , (2001), MacMillan India Ltd.
25. Principles of Operations Research with Applications to Management Decisions: Harvey M. Wagner, 2nd Edition, Prentice Hall of India Ltd.

Scheme of Examinations

1. Two Internals of 20 marks each. Duration 30 min for each.
2. One External (Semester End Examination) of 60 marks. Duration: 2 hours.
3. One Practical at the end of Semester consisting of practical I-50 marks, Practical II-50 marks and Practical III-50 but passing combined out of 150.
4. Minimum marks for passing Semester End Theory and Practical Exam is 40 %.
5. Students must appear for at least one of the two Internal Tests to be eligible for the Semester End Examination.
6. For any KT examinations, there shall be ODD-ODD/EVEN-EVEN pattern followed.
7. A candidate will be allowed to appear for the practical examinations if he/she submits a certified journal of S.Y.B.Sc. STATISTICS or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of S.Y.B.Sc. STATISTICS as per the minimum requirements.
8. In case of loss of journal, a candidate must produce a certificate from the Head of the department /Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal will not be granted.
9. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

Evaluation and Assessment

Evaluation (Theory): Total marks per course - 100.

CIA- 40 marks

CIA 1: Written test -20 marks

CIA 2: Written Test / Assignment -20 marks

Semester End Examination – 60 marks

Question paper covering all units

Evaluation of Practicals 150 marks in Semester III and IV (50 marks for each practical RJSUSTAP301, RJSUSTAP302 & RJSUSTAP303 AND RJSUSTAP401 , RJSUSTAP402 & RJSUSTAP403)

Course Semester End Examination in Semester III and IV (RJSUSTA301, RJSUSTA302 & RJSUSTA303 AND RJSUSTA401, RJSUSTA402 & RJSUSTA403).

Question	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
Unit 1	10	05	05	20
Unit 2	10	05	05	20
Unit 3	10	05	05	20
-TOTAL- Per objective	30	15	15	**60**
% WEIGHTAGE	50	25	25	**100%**

Continuous Evaluation of components which require adequate duration for completion of the task, observation and interpretation: 25%

Course end Practical Evaluation of skills of students in terms of skill, analysis, interpretation and conclusion.

Mapping of the course to employability/ Entrepreneurship/skill development

Class	Course Name	Course Code	Topic focusing on Employability/ Entrepreneurship/skill development	Employability/Entrepreneurship/Skill development	Specific activity
S Y B Sc STATISTICS	Probability Distributions and Probability and Sampling distribution	RJSUSTA301 RJSUSTA401	Unit 1. Univariate Random Variables. (Discrete and Continuous) Unit 2. Standard Discrete Probability Distributions. Unit 3. Bivariate Probability Distributions. Unit 1. Standard Continuous Probability Distributions Unit 2. Normal Distribution Unit 3. Exact Sampling Distributions	1. Employability in the field of NSSO, WHO, FAO 2. Critical thinking 3. Problem solving abilities 4. Decision making skills	Designing a questionnaire and data collection.
	Theory of Sampling, and Analysis of Variance and Design of Experiments	RJSUSTA302 RJSUSTA402	Unit 1- Concepts of Sampling and Simple Random Sampling Unit 2- Stratified Sampling Unit 3 -Ratio and Regression Estimation Unit 1- Analysis Of Variance Unit 2 - Design Of Experiments Unit 3 - Factorial Experiment	5. Employability in the field of NSSO, WHO, FAO 6. Employability in the field of Agriculture 7. Problem solving abilities 8. Decision making skills	

S Y B Sc STATISTICS	Operations Research-1 and Operations Research-2	RJSUSTA303 RJSUSTA403	Unit 1. LPP Unit 2. Transportation Problem Unit 3. Assignment Problem Unit 1. PERT CPM Unit 2. Game Theory Unit 3. Decision Theory	1. Employability in the field of Quality Control. 2. Critical thinking 3. Problem solving abilities 4. Decision making skills	Data collection based on a game played (For eg. Stone-Paper-Scissor) and verification of the results.
S Y B Sc STATISTICS	Practicals	RJSUSTAP301 RJSUSTAP302 RJSUSTAP303 RJSUSTAP401 RJSUSTAP402 RJSUSTAP402	Practical based on above topics	1. Analytical skills 2. Interpretation skills 3. Writing skills	