Resolution No.: AC/I(19-20).2.RUA14

S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Syllabus for: T.Y.B.Sc.

Program: B.A.

Course Code: Statistics (RUASTA)

(Choice Based Credit System (CBCS) with effect from academic year 2018-19)

Objective of Course

In the second year, there will be three courses in Statistics per semester. The following are the objectives of these courses:

1. To enable learners with the concepts of probability distributions and its applications.
2. To equip learners with methods of sampling and designs of experiments
3. To use different sampling techniques and designs of experiments in various real life situations.
4. To equip learners with requisite optimization techniques that they can employ.
5. To understand statistical quality control techniques and its applications using mathematical methods and their graphical representation.

Learning Outcomes

1. Learners will be able to choose and apply appropriate statistical techniques to solve problems in different fields.

2. Learners will be able to use statistical tools to solve problems from different fields.

3. Student will be able to engage in interpretation of wide range of information from variety of disciplines including quantitative analysis.

4. Learners will be able to use optimization techniques in real life situation

5. Learners will be able to employ statistical quality control techniques in various fields.

SEMESTER V

Title of the course	PROBABILITY DISTRIBUTIONS			
Course Code	**UNIT**	**TOPICS**	**Credits**	**L / Week**
RUASTA501	I	Univariate Random Variables. (Discrete and Continuous)	3	1
	II	Standard Discrete Probability Distributions.		1
	III	Bivariate Probability Distributions		1
Title of the course	**THEORY OF SAMPLING**			
RUASTA502	I	Concepts of Sampling and Simple Random Sampling	3	1
	II	Stratified Sampling		1
	III	Ratio and Regression Estimation		1
Title of the course	**APPLIED STATISTICS-I**			
RUASTA503	I	Mortality tables	2.5	1
	II	Compound interest and annuities certain		1
	III	Life annuities and assurance benefits		1
RUASTAP501	Practical based on courses RUASTA501, RUASTA502 & RUASTA503		3	9

SEMESTER V

Course Code RUASTA501: PROBABILITY DISTRIBUTIONS

Unit I : <u>Univariate Random Variables (Discrete and Continuous):</u> Moment Generating Function, Cumulant generating Function-Their important properties. Relationship between moments and cumulants and their uses. Characteristic Function- Its properties (without proof). Transformation of random Variable	**15 Lectures**
Unit II :<u>Standard Discrete Probability Distributions:</u> 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.	**15 Lectures**
Unit III : <u>Bivariate Probability Distributions:</u> Joint Probability mass function for Discrete random variables**,** Joint Probability density function for continuous random variables. Their properties. Marginal and conditional Distributions. Independence of Random Variables. Conditional Expectation & Variance. Regression Function. Coefficient of Correlation. Transformation of Random Variables and Jacobian of transformation with illustrations.	**15 Lectures**

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: RUASTA502: THEORY OF SAMPLING

Unit I : 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, 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.	15 Lectures
Unit II : Stratified 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	15 Lectures
Unit III : **a. 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. **b.** 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.	15 Lectures

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: Course Code RUASTA503: ELEMENTS OF ACTUARIAL SCIENCE:

Unit I : MORTALITY TABLES: • Various mortality functions. Probabilities of living and dying. • The force of mortality. Estimation of μ_x from the mortality table. • Central Mortality Rate. Laws of mortality: Gompertz's and Makeham's first law. Select, Ultimate and Aggregate mortality tables. Stationary population. Expectation of life and Average life at death. (Ref.2,3)	**15 Lectures**
Unit II: COMPOUND INTEREST AND ANNUITIES CERTAIN: • Accumulated value and present value, nominal and effective rates of interest. • Varying rates of interest. Equation of value. Equated time of payment. • Present and accumulated values of annuity certain (immediate and due) with and without deferment period. • Present value for perpetuity (immediate and due) with and without deferment Period. • Present and accumulated values of (i) increasing annuity (ii) increasing annuity when successive installments form i) arithmetic progression ii)Geometric progression • (iii) annuity with Frequency different from that with which interest is convertible. Redemption of loan. (Ref.2)	**15 Lectures**

Unit III: LIFE ANNUITIES AND ASSURANCE BENEFITS:	**15 Lectures**
• Present value in terms of commutation functions of Life annuities and Temporary life annuities (immediate and due) with and without deferment period. • Present values of Variable, increasing life annuities and increasing Temporary life annuities (immediate and due). • Present value of Assurance benefits in terms of commutation functions of : (i) pure endowment assurance (ii) temporary assurance (iii) endowment assurance (iv) whole life assurance (v) special endowment assurance (vi) deferred temporary assurance • Net premiums: Net level annual premiums (including limited period of payment) for various assurance plans. • Office premiums. • Double Endowment (Ref:1,2)	

