Resolution No.: AC/II(20-21).2.RUA14

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for

Program: B. A.

Program Code: (STATISTICS) RUASTA

(Credit Based Semester and Grading System for academic year 2020–2021)

PROGRAM OUTCOMES

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.

PO	PO Description **A student completing Bachelor's Degree in Arts program will be able to:**
PO 1	Demonstrate understanding and skills of application of knowledge of historical and contemporary issues in the social and linguistic settings with a transdisciplinary perspective to make an informed judgement.
PO 2	Analyse and evaluate theories of individual and social behaviour in the familiar contexts and extrapolate to unfamiliar contexts in order to resolve contemporary issues.
PO 3	Effectively and ethically use concepts, vocabularies, methods and modern technologies in human sciences to make meaningful contribution in creation of information and its effective dissemination
PO 4	Explore critical issues, ideas, phenomena and debates to define problems or to formulate hypotheses; as well as analyse evidences to formulate an opinion, identify strategies, evaluate outcomes, draw conclusions and/or develop and implement solutions.
PO 5	Demonstrate oral and written proficiency to analyse and synthesise information and apply a set of cognitive, affective, and behavioral skills to work individually and with diverse groups to foster personal growth and better appreciate the diverse social world in which we live.
PO 6	Develop a clear understanding of social institutional structures, systems, procedures, and policies existing across cultures, and interpret, compare and contrast ideas in diverse social- cultural contexts, to engage reasonably with diverse groups.

PO 7	React thoughtfully with emotional and moral competence to forms of expressive direct action and apply social strategies toward eradicating threats to a democratic society and a healthy planet.
PO 8	Articulate and apply values, principles, and ideals to the current societal challenges by integrating management and leadership skills to enhance the quality of life in the civic community through actions that enrich individual lives and benefit the community.
PO 9	Recognize and appreciate the diversity of human experience and thought, and apply intellect and creativity to contemporary scenario, to promote individual growth by practicing lifelong learning.

PROGRAM SPECIFIC OUTCOMES

PSO	Description **A student completing Bachelor's Degree in Arts program in the subject of Statistics will be able to:**
PSO 1	Understand, condense, visualize, analyze and interpret the data collected in daily walk of life.
PSO 2	Understand the data generated in various scenarios of scientific, industrial, or social problems.
PSO 3	Pursue their higher education programs leading to post-graduate or doctoral degrees.
PSO 4	Enhance knowledge of Statistical tools.
PSO 5	Enhance the theoretical rigor with technical skills which prepare them to become globally competitive to enter into a promising professional life after graduation.

PSO 6	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.
PSO 7	Seek employment in different sectors like Stock trading, Sports, Politics, Business, Financial services and Media Industry.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
FYBA	I	RUASTA101	DESCRIPTIVE STATISTICS - I	2
FYBA	I	RUASTAP101	Practical based on RUASTA101	1
FYBA	II	RUASTA201	DESCRIPTIVE STATISTICS - II	2
FYBA	II	RUASTAP201	Practical based on RUASTA201	1
SYBA	III	RUASTA301	STATISTICAL METHODS - I	2
SYBA	III	RUASTA302	OPERATIONS RESEARCH	2
SYBA	III	RUASTAP301	Practical based on RUASTA301 & RUASTA302	2
SYBA	IV	RUASTA401	STATISTICAL METHODS – II	2
SYBA	IV	RUASTA402	PROJECT MANAGEMENT AND INDUSTRIAL STATISTICS	2

SYBA	IV	RUASTAP401	Practical based on RUASTA401 & RUASTA402	2
TYBA	V	RUASTA501	PROBABILITY DISTRIBUTIONS	3
TYBA	V	RUASTA502	THEORY OF SAMPLING	3
TYBA	V	RUASTA503	ELEMENTS OF ACTUARIAL SCIENCE	2.5
TYBA	V	RUASTAP501	Practical based on RUASTA501, RUASTA502 & RUASTA503	3
TYBA	VI	RUASTA601	PROBABILITY AND SAMPLING DISTRIBUTIONS	3
TYBA	VI	RUASTA602	ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS	3
TYBA	VI	RUASTA603	APPLIED STATISTICS	2.5
TYBA	VI	RUASTAP601	Practical based on RUASTA601, RUASTA602 & RUASTA603	3

