Resolution No.: **AC/II(23-24).2.RUS11**

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for

Program: S.Y.B.Sc./S.Y.B.A.(Minor)

Program Code: (STATISTICS) RUSSTA/RUASTA

(As per the guidelines of National Education Policy 2020-
Academic year 2024-25)

(Choice based Credit System)

GRADUATE ATTRIBUTES

S. P. Mandali's Ramnarain Ruia Autonomous College has adopted the Outcome Based Education model to make its science graduates globally competent and capable of advancing in their careers. The Bachelors Program in Science also encourages students to reflect on the broader purpose of their education.

	Graduate Attributes Description **A student completing Bachelor's Degree in Science program will be able to:**
GA 1	Recall and explain acquired scientific knowledge in a comprehensive manner and apply the skills acquired in their chosen discipline. Interpret scientific ideas and relate its interconnectedness to various fields in science.
GA 2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
GA 3	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
GA 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
GA 5	Take complex challenges, work responsibly and independently, as well as in cohesion with a team for completion of a task. Communicate effectively, convincingly and in an articulate manner.
GA 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
GA 7	Follow ethical practices at work place and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
GA 8	Keep abreast with current scientific developments in the specific discipline and adapt to technological advancements for better application of scientific knowledge as a lifelong learner.

PROGRAM OUTCOMES

PO	Description **A student completing Bachelor's Degree in Science program in the subject of Statistics will be able to:**
PO 1	Understand, condense, visualize, analyze and interpret various data types generated in various scenarios of scientific, industrial, or social problems
PO 2	Apply Statistical tools for data analysis.
PO 3	Pursue their higher education programs leading to post-graduate and/or doctoral degrees in Statistics, Data Science, Business Analytics, Biostatistics, Econometrics, Management Studies.
PO 4	Compete globally to enter into promising careers.
PO 5	Make a pathway to a range of traditional avenues in Academia and Industry, Govt. Service, IAS, Indian Statistical/ Economic Services, Industries, Commerce, Investment Banking, Banks and Insurance Sectors, CSO and NSSO, Research Personnel/Investigator in Govt. organizations such as NCAER, IAMR, ICMR, Statistical and Economic Bureau & various PSUs., Market Research, Actuarial Sciences, Biostatistics, Demography etc.
PO 6	Seek employment or self-employment in different sectors like Stock trading, Pharmaceutical sector, Sports, Politics, Business, Financial services and Media Industry.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
SYBSc	III	DSC1	PROBABILITY DISTRIBUTIONS AND HYPOTHESIS TESTING	3
SYBSc/ SYBA	III	DSC2/Minor	THEORY OF SAMPLING	3
SYBSc	III	DSC Practical I	Practical based on DSC1	1
SYBSc	III	DSC Practical II	Practical based on DSC 2/Minor	1
SYBSc	IV	DSC1	PROBABILITY AND SAMPLING DISTRIBUTIONS	3
SYBSc/ SYBA	IV	DSC2/Minor	ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS	3
SYBSc	IV	DSC Practical I	Practical based on DSC1	1
SYBSc/ SYBA	IV	DSC Practical II/Minor	Practical based on DSC 2	1

CREDIT STRUCTURE BSc

Semester	Subject 1		Subject 2	GE/ OE course (Across disciplines)	Vocational and Skill Enhancement Course (VSC) & SEC	Ability Enhancement Course/ VEC/IKS	OJT/FP/CEPCC, RP	Total Credits
	DSC	DSE						
3	Major 8		Minor 4	2	VSC-2	AEC-2 MIL	FP-2, CC-2	22
4	Major 8		Minor 4	2	SEC-2	AEC-2 MIL	CEP-2, CC-2	22
Total	16		8	4	4	4	8	44

Exit option: award of UG Diploma in Major with 88 credits and an additional 4 credit Core NSQF course/ Internship or Continue with Major and Minor