REFERENCES:

1. Kantiswaroop and Manmohan Gupta. 4th Edition; S Chand & Sons: Operations Research
2. Richard Broson. 2nd edition Tata Mcgraw Hill Publishing Company Ltd.: Schaum Series book in O.R.
3. Methods and Problems: Maurice Sasieni, Arthur Yaspan and Lawrence Friedman, (1959), John Wiley & Sons.: Operations Research
4. J K Sharma, (1989), Tata McGraw Hill Publishing Company Ltd.: Mathematical Models in Operations Research
5. Harvey M. Wagner, 2nd Edition, Prentice Hall of India Ltd.: Principles of Operations Research with Applications to Management Decisions
6. S.D.Sharma.11th edition, Kedar Nath Ram Nath & Company.: Operations Research
7. H. A.Taha.6th edition, Prentice Hall of India.: Operations Research
8. J.K.Sharma, (2001), MacMillan India Ltd.: Quantitative Techniques For Managerial Decisions

DISTRIBUTION OF TOPICS FOR PRACTICALS
SEMESTER-III
COURSE CODE RUSSTAP301

Sr. No.	**RUSSTAP501(A)**
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.
7	Applications of R.

Sr. No.	**RUSSTAP501(B)**
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.
7	Systematic Sampling

Sr. No.	**RUSSTAP501(C)**
5.4.1	Mortality tables 1
5.4.2	Mortality tables 2
5.4.3	Annuities 1
5.4.4	Annuities 2
5.4.5	Life annuities
5.4.6	Assurance benefits

SEMESTER VI

Title of course	PROBABILITY AND SAMPLING DISTRIBUTIONS			
Course code	**UNIT**	**TOPICS**	**Credits**	**L / Week**
RUASTA601	I	Standard Continuous Probability Distributions	3	1
	II	Normal Distribution.		1
	III	Exact Sampling Distributions.		1
Title of course	**ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS**			
RUASTA602	I	Analysis of Variance.	3	1
	II	Design Of Experiments, Completely Randomized design & Randomized Block Design		1
	III	Latin Square Design & Factorial Experiments		1
Title of course	**APPLIED STATISTICS-II**			
RUASTA603	I	Linear Regression	2.5	1
	II	Simulation		1
	III	Decision Theory and Game Theory		1
RUSSTAP601	Practicals Based on the above Courses		3	9

Semester IV
Course Code RUSSTA401: PROBABILITY AND SAMPLING DISTRIBUTIONS

Unit I : <u>Standard Continuous Probability Distributions:</u> Rectangular, Triangular, 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. **<u>Normal Distribution:</u>** 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.	**15 Lectures**
Unit II : <u>Chi-Square Distribution:</u> 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). **<u>Applications of Chi-Square:</u>** 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)	**15 Lectures**

Unit III: <u>t-distribution:</u> Mean, Median, Mode & Standard deviation. Derivation of t Distribution using Fisher's t. Student's t. Asymptotic properties. **<u>Applications of t:</u>** 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). **<u>F-distribution:</u>** 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. **<u>Applications of F:</u>** Test for equality of variances of two independent Normal populations.	**15 Lectures**

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 RUSSTA402: ANALYSIS OF VARIANCE & DESIGNS OF EXPERIMENTS

Unit I : 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 and Confidence limits Testing for significance of elementary linear contrasts.	**15 Lectures**
Unit II : 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 D_1 with respect to design D_2. • 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 a CRD.	**15 Lectures**

Unit III : Latin Square Design (LSD): • 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 & 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)**	**15 Lectures**

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

Course Code RUASTA603: APPLIED STATISTICS-II

Unit I: LINEAR REGRESSION I
• Linear regression model with one or more explanatory variables. Assumptions of the model, Derivation of Ordinary Least Square (OLS) estimators of regression coefficients, (for one and two explanatory variables models). Properties of least square estimators (without proof). Coefficient of determination R^2 and adjusted R^2.
• Procedure of testing :
  •Overall significance of the model
  •Significance of individual coefficients
• Significance of incremental contribution of explanatory variable for two explanatory variables model.
• Confidence intervals for the regression coefficients.
• Multiple Linear Regression with Qualitative Independent Variable.
• Autocorrelation, Multicollinearity, Heteroscedasticity : Concept Only
(Ref: 8,9)
	15 Lectures