Course Code: RUASTA101

Course Title: DESCRIPTIVE STATISTICS - I

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Distinguish between different types of scales. Compare the different types of data and describe the various methods of data collection.
CO 2	Compute Yule's coefficient of association Q and Yule's coefficient of Colligation Y and associate two attributes, and relate Q and Y.
CO 3	Construct Univariate and Bivariate frequency distribution of discrete, continuous variables and Cumulative frequency distribution. Draw Graphs and Diagrams: Histogram, Polygon/curve, Ogives. Heat Map, Tree map.
CO 4	Describe the need of measures of central tendency, Explain the various measures of central tendencies. Relate mean, median and mode. Justify merits and demerits of using different measures.
CO 5	Compute and comprehend the measures of dispersion. Compare Absolute and Relative measures of dispersion.
CO 6	Relate raw moments and central moments. Understand Skewness and Kurtosis of data. Identify the outliers.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA101	Unit I	**Types of Data and Data Condensation:** • **Global Success stories of Statistics/Analytics in various fields.** • Concept of Population and Sample. Finite, Infinite Population, Notion of SRS, SRSWOR and SRSWR • Different types of scales: Nominal, Ordinal, Interval and Ratio. • Methods of Data Collection: i) Primary data: concept of a Questionnaire and a Schedule, ii) Secondary Data	15 Lectures

		• Types of data: Qualitative and Quantitative Data; Time Series Data and Cross Section Data, Discrete and Continuous Data • Tabulation • Dichotomous classification- for two and three attributes, Verification for consistency • Association of attributes: Yule's coefficient of association Q. Yule's coefficient of Colligation Y, Relation between Q and Y (with proof). • Univariate frequency distribution of discrete and continuous variables. Cumulative frequency distribution • Data Visualization: Graphs and Diagrams: Histogram, Polygon/curve, Ogives. Heat Map, Tree map. • Bivariate Frequency Distribution of discrete and continuous variables	
RUASTA101	**Unit II**	**Measures of central tendency** • Concept of central tendency of data, Requirements of good measures of central tendency. • Location parameters: Median, Quartiles, Deciles, and Percentiles • Mathematical averages Arithmetic mean (Simple, weighted mean, combined mean), Geometric mean, Harmonic mean, Mode, Trimmed mean. • Empirical relation between mean, median and mode. • Merits and demerits of using different measures & their applicability.	15 Lectures
RUASTA101	**Unit III**	**Measures of Dispersion, Skewness & Kurtosis** • Concept of dispersion, Requirements of good measure • Absolute and Relative measures of dispersion: Range, Quartile Deviation, Inter Quartile Range, Mean absolute deviation, Standard deviation. • Variance and Combined variance, raw moments and central moments and relations between them. Their properties • Concept of Skewness and Kurtosis: Measures of Skewness: Karl Pearson's, Bowley's and Coefficient of skewness based on moments. Measure of Kurtosis. Absolute and relative measures of skewness. Box Plot: Outliers	15 Lectures

Distribution of topics for Practicals

Course Code RUASTAP101	
Sr. No.	**Practicals based on course**
1	Tabulation
2	Classification of Data
3	Attributes
4	Diagrammatic representation
5	Measures of central tendency
6	Measures of dispersion
7	Practical using Excel i) Classification of Data and Diagrammatic representation ii) Measures of central tendency iii) Measures of dispersion

References:

1. Medhi J.: "Statistical Methods, An Introductory Text", Second Edition, New Age International Ltd.
2. Agarwal B.L.: "Basic Statistics", New Age International Ltd.
3. Spiegel M.R.: "Theory and Problems of Statistics", Schaum's Publications series. Tata McGraw-Hill.
4. Kothari C.R.: "Research Methodology", Wiley Eastern Limited.
5. David S.: "Elementary Probability", Cambridge University Press.
6. Hoel P.G.: "Introduction to Mathematical Statistics", Asia Publishing House.
7. Hogg R.V. and Tannis E.P.: "Probability and Statistical Inference". McMillan Publishing Co. Inc.
8. Pitan Jim: "Probability", Narosa Publishing House.
9. Goon A.M., Gupta M.K., Dasgupta B.: "Fundamentals of Statistics", Volume II: The World Press Private Limited, Calcutta.
10. Gupta S.C., Kapoor V.K.: "Fundamentals of Mathematical Statistics", Sultan Chand &Sons
11. Gupta S.C., Kapoor V.K.: "Fundamentals of Applied Statistics", Sultan Chand & Sons

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	Class Test/ Project / Assignment / Presentation	20
2	Class Test/ Project / Assignment / Presentation	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours duration**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
1	A	20	Unit I
	B or C		
2	A	20	Unit II
	B or C		
3	A	20	Unit III
	B or C		
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Marks
Journal	5
Assignments using Statistical Software	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:
Duration - These examinations shall be of **one and half hour** duration.