Course Code: RUSMJSTAO201

Course Title: PROBABILITY DISTRIBUTIONS AND HYPOTHESIS TESTING

Type of Course: Discipline Specific Core Course 1

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION At the end of this course students will be able to
CO 1	Identify and analyse various Standard Discrete Distributions, including their Moment Generating Functions (MGF) and Cumulative Generating Functions (CGF), to model discrete random variables and solve related problems.
CO 2	Understand the properties and characteristics of Continuous Random Variables, including distributions such as Rectangular and Exponential distributions, and apply them to model continuous phenomena and solve relevant problems.
CO 3	Explore Bivariate Continuous Distributions and their applications in modelling relationships between two continuous random variables, and analyse scenarios using bivariate distribution techniques.
CO 4	Apply statistical hypothesis testing methodologies, including concepts like null hypothesis, alternative hypothesis, p-values, significance levels, and types of errors.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Hours
	Unit I	**Some Standard Discrete Distributions with MGF and CGF** • Univariate Random Variables (Discrete and Continuous): Moment Generating Function, Cumulant generating Function-Their important properties. Relationship between moments and cumulants and their uses Standard Discrete Probability Distributions:	**1/15**

		• Uniform, Bernoulli, Binomial, Poisson, Geometric, Negative Binomial & Hypergeometric distributions. • The following aspects of the above distributions (wherever applicable) to be discussed: Mean, Mode and Standard deviation, Moment Generating Function, Cumulant Generating Function, Additive property, Recurrence relation for central Moments, Skewness and Kurtosis (without proof), Limiting distribution, Fitting of distribution	
	Unit II	**Continuous random variable, Bivariate Continuous distribution, Rectangular, Exponential** • Concept of Continuous random variable and properties of its probability distribution • Probability density function and cumulative distribution function. • Their graphical representation. Standard Continuous Probability Distributions: • Rectangular, Exponential, Gamma (with Single & Double parameter), Beta (Type I & Type II). • The following aspects of the above distributions (wherever applicable) to be discussed: Mean, Median, Mode & Standard deviation, Moment Generating Function, Additive property, Cumulant Generating Function. Skewness and Kurtosis (without proof). Interrelation between the distributions. Fitting of distribution	**1/15**
	Unit III	**Testing of hypothesis** • Point and Interval estimate of single mean, single proportion from sample of large size. • Statistical tests: Concept of hypothesis, Null and Alternative Hypothesis, Types of Errors, Critical region, Level of significance, Power	**1/15**

Practical

Distribution of topics for Practical

Course Code: RUSMJSTAPO201	
Sr. No.	**Practical based on course**
1	Standard Discrete Distributions

2	Fitting Standard Discrete Distributions.
3	Standard Continuous Distributions
4	Bivariate Probability Distributions
5	Testing of Hypothesis
6	Applications of R.

REFERENCES:

1. A. M. Mood, F.A. Graybill, D. C. Boyes, Third Edition; McGraw-Hill Book Company. Introduction to the theory of statistics
2. R.V. Hogg, A.T. Craig; Fourth Edition; Collier McMillan Publishers: Introduction to Mathematical Statistics
3. R.V. Hogg, E. A. Tannis, Third Edition; Collier McMillan Publishers: Probability and Statistical Inference
4. I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.: John E. Freund's Mathematical Statistics
5. P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.: Introduction to Mathematical Statistics
6. S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.: Fundamentals of Mathematical Statistics
7. J.N. Kapur, H.C. Saxena; Fifteenth Edition; S. Chand & Company Ltd.: Mathematical Statistics
8. J. Medhi; Second edition; Wiley Eastern Ltd.: Statistical Methods: An Introductory Text
9. A.M. Goon, M.K. Gupta, B. DasGupta; Third Edition; The World Press Pvt. Ltd.: An Outline of Statistical Theory Vol. 1

