VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

VISION AND MISSION OF THE DEPARTMENT

Vision

To enable and empower the women students - especially from the weaker sections of society with a rural background, with hard and soft skills and human values that contribute for the acquisition and development of a good career and multidimensional empowerment.

Mission

To provide education that embraces current and inclusive fields through which the needs of all the sections of the society can be addressed. To enhance quality through innovations in the curriculum by offering need-based courses. To promote research environment and further the prospects of transforming the college into a university. To impart and develop their soft skills and employability skills for better life. To inculcate human values among the students. To propagate the rich tradition and culture of India for the promotion of National Integration. To empower them with competencies in economic, social, psychological, legal and political arena. To employ innovative methods of Teaching – Learning and Evaluation. To encourage teachers to undertake research and consultancy. To create environmental consciousness among the students. To encourage participation in community development programs.

Curriculum Development

As the College is conferred with Autonomy Board of Studies meetings were organized and Curriculum was modified to some extent. The suggestions and ideas obtained from various bodies is thoroughlydiscussed by the experts in the Academic Council and carefully incorporated in the curriculum.

Eligibility

B.Sc. degree in Statistics or Mathematics with Statistics as a minor subject with a minimum 55% of marks.

Duration of the Course

The course duration shall normally be of two years duration spread over four semesters.

Intake

A total of 44 seats are available for the M.Sc.Program in Statistics

Medium

The medium of instruction shall be English.

HEAD
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VIKRAMA SIMHAPURI UNIVERSITY
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SPS Nellore Dist. A.P.

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

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Choice Based Credit System (CBCS)

The M.Sc. Statistics program is offered through a unique CBCS. The salient features of the CBCS are that the program is offered through credit-based courses.

Weightage of marks

The weightage of marks for continuous internal assessment (CIA) and end semester examinations shall be 30 and 70 respectively. A student is declared passed in a given subject when he/she secures a minimum of 40% in the end semester examination in that subject.

Board Of Studies

1. Prof.B. Muni Swamy - Chairman, BOS, Andhra University, Visakhapatnam
2. Head, Department of Statistics, Ex-Officio Member, V.S. University, Nellore
3. Dr.R Vishnu Vardhan, Member, Pondicherry University, Puducherry
4. Dr.B.Sarojamma, Member, S.V.University, Tirupati
5. Dr.L.Venkateswara Rao, Member, Andhra University, Visakhapatnam
6. Dr.S. Yadavendra Babu, Industry Expert, Ford Motors Pvt Ltd, Chennai
7. K. Gayathrinadh, Student, V.S. University, Nellore
8. B.Bhavani, Student, V.S. University, Nellore

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SPS Nellore Dist. A.P.

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

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COURSE STRUCTURE:

S. No.	Course code	Course/Subject	Course Focus on (Employability/ Entrepreneurship / Skill Development/ project/ Field work/Internship)	Relevant of development al needs (Local/ Regional/ National/ Global)	No. of credits	Internal Marks	External Marks	Lab-Internal Marks	Total
Semester – I									
1	22RMSCST101	Probability Theory-I	Employability	Global, National	4	30	70	-	100
2	22RMSCST102	R Programming and Data Analysis	Employability	Global, National	4	30	70	-	100
3	22RMSCST103	Theory of Estimation	Employability	Global, National	4	30	70	-	100
4	22RMSCST104	(a)Distribution Theory (b)Linear Algebra	Employability	Global, National	4	30	70	-	100
5	22RMSCST105	(a) Sampling Techniques (b)Testing of Statistical Hypothesis	Skill development	Global, National	4	30	70	-	100
6	22RMSCST106	Practical –I	Employability	Global, National	4	-	100	-	100
7	22RCS101	Cyber Security	Skill development	National	0	30	70	-	100
Semester – II									
1	22RMSCST201	Statistical Inference	Employability	Global, National	4	30	70	-	100
2	22RMSCST202	Multivariate Analysis	Employability	Global, National	4	30	70	-	100
3	22RMSCST203	Probability Theory – II	Employability	Global, National	4	30	70	-	100
4	22RMSCST204	(a)Stochastic Processes (b)Theory of Linear Estimation and Analysis of	Employability	Global, National	4	30	70	-	100

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		Vairance							
5	22RMSCST205	(a)Linear Models and Applied Regression Analysis (b)Statistical Pattern Recognition	Employability	Global, National	4	30	70	-	100
6	22RMSCST206	Practical-II	Employability	Global, National	4	-	100	-	100
7	22RPEL201	Personality Enhancement and Leadership	Skill development	National	0	30	70	-	100
			SEMESTER – III						
1	22RMSCST301	Econometrics	Employability	Global, National	4	30	70	-	100
2	22RMSCST302	Design of Experiments	Employability	Global, National	4	30	70	-	100
3	22RMSCST303	Operations Research-I	Employability	Global, National	4	30	70	-	100
4	22RMSCST304	(a) Demography and Official Statistics (b) Statistical Modelling	Employability	Global, National	4	30	70	-	100
5	22RMSCST305	Computer Programming and Data Analysis using SPSS	Employability	Global, National	4	30	70	-	100
6	22RMSCST306	Practical – III	Employability	Global, National	4	-	100	-	100
7	22RMSCST307	(a)Statistics for Biological and Earth Sciences (b)Statistics for Social and Behavioral Sciences	Employability	Global, National	4	-	100	-	100