Particulars	Paper
Exam (There shall be **Three** COMPULSORY Questions of 10 marks each with internal choice**)**	30
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester I

Course	RUASTA101		
	Internal	External	Total
Theory	40	60	100
Practicals	20	30	50

Course Code: RUASTA201
Course Title: DESCRIPTIVE STATISTICS - II
Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Compute the numerical measures to identify the direction and strength of linear relationship between two variables using. Also, list their properties.
CO 2	Build a simple linear regression model and interpret regression coefficients and coefficient of determination.
CO 3	Calculate and interpret various measures of associations between two attributes.
CO 4	Identify various components of time series. Apply the appropriate methods to evaluate and eliminate these components.
CO 5	Comprehend the concept and construct various index numbers.
CO 6	Use the basic mathematical operators in R for different data types. Apply different data management techniques and data visualisation.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA201	**UNIT I**	**Correlation, Simple linear Regression Analysis and Fitting of curves** • Karl Pearson's Product moment correlation coefficient and its properties. • Spearman's Rank correlation. (With and without ties) • Concept of Simple linear regression. Principle of least squares. Fitting a straight line by method of least squares (Linear in Parameters) • Relationship between regression coefficients and correlation coefficient, cause and effect relationship, Spurious correlation. • Concept and use of coefficient of determination (R^2). • Measures of association with the help of Tau A, Tau B, Tau C, Gamma and Lambda, Somer's d • Fitting of curves reducible to linear form by transformation.	15 LECTURES
RUASTA201	**Unit II**	**Time Series and Index numbers** • Definition of time series. Components of time series. Models of time series. • Estimation of trend by: (i) Freehand Curve Method (ii) Method of Semi Average (iii) Method of Moving Average (iv) Method of Least Squares (Linear Trend only) • Estimation of seasonal component by (i) Method of Simple Average (ii) Ratio to Moving Average (iii) Ratio to Trend Method • Simple exponential smoothing • Stationary Time series **Index numbers:** • Index numbers as comparative tool. Stages in the construction of Price Index Numbers. • Measures of Simple and Composite Index Numbers. Laspeyre's, Paasche's, Marshal-Edgeworth's, Dobisch & Bowley's and Fisher's Index Numbers formula • Quantity Index Numbers and Value Index Numbers Time reversal test, Factor reversal test, Circular test • Fixed base Index Numbers, Chain base Index Numbers. Base shifting, splicing and deflating. • Cost of Living Index Number. Concept of Real Income.	15 LECTURES

RUASTA201	**UNIT III**	**Fundamentals of R:** • Introduction to R, features of R, installation of R, Starting and ending R session, getting help in R , Value assigning to variables, Basic Operations : +, -, *, ÷, ^, sqrt, Numerical functions : log 10, log , sort, max, unique, range, length, var, prod, sum, summary, dim, sort, five num etc. • Data Types: Vector, list, matrices, array and data frame, Variable Type: logical, numeric, integer, complex, character and factor • Data Manipulation: Selecting random N rows, removing, duplicate row(s), dropping a variable(s), Renaming variable(s), sub setting data, creating a new variable(s), selecting of random fraction of row(s), appending of row(s) and column(s), simulation of variables. • Data Processing: Data import and export, setting working directory, checking structure of Data: Str(), Class(), Changing type of variable (for eg as.factor, as.numeric) • Data Visualisation using ggplot: Simple bar diagram, subdivided bar diagram, multiple bar diagram pie diagram, Box plot for one and more variables, histogram, frequency polygon, scatter plot. Visualizing relationship using Bubble chart, Scatter Diagram.	15 LECTURES

Distribution of topics for Practicals

Course Code RUASTAP201	
Sr. No.	**Practicals based on course**
1	Correlation analysis
2	Regression analysis
3	Fitting of curve
4	Time series
5	Index Numbers.
6	Practical using R i) Measures of Central Tendency ii) Measures of Dispersion iii) Diagrams and Graphs iv) Correlation analysis v) Regression analysis vi) Fitting of curve

REFERENCES:

1. Medhi J.:“Statistical Methods, An Introductory Text”, Second Edition, New Age International Ltd.
2. Agarwal B.L.:“Basic Statistics”, New Age International Ltd.