Course Code: RUSMJSTAO202/ RUSMISTAO202 / RUAMISTAO201

Course Title: THEORY OF SAMPLING

Type of Course: Discipline Specific Core Course 2/Minor

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Understand the importance and use of sampling and its various methods.
CO 2	Calculate population parameters using Simple Random Sampling, Stratified Sampling, and Systematic Sampling techniques.
CO 3	Differentiate between types of probability sampling methods.
CO 4	Apply Ratio and Regression methods of estimation to incorporate auxiliary information into surveys.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Hours
	Unit I	**SRSWOR, SRSWR** • Concepts: Population, Population unit, Sample, Sample unit, Parameter, Statistic, Estimator, Bias, Unbiasedness, Mean square error & Standard error. • Census survey, Sample Survey. Steps in conducting a sample survey. Concepts of Sampling and Non-sampling errors. • Concepts and methods of Probability and Non-Probability sampling. Simple Random Sampling (SRS): • Description of Simple Random Sampling with & without replacement. • Lottery method & use of Random numbers to select Simple random sample. • Estimation of population mean & total. Expectation & Variance of the estimators,	1/15

		Unbiased estimator of variance of these estimators. • Estimation of population proportion. Expectation & Variance of the estimators, • Unbiased estimator of variance of these estimators. • Estimation of Sample size based on a desired accuracy in case of SRS for variables & attributes.	
	Unit II	**Stratified Random Sampling** • Need for Stratification of population with suitable examples. Description of Stratified Random Sample. • Advantages of stratified random Sampling. Stratified Random Sampling: • Estimation of population mean & total in case of Stratified Random Sampling (WOR within each stratum). Expectation & Variance of the unbiased estimators, Unbiased estimators of variances of these estimators. • Equal Allocation, Proportional allocation, Optimum allocation with and without varying costs. • Comparison of Simple Random Sampling, Stratified Random Sampling using • Proportional allocation & Neyman allocation	**1/15**
	Unit III	**Ratio and Regression Estimators, Systematic sampling** • Ratio & Regression Estimation assuming SRSWOR: • Ratio Estimators for population Ratio, Mean & Total. Expectation & MSE of the Estimators. Estimators of MSE. Uses of Ratio Estimator. • Regression Estimators for population Mean & Total. Expectation & 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. • Systematic sampling: Estimator of Population Mean and its Variance. Comparison of Systematic Sampling with Simple Random sampling • Introduction to Cluster sampling & Two Stage sampling with suitable illustrations	**1/15**

Practical

Distribution of topics for Practical

Course Code: RUSMJSTAPO202/ RUSMJSTAPO202 / RUAMISTAPO201	
Sr. No.	**Practical based on course**
1	Designing of 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 Estimation- Regression Estimation.

REFERENCES:

1. W.G. Cochran; 3rd Edition; Wiley (1978): Sampling Techniques
2. M. N. Murthy; Statistical Publishing Society. (1967): Sampling Theory and methods
3. Des Raj; McGraw Hill Series in Probability and Statistics. (1968): Sampling Theory
4. P.V. Sukhatme and B.V. Sukhatme; 3rd Edition; Iowa State University Press (1984): Sampling Theory of Surveys with Applications
5. S. C. Gupta and V.K. Kapoor; 3rd Edition; Sultan Chand and Sons (2001): Fundamentals of Applied Statistics
6. Daroga Singh, F.S.Chaudhary, Wiley Eastern Ltd. (1986): Theory and Analysis of Sample Survey Designs:
7. S. Sampath, Second Edition (2005), Narosa: Sampling Theory and Methods
8. Parimal Mukhopadhyay, (1998), Prentice Hall Of India Pvt. Ltd.: Theory and Methods of Survey Sampling