Unit II : SIMULATION • Scope of simulation applications. Types of simulation. Monte Carlo Technique of Simulation. Bootstrapping. • Elements of discrete event simulation. • Generation of random numbers. Sampling from probability distribution. Inverse method. Generation of random observations from i) Uniform distribution ii) Exponential distribution iii) Gamma distribution iv) Normal distribution. • Applications of Simulation techniques to real life situation. (Ref.4,5)	**15 Lectures**
Unit III : GAME THEORY: Definitions of Two-person Zero Sum Game, Saddle Point, Value of the Game, Pure and Mixed strategy. Optimal solution of two person zero sum games. Dominance property, Derivation of formulae for (2x2) game. Graphical solution of (2xn) and (mx2) games. Solution to Game using Linear Programming Approach. **DECISION THEORY** • Decision making under uncertainty: Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwicz α criterion, Minimax Regret criterion. • Decision making under risk: Expected Monetary Value criterion, Expected Opportunity Loss criterion, EPPI, EVPI. Bayesian Decision rule for Posterior analysis. • Decision tree analysis. (Ref. 1)	**15 Lectures**

REFERENCES:

1. E.L. Grant. (2nd edition) McGraw Hill, 1988.: Statistical Quality Control
2. Duncan. (3rd edition) D. Taraporewala sons & company.: Quality Control and Industrial Statistics
3. Bertrand L. Hansen, (1973), Prentice Hall of India Pvt. Ltd.: Quality Control: Theory and Applications
4. Douglas Montgomery, Arizona State University. John Wiley & Sons, Inc. (6^{th} Edition): Statistical Quality Control
5. Gupta S.C., Kapoor V.K., Fundamentals of Applied Statistics, Sultan Chand &Sons
6. Srinath. 2nd edition, East-west press Pvt. Ltd.: PERT and CPM, Principles and Applications
7. Kantiswaroop and Manmohan Gupta. 4th Edition; S Chand & Sons.: Operations Research
8. Richard Broson. 2nd edition Tata Mcgraw Hill Publishing Company Ltd.: Schaum Series book in O.R.
9. Maurice Sasieni, Arthur Yaspan and Lawrence Friedman, (1959), John Wiley & Sons.: Operations Research: Methods and Problems
10. J K Sharma, (1989), Tata McGraw Hill Publishing Company Ltd.: Mathematical Models in Operations Research
11. S.D.Sharma.11th edition, Kedar Nath Ram Nath & Company.: Operations Research
12. H. A. Taha, 6th edition, Prentice Hall of India.: Operations Research
13. J.K.Sharma, (2001), MacMillan India Ltd.: Quantitative Techniques for Managerial Decisions

DISTRIBUTION OF TOPICS FOR PRACTICALS
SEMESTER-VI
COURSE CODE RUASTAP601

Sr. No.	Course Code: RUASTAP601(A) PROBABILITY AND SAMPLING DISTRIBUTIONS
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

Sr. No.	Course Code: RUASTAP601(B) ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS
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 CRD, RBD & LSD
7	Factorial Experiments
8	Practical using Excel and R software

Sr. No.	Course Code: RUASTAP601(C) APPLIED STATISTICS-II
1	Multiple regression model -1
2	Simulation
3	Decision Theory-1
4	Decision Theory-2
5	Game Theory
6	Use of R in MLR

THEORY

Internal Assessment of Theory Core Courses Per Semester Per Course

1. One Class Test (Objective type) / Project / Assignment / Presentation: ……. ..20 Marks.
2. One Class Test (Objective type) / Project / Assignment / Presentation: ……. ..20 Marks.

Semester End Examination

Theory: At the end of the semester, examination of two hours duration and 60 marks based on the three units shall be held for each course.

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

There shall be THREE COMPULSORY Questions of 20 marks each (Internal Option).

Question1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III.

PRACTICAL

Internal Assessment of Practical Core Courses per Semester per course

One Class Test	……. ..10 Marks.
Journal (All Three Papers Together)	……. .. 10 Marks.

Practical Core Courses per Semester per course

1. Practical Examination ……20 Marks.

At the end of the semester, examination of one hour duration and 20 marks shall be held for **each course**.

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

There shall be **Two** COMPULSORY Questions with internal choice.

Workload

Theory: 3 lectures per week per course.

Practicals: 3 lecture periods per course per week per batch. All three lecture periods of the practical shall be conducted in succession together on a single day.

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