3. Spiegel M.R.:"Theory and Problems of Statistics", Schaum's Publications series. Tata McGraw-Hill.
4. Kothari C.R.:"Research Methodology", Wiley Eastern Limited.
5. David S.:"Elementary Probability", Cambridge University Press.
6. Hoel P.G.:"Introduction to Mathematical Statistics", Asia Publishing House.
7. Hogg R.V. and Tannis E.P.:"Probability and Statistical Inference". McMillan Publishing Co. Inc.
8. Pitan Jim:"Probability", Narosa Publishing House.
9. Goon A.M., Gupta M.K., Dasgupta B.:"Fundamentals of Statistics", Volume II: The World Press Private Limited, Calcutta.
10. Gupta S.C., Kapoor V.K.: "Fundamentals of Mathematical Statistics", Sultan Chand &Sons
11. Gupta S.C., Kapoor V.K.: "Fundamentals of Applied Statistics", Sultan Chand & Sons

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	Class Test/ Project / Assignment / Presentation	20
2	Class Test/ Project / Assignment / Presentation	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
1	A	20	Unit I
	B or C		
2	A	20	Unit II
	B or C		
3	A	20	Unit III
	B or C		
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Marks
Journal	5
Projects based on primary / secondary data	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:
Duration - These examinations shall be of **one and half hour** duration.

Particulars	Paper
Exam (There shall be **Three** COMPULSORY Questions of 10 marks each with internal choice**)**	30
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester II

Course	RUASTA201		
	Internal	**External**	**Total**
Theory	**40**	**60**	**100**
Practicals	**20**	**30**	**50**

Course Code: RUASTA301

Course Title: STATISTICAL METHODS- I

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Differentiate between random and non-random experiments
CO 2	Compute the probabilities of events
CO 3	Understand the concept of a random variable, its probability distribution of a random variable (one or two) and its properties
CO 4	Apply standard discrete probability distributions based on real life situations

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA301	Unit I	**Elementary Probability Theory** • Trial, random experiment, sample point and sample space. • Definition of an event, Operation of events, mutually exclusive and exhaustive events. • Classical (Mathematical) and Empirical definitions of Probability and their properties. • Theorems on Addition and Multiplication of probabilities • Independence of events, Pair-wise and Mutual Independence for three events, Conditional probability, Bayes' theorem and its applications	15 Lectures
RUASTA301	Unit II	**Discrete random variable** • Random variable. Definition and properties of probability distribution and cumulative distribution function of discrete random variable. • Raw and Central moments and their relationships.	15 Lectures

		• Concepts of Skewness and Kurtosis and their uses. • Expectation of a random variable. Theorems on Expectation & Variance. Concept of Generating function, Moment Generating function, Cumulant generating function, Probability generating function • Joint probability mass function of two discrete random variables. Independence of two random variables. • Marginal and conditional distributions. Theorems on Expectation &Variance, Covariance and Coefficient of Correlation.	
RUASTA301	**Unit III**	**Some Standard Discrete Distributions** • Degenerate (one point): Discrete Uniform, Bernoulli, Binomial, Poisson and Hypergeometric distributions derivation of their mean and variance for all the above distributions. • Moment Generating Function and Cumulant Generating Function of Binomial and Poisson distribution. Recurrence relationship for probabilities of Binomial and Poisson distributions, Poisson approximation to Binomial distribution, Binomial approximation to hypergeometric distribution.	15 Lectures

Distribution of topics for Practicals

Course Code RUASTAP301(A)	
Sr. No.	**Practicals based on course**
1	Probability
2	Discrete Random Variables
3	Bivariate Probability Distributions
4	Binomial Distribution
5	Poisson Distribution
6	Hypergeometric Distribution
7	Practical using Excel i) Binomial distribution ii) Poisson distribution iii) Hypergeometric distribution

References:

1. Medhi J.: “Statistical Methods, An Introductory Text”, Second Edition, New Age International Ltd.
2. Agarwal B.L.: “Basic Statistics”, New Age International Ltd.