Course Code: RUSMJSTAE211

Course Title: PROBABILITY AND SAMPLING DISTRIBUTIONS

Type of Course: Discipline Specific Core Course 1

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Know different types of Standard Continuous Probability Distributions and their importance.
CO 2	Differentiate between various Standard Continuous Probability Distributions and use their properties for solving various problems.
CO 3	Implement Exact Sampling distribution methods.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Hours
	Unit I	**Normal Distribution** • Mean, Median, Mode, Standard deviation, Moment Generating function, Cumulant Generating function, Moments & Cumulants (up to fourth order). Recurrence relation for central moments, skewness & kurtosis, Mean absolute deviation. Distribution of linear function of independent Normal variables. Fitting of Normal Distribution. • Central Limit theorem for i.i.d. random variables. • Log Normal Distribution: Derivation of mean & variance. • Large sample tests for testing specified value of population mean For testing specified value in difference of two means For testing specified value of population proportion For	**1/15**

		testing specified value of difference of population proportion Concept of p-value	
	Unit II	**Chi-Square distribution** • Concept of degrees of freedom. Mean, Median, Mode & Standard deviation. Moment generating function, Cumulant generating function. Additive property, 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: Test of significance for specified value of variance of a Normal population. Test for goodness of fit & Test for independence of attributes (derivation of test statistics is not expected).	**1/15**
	Unit III	**t and F distributions** • Mean, Median, Mode & Standard deviation. Derivation of t distribution using Fisher's t. Student's t. Asymptotic properties. • Applications of t: Confidence interval for: Mean of Normal population, difference between means of two independent Normal populations having the same variance. Test of significance of: mean of a Normal population, difference in means of two Normal populations (based on: (i) independent samples with equal variances. (Effect Size, Cohen's d) (ii) dependent samples). • F-distribution: Mean, Mode & Standard deviation. Distribution of: reciprocal of an F variate, Ratio of two independent Chi-squares divided by their respective degrees of freedom. Interrelationship of F with: t-distribution, Chi-square distribution & Normal distribution. • Applications of F: Test for equality of variances of two independent Normal populations.	**1/15**

Practical

Distribution of topics for Practical

Course Code: RUSMJSTAPE211	
Sr. No.	**Practical based on course**
1	Standard Continuous distributions.
2	Normal Distribution
3	Central Limit Theorem
4	Chi Square distribution
5	t distribution
6	F distribution
7	Practical using Excel, R software

REFERENCES:

1. A M Mood, F.A. Graybill, D C Boyes; Third Edition; McGraw-Hill Book Company.: Introduction to the theory of statistics
2. R.V.Hogg, A.T. Craig; Fourth Edition; Collier McMillan Publishers.: Introduction to Mathematical Statistics
3. R.V.Hogg, E. A.Tannis, Third Edition; Collier McMillan Publishers.: Probability and Statistical Inference
4. I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.: John E. Freund's Mathematical Statistics
5. P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.: Introduction to Mathematical Statistics
6. S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.: Fundamentals of Mathematical Statistics
7. J.N. Kapur, H.C. Saxena; Fifteenth Edition; S. Chand & Company Ltd.: Mathematical Statistics
8. J. Medhi; Second edition; Wiley Eastern Ltd.: Statistical Methods- An Introductory Text
9. A.M. Goon, M.K. Gupta, B. DasGupta; Third Edition; The World Press Pvt. Ltd.: An Outline of Statistical Theory Vol. 1

Course Code: RUSMJSTAE212/ RUSMISTAE212

Course Title: ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS

Type of Course: Discipline Specific Core Course 2

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Explain and illustrate the analysis of one-way and two-way classification.
CO 2	Define key concepts in Experimental Design, outline the principles of experimental design, and enumerate various types of experimental designs.
CO 3	Examine Completely Randomized Designs (CRD), Randomized Block Designs (RBD), and Least Significant Difference (LSD) using Analysis of Variance (ANOVA).
CO 4	Create factorial experiments, analyze their results, and grasp the concept of confounding.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Hours
	Unit I	**ANOVA One way and Two-way classified data** • Analysis of Variance: • Introduction, Uses, Cochran's Theorem (Statement only). • One-way classification with equal & unequal observations per class, • Two-way classification with one observation per cell. • For both the cases: Mathematical Model, Assumptions, Expectation of various sums of squares, F- test, Analysis of variance table. Least square estimators of the parameters, Expectation and Variance of the estimators, Estimation of linear contrasts, Standard Error	**1/15**