3. Spiegel M.R.: “Theory and Problems of Statistics”, Schaum’s Publications series. Tata McGraw-Hill.
4. Kothari C.R.: “Research Methodology”, Wiley Eastern Limited.
5. David S.: “Elementary Probability”, Cambridge University Press.
6. Hoel P.G.: “Introduction to Mathematical Statistics”, Asia Publishing House.
7. Hogg R.V. and Tannis E.P.: “Probability and Statistical Inference”. McMillan Publishing Co. Inc.
8. Pitan Jim: “Probability”, Narosa Publishing House.
9. Goon A.M., Gupta M.K., Dasgupta B.: “Fundamentals of Statistics”, Volume II: The World Press Private Limited, Calcutta.
10. Gupta S.C., Kapoor V.K.: “Fundamentals of Mathematical Statistics”, Sultan Chand &Sons
11. Gupta S.C., Kapoor V.K.: “Fundamentals of Applied Statistics”, Sultan Chand & Sons

Course Code: RUASTA302

Course Title: OPERATIONS RESEARCH

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Formulate and solve a linear programming problem graphically and using simplex method.
CO 2	Obtain dual of a given problem and solve the primal from the optimum solution of a primal.
CO 3	Solve a transportation problem and its variants using various methods and optimise it.
CO 4	Solve an assignment problem and its variants using Hungarian methods.
CO 5	Process sequencing problems using Johnson’s Method

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA302	**Unit I**	**Linear Programming Problem (L.P.P.):** • Mathematical Formulation: Maximization & Minimization. Concepts of Solution, Feasible Solution, Basic Feasible Solution, Optimal solution. • 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.	**15 Lectures**
RUASTA302	**Unit II**	**Transportation Problem:** • Concept, Mathematical Formulation. Concepts of Solution, Feasible Solution. Initial Basic Feasible Solution by North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method. Optimal Solution by MODI Method. Optimality test, Improvement procedure. • Variants in Transportation Problem: Unbalanced, Maximization type, Restricted allocations.	**15 Lectures**
RUASTA302	**Unit III**	**Assignment Problem:** • Concept. Mathematical Formulation • Solution by: Complete Enumeration Method and Hungarian method. • Variants in Assignment Problem: Unbalanced, Maximization type. • Airline Operating Problem • Travelling Salesman Problem **Sequencing:** • Processing n Jobs through 2 and 3 Machines, 2 Jobs through m Machines and n jobs through m machines	**15 Lectures**

Distribution of topics for Practicals

Course Code RUASTAP301(B)	
Sr. No.	**Practicals based on course**
1	Formulation and Graphical Solution of L.P.P.
2	Simplex Method.
3	Duality.
4	Transportation.
5	Assignment.
6	Sequencing.
7	Problems solving using TORA.

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

Modality of Assessment

Theory Examination Pattern:

C) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	Class Test/ Project / Assignment / Presentation	20
2	Class Test/ Project / Assignment / Presentation	20
	TOTAL	**40**

D) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours duration**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
1	A	20	Unit I
	B or C		
2	A	20	Unit II
	B or C		
3	A	20	Unit III
	B or C		
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Marks
Journal	5
Assignments using Statistical Software	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:
Duration - These examinations shall be of **one and half hour** duration.

Particulars	Paper
Exam (There shall be **Three** COMPULSORY Questions of 10 marks each with internal choice**)**	30
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester III

Course	RUASTA301			RUASTA302			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

Course Code: RUASTA401
Course Title: STATISTICAL METHODS - II

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Obtain a probability density function and cumulative distribution function for continuous random variable
CO 2	Apply standard continuous probability distributions to different situations
CO 3	Distinguish between point estimation and interval estimation
CO 4	Define the various terminologies of testing of hypotheses and apply large sample tests

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA401	**UNIT I**	**Continuous random variable and some Standard Continuous Distributions** • Concept of Continuous random variable and properties of its probability distribution • Probability density function and cumulative distribution function. • Their graphical representation. • Expectation of a random variable and its properties. Concept of M.G.F. and C.G.F. characteristics. Measures of location, dispersion, skewness and kurtosis. • Raw and central moments (simple illustrations). • Uniform, Exponential distribution (location and scale parameter), memory less property of exponential distribution, Derivations of mean, median, variance, MG.F. and C.G.F. for Uniform and Exponential distributions.	15 Lectures
RUASTA401	**UNIT II**	**Normal Distribution and Sampling Distribution** • Normal distribution • Properties of Normal distribution/curve (without proof). Use of normal tables. • Normal approximation to Binomial and Poisson distribution (statement only) • Sample from a distribution: Concept of a statistic, estimate and its sampling distribution. Parameter, its estimator and bias, unbiasedness, standard error of an estimator. • Concept of Central Limit theorem (statement only) • Sampling distribution of sample mean and sample proportion difference between two population means and two proportions. • Standard errors of sample mean and sample proportion.	15 Lectures
RUASTA401	**UNIT III**	**Basics of Theory of Estimation and 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	15 Lectures

		• 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 testing specified value of difference of population proportion Concept of p-value	

Distribution of topics for Practicals

Course Code RUASTAP401(A)	
Sr. No.	**Practicals based on course**
1	Continuous Random Variables
2	Uniform and Exponential Distributions
3	Normal Distribution
4	Sampling Distribution
5	Testing of Hypothesis
6	Large sample Tests
7	Practical using Excel and R (i) Binomial and Poisson (ii) Uniform and Exponential (iii) Normal Distribution (iv) Sampling Distribution (v) Testing of Hypotheses (vi) Large Sample Tests

REFERENCES:

1. Medhi J.:“Statistical Methods, An Introductory Text”, Second Edition, New Age International Ltd.
2. Agarwal B.L.:“Basic Statistics”, New Age International Ltd.
3. Spiegel M.R.:“Theory and Problems of Statistics”, Schaum’s Publications series. Tata McGraw-Hill.
4. Kothari C.R.:“Research Methodology”, Wiley Eastern Limited.
5. David S.:“Elementary Probability”, Cambridge University Press.
6. Hoel P.G.:“Introduction to Mathematical Statistics”, Asia Publishing House.
7. Hogg R.V. and Tannis E.P.:“Probability and Statistical Inference”. McMillan Publishing Co. Inc.
8. Pitan Jim:“Probability”, Narosa Publishing House.
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Course Code: RUASTA402

Course Title: PROJECT MANAGEMENT AND INDUSTRIAL STATISTICS

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Draw project networks for probabilistic and deterministic time estimates to obtain critical path.
CO 2	Crash activities to optimise the project cost and update networks from time to time.
CO 3	Construct various control charts for variables and attributes to obtain standard values for future use.
CO 4	Design a single sampling plan and obtain its various characteristics and understand the concept of Double Sampling Plan

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA402	Unit I	**CPM and PERT:** • 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. Probability consideration in project scheduling. • Project cost analysis. • Updating.	15 Lectures
RUASTA402	Unit II	**Statistical Quality Control-I:** • Principles of control. Process quality control of variables. *X* bar and R, Xbar and Sigma Chart and their uses. Problems involving setting up standards for future use. • Exponentially weighted moving average (EWMA) control charts, Cumulative Sum	15 Lectures

		(CUSUM) control chart, Introduction to Six sigma limits. • Concept of Natural Tolerance Limits, Specification Limits and Detection of shift	
RUASTA402	**Unit III**	**Statistical Quality Control-II:** • Principles of control. Process quality control of attributes p, c, np charts and their uses. p-chart and C-chart with variable sample size. Problems involving setting up standards for future use • Acceptance sampling plan • Single Sampling Plans (without curtailment). • OC function and OC curves. AQL, LTPD, ASN, ATI, AOQ, Consumer's risk, Producer's risk. • Double Sampling Plan (Concept only)	**15 Lectures**

Distribution of topics for Practicals

Course Code: RUASTAP401(B)	
Sr. No.	**Practicals based on course**
1	PERT
2	CPM
3	Project cost analysis
4	Updating
5	Control Charts for attributes
6	Control Charts for variables
7	Acceptance Sampling Plans.
8	Practical using EXCEL and TORA software

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. (6th 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

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	Class Test/ Project / Assignment / Presentation	20
2	Class Test/ Project / Assignment / Presentation	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
1	A	20	Unit I
	B or C		
2	A	20	Unit II
	B or C		
3	A	20	Unit III
	B or C		
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Marks
Journal	5
Projects based on primary / secondary data	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:
Duration - These examinations shall be of **one and half hour** duration.