		and Confidence limits Testing for significance of elementary linear contrasts.	
	Unit II	**Design Of Experiments- CRD and RBD** • Design Of Experiments: • Concepts of Experiments, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision. • Principles of Design of Experiments: Replication, Randomization & Local Control. • Efficiency of design D1 with respect to design D2. • Choice of size, shape of plots & blocks in agricultural & non-agricultural experiments. • Completely Randomized Design (CRD) & 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 linear contrasts, Standard Error and Confidence limits Testing for significance of elementary linear contrasts. Efficiency of RBD relative to CRD. • Missing plot technique for one missing observation in case of CRD, RBD	**1/15**
	Unit III	**Latin Square Design and Factorial experiments** • 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 LSD. • Factorial Experiments: Definition, Purpose & Advantages. 2^2, 2^3 Experiments. • Calculation of Main & interaction Effects. Yates' method. Analysis of 2^2 & 2^3 factorial Experiments. • Concept of Confounding. (partial and total)	**1/15**

Practical

Distribution of topics for Practical

Course Code: RUSMJSTAPE212/ RUSMISTAPE212/ RUAMISTAPE211	
Sr. No.	**Practical based on course**
1	Analysis of Variance- One Way
2	Analysis of Variance- Two Way
3	Completely Randomized Design
4	Randomized Block Design
5	Latin Square Design.
6	Missing Observations in Designs of Experiments
7	Factorial Experiments
8	Practical using Excel and R software

REFERENCES:

1. W.G. Cochran and G.M.Cox; Second Edition;John Wiley and Sons.: Experimental Designs
2. Oscar Kempthorne, John Wiley and Sons.: The Design and Analysis of Experiments
3. Douglas C Montgomery; 6th Edition;John Wiley & Sons.: Design and Analysis of Experiments
4. M.N.Das and N.C.Giri, 2nd Edition; New Age International (P) Limited; 1986: Design and Analysis of Experiments
5. Walter T Federer; Oxford & IBH Publishing Co. Pvt. Ltd.: Experimental Design, Theory and Application
6. S.C.Gupta and V.K.Kapoor; 3rd Edition; Sultan Chand and Sons (2001): Fundamentals of Applied Statistics
7. B.J. Winer, McGraw Hill Book Company.: Statistical Principles in Experimental Design

Modality of Assessment: Discipline Specific Core Course 1 and 2 and Minor (3 Credit Theory Course for BSc)

A) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	Class Test	20
2	Class Test/ Project / Assignment / Presentation	10
	TOTAL	**30**

B) External Examination (Semester End)- 60%- 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **One hour 30 Minutes**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
1	Any 2 out of 3 subparts	15	Unit I
2	Any 2 out of 3 subparts	15	Unit II
3	Any 2 out of 3 subparts	15	Unit III
	TOTAL	**45**	

C) Practical Examination Pattern (Per Semester)

Practical Examination …….. **25 Marks (20+5)**

Journal and attendance …… **5 Marks**

At the end of the semester, examination of **1 hour** duration.

Pattern of **Practical question** paper at the end of the semester for **the course**:

1. Paper will consist of **two questions** and Learners will attempt **one question**.

Sub-Questions	Marks	Questions on
1	8	Unit I
2	6	Unit II
3	6	Unit III
Total	**20**	

PRACTICAL JOURNAL(5 marks)

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will **not be allowed to appear for the examination. The journals will be certified if the student attends 75% practicals.**

In case of loss of Journal and/or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In charge of the department; failing which the student will not be allowed to appear for the practical examination.

****