Particulars	Paper
Exam (There shall be **Three** COMPULSORY Questions of 10 marks each with internal choice**)**	30
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester IV

Course	RUASTA401			RUASTA402			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practicals	**20**	**30**	**50**	**20**	**30**	**50**	**100**

Course Code: RUASTA501
Course Title: PROBABILITY DISTRIBUTIONS

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Understand different Standard Discrete Probability Distributions.
CO 2	Differentiate between the Standard Discrete Probability Distributions, understand their properties.
CO 3	Solve problems after identifying the underlying distribution.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA501	Unit I	**Univariate Random Variables (Discrete and Continuous):** • 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
RUASTA501	Unit II	**Standard Discrete Probability Distributions:** • 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

RUASTA501	**Unit III**	**Bivariate Probability Distributions:** • 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**

Distribution of topics for Practicals

Course Code RUASTAP501(A)	
Sr. No.	**Practicals based on course**
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.

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

Course Title: THEORY OF SAMPLING

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Understand the need of sampling and define the principal concepts in sampling
CO 2	Formulate and calculate estimates of population parameters for Simple Random Sampling, Stratified Sampling and Systematic sampling
CO 3	Contrast types of probability sampling
CO 4	Utilize auxiliary information in survey by means of Ratio and Regression method of estimation

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA502	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.	15 Lectures

		• 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.	
RUASTA502	**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
RUASTA502	**Unit III**	**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	15 Lectures

		• 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.	

Distribution of topics for Practicals

Course Code RUASTAP501(B)	
Sr. No.	**Practicals 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.
7	Systematic Sampling

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: RUASTA503

Course Title: ELEMENTS OF ACTUARIAL SCIENCE

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	**Understand** the functions of Mortality Table and should be able to **relate** them with the rate of mortality and calculate probabilities of living and dyeing
CO 2	Differentiate between Nominal and Effective rate of interest. Analyse and evaluate various types of annuities certain, and also calculate the present values and accumulated values
CO 3	Distinguish between the Life annuities and Temporary annuities and calculate the present values of various Life and Temporary annuities
CO 4	Understand the difference between assurance and insurance. Evaluate the single premiums and level annual premiums for various assurance schemes. Distinguish between the Net premiums and the Office premiums

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA503	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.	15 Lectures

		Stationary population. Expectation of life and Average life at death.	
RUASTA503	**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 instalments form (i) arithmetic progression (ii) Geometric progression (iii) annuity with Frequency different from that with which interest is convertible. Redemption of loan.	**15 Lectures**
RUASTA503	**Unit III**	**LIFE ANNUITIES AND ASSURANCE BENEFITS:** • 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 (vii) Double Endowment • Net premiums: Net level annual premiums (including limited period of payment) for various assurance plans. • Office premiums.	**15 Lectures**

Distribution of topics for Practicals

Course Code: RUASTAP501(C)	
Sr. No.	**Practicals based on course**
1	Mortality tables 1
2	Mortality tables 2
3	Annuities 1
4	Annuities 2
5	Life annuities
6	Assurance benefits

REFERENCES:

1. Neill A. : Life Contingencies, First edition, Heineman educational books London
2. Dixit S.P., Modi C.S., Joshi R.V.: Mathematical Basis of Life Assurance, First edition Insurance Institute of India.
3. Gupta S. C. &. Kapoor V. K.: Fundamentals of Applied Statistics, Fourth edition, Sultan Chand & Sons.
4. Ajaykumar Srivastava and Gorakhnath Agarwal: Mathematical Basis of Life Assurance

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	Class Test/ Project / Assignment / Presentation	20
2	Class Test/ Project / Assignment / Presentation	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
1	A	20	Unit I
	B or C		
2	A	20	Unit II
	B or C		
3	A	20	Unit III
	B or C		
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Marks
Journal	5
Assignments using Statistical Software	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:
Duration - These examinations shall be of **one and half hour** duration.

Particulars	Paper
Exam (There shall be **Three** COMPULSORY Questions of 10 marks each with internal choice**)**	30
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester V

Course	RUASTA501			RUASTA502			RUASTA503			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	300
Practicals	20	30	50	20	30	50	20	30	50	150

Course Code: RUASTA601

Course Title: PROBABILITY AND SAMPLING DISTRIBUTIONS

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Understand different Standard Continuous Probability Distributions.
CO 2	Differentiate between the Standard Continuous Probability Distributions, understand their properties and solve problems based on these distributions.
CO 3	Apply Standard Continuous Probability Distributions in real life examples.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA601	Unit I	**Standard Continuous Probability Distributions:** • 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. **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.	15 Lectures

		• Central Limit theorem for i.i.d. random variables. • Log Normal Distribution: Derivation of mean & variance.	
RUASTA601	**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).	**15 Lectures**
RUASTA601	**Unit III**	**t-distribution:** • 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.	**15 Lectures**

Distribution of topics for Practicals

Course Code: RUASTAP601(A)	
Sr. No.	**Practicals 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: RUASSTA602

Course Title: ANALYSIS OF VARIANCE & DESIGNS OF EXPERIMENTS

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Demonstrate analysis of one-way and two-way classification
CO 2	Explain the different components of ANOVA Table
CO 3	Define fundamental concepts in Designs of Experiment, describe the principles of designs of experiment and list the different types of experimental designs
CO 4	Analyse CRD, RBD and LSD using ANOVA
CO 5	Construct factorial experiments, analyse them and understand the concept of confounding

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASSTA602	**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**

RUASSTA602	**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 CRD. • Missing plot technique for one missing observation in case of CRD, RBD	**15 Lectures**
RUASSTA602	**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 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**

Distribution of topics for Practicals

Course Code: RUASTAP601(B)	
Sr. No.	**Practicals 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 CRD, RBD & LSD
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

Course Code: RUASTA603

Course Title: APPLIED STATISTICS

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION A student completing this course will be able to:
CO 1	Understand the concept of Predictive modelling and use techniques like regression analysis, time series for real life situations.
CO 2	Simulate random numbers and random observations for various probability distributions. Apply Monte-Carlo technique to solve problems in Inventory and Queueing Theory.
CO 3	Understand the various terminologies of Micro Economics and its applications.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures
RUASTA603	Unit I	**LINEAR REGRESSION** • 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.	15 Lectures

		• Multiple Linear Regression with Qualitative Independent Variable. • Autocorrelation: Concept, Detection using Durbin Watson Test, Generalized Least Square (GLS) method. • Heteroscedasticity: Concept, Detection using Breusch-Pagan-Godfrey test. Weighted Least Square (WLS) estimators • Multicollinearity: Concept, Detection using • R square & t ratios (ii) Variance Inflation Factor (VIF)	
RUASTA603	**Unit II**	**SIMULATION** • Scope of simulation applications. Types of simulation. Monte Carlo Technique of Simulation and 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. • Application of Simulation techniques to real life situations.	**15 Lectures**
RUASTA603	**Unit III**	**Mathematical Economics:** • Behaviour of Demand and Supply, Demand functions. Cost and Revenue functions. The elasticity of a function, Elasticity of (i) Demand (ii) Cost. • Normal conditions of (i) demand (ii) cost. Features of prefect competition. • Monopoly (including effects of taxation and subsidy), Duopoly. • Production function. Euler's theorem linear homogenous production functions, Cobb-Douglas production function, CES production function. • The elasticity of substitution.	15 Lectures

Distribution of topics for Practicals

Course Code: RUASTAP601(C)	
Sr. No.	**Practicals based on course**
1	Multiple regression model 1
2	Multiple regression model- 2
3	Simulation
4	Mathematical Economics 1
5	Mathematical Economics 2
6	Use of R in MLR

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. (6th 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

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	Class Test/ Project / Assignment / Presentation	20
2	Class Test/ Project / Assignment / Presentation	20
	TOTAL	**40**

B) External Examination- 60%- 60 Marks
Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
1	A	20	Unit I
	B or C		
2	A	20	Unit II
	B or C		
3	A	20	Unit III
	B or C		
	TOTAL	**60**	

Practical Examination Pattern:

A) Internal Examination: 40%- 40 Marks

Particulars	Marks
Journal	5
Projects based on primary / secondary data	15
Total	**20**

B) External Examination: 60%- 60 Marks

Semester End Practical Examination:
Duration - These examinations shall be of **one and half hour** duration.

Particulars	Paper
Exam (There shall be **Three** COMPULSORY Questions of 10 marks each with internal choice**)**	30
Total	**30**

Overall Examination & Marks Distribution Pattern

Semester VI

Course	RUASTA601			RUASTA602			RUASTA603			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	300
Practicals	20	30	50	20	30	50	20	30	50	150