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Department of Statistics
VIKRAMA SIMHAPURI UNIVERSITY
KAKUTUR-524 324.
SPS Nellore Dist. (A.P)

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

SEMESTER – IV									
1	22RMSCST401	Time Series Analysis and Forecasting Methods	Employability	Global, National	4	30	70	-	100
2	22RMSCST402	Business Analytics	Employability	Global, National	4	30	70	-	100
3	22RMSCST403	Operations Research - II	Employability	Global, National	4	30	70	-	100
4	22RMSCST404	(a) Statistical Process and Quality Control (b) Statistics for Research, Industry and Community Development	Employability	Global, National	4	30	70	-	100
5	22RMSCST405	Bio-Statistics	Employability	Global, National	4	30	70	-	100
6	22RMSCST406	Practical – IV	Employability	National	4	30	70	-	100
7	22RMSCST407	(a) Survival Analysis (b) Inferential Statistics	Employability	Global, National	4	30	70	-	100

Program Educational Objectives -M.Sc. (Statistics)

1. Students will learn statistical methods and applications in real-world settings.
2. Students will understand techniques required for managing data in the workplace environment with the help of well-equipped modern facilities available at the campus.
3. The course emphasizes the Development of computational and analytical skills of a student.
4. The "Industry Interface Program" has been initiated to keep the students abreast of the latest industry/research organizations' latest trends through industrial visits and guest lectures.
5. The curricular and extra-curricular activities are conducted for the overall development of students

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VIKRAMA SIMHAPURI UNIVERSITY
KAKUTUR-524 324
SPS Nellore Dist. (A.P)

6. Get employment in government, public, private, industrial, health, business, banking, agricultural and educational sectors
7. Expand their knowledge to set their career in research and higher studies
8. Comprehend the statistical concepts and principles for interdisciplinary research
9. Acquire proficiency in adopting statistical software for data analysis

Program Outcomes - M.Sc. (Statistics)

On successful completion of the Course a student will be able to:

PO1 - Computational Knowledge: Understand and apply mathematical foundation, computing and domain knowledge for the conceptualization of computing models from defined problems.

PO2 - Problem Analysis: Ability to identify, critically analyse and formulate complex computing problems using fundamentals of computer science and application domains.

PO3 - Design / Development of Solutions: Ability to transform complex business scenarios and contemporary issues into problems, investigate, understand and propose integrated solutions using emerging technologies

PO4 - Conduct Investigations of Complex Computing Problems: Ability to devise and conduct experiments, interpret data and provide well informed conclusions.

PO5 - Modern Tool Usage: Ability to select modern computing tools, skills and techniques necessary for innovative software solutions

PO6 – Environment and Sustainability: Understanding the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO7 - Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO8 - Individual & Team Work: Ability to work as a member or leader in diverse teams in multidisciplinary environment.

PO9 - Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO10– Life-Long Learning: Ability to recognize economic, environmental, social, health, legal, ethical issues involved in the use of computer technology and other consequential responsibilities relevant to professional practice.

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Program Specific Outcomes

PS01: Domain Specific Knowledge: The students are expected to understand the principles, concepts and recent developments in the Statistics.

PS02: Problem Solving Skills: To enhance student sense of enthusiasm for Statistics and to involve them in an intellectually stimulating experience of learning in a supportive environment.

PS03: Software Product Development: The practical course is framed in relevance with the theory courses to improve the understanding of the various concepts in Statistics.

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Department of Statistics
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SPS Nellore Dist. (A.P)

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	I
COURSE CODE & TITLE	22RMSCST101: **PROBABILITY THEORY– I**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To discuss about classes of sets and Probability measures 2. To discuss on random variables and convergence in probability and the important theorems 3. To discuss about Conditional Probability and Decomposition of Distribution Functions 4. To discuss about Convergence theorem for Expectation		

UNIT	CONTENT	NO. OF HOURS
I	Algebra of sets Fields Sigma field's Inverse function Measurable function Random Variables Induced Sigma Fields Limits of Random variables.	15
II	Probability Definition Simple Properties Discrete Probability Space General Probability Space Induced Probability Space Conditional Probability - Distribution Function of a Random Variable Decomposition of distribution functions Distribution function of random vectors.	15
III	Expectation and moments Definition and properties Moment Generating Function. Convergence: Modes of convergence Convergence in probability Convergence in distribution Convergence in rth mean Almost sure convergence and their interrelationships.	15
IV	Convergence theorem for expectation: Monotone Convergence theorem Fatou s theorem Dominated Convergence theorem - Definition of product space Fubini s Theorem (statement only) - Independence: Definition Multiplication properties Zero-one law.	15

REFERENCES

1. Ash, R.B (1972): Real Analysis and Probability, Academic Press.
2. Burril,C.W (1972): Measure, Integration and. Probability, Mc Graw Hill International.
3. Chow, Y.S and Teicher, H (1979): Probability Theory, Springer, Narosa.
4. Loeve, M (1985):Probability Theory, 3/e, Von Nostrand.

COURSE OUTCOME

	On the successful completion of course students will be able to	Knowledge
CO1	Students understand and learn how to apply algebra of sets	K 2
CO2	Student able to understand the Decomposition of distribution functions Distribution function of random vectors.	K 2, K 6
CO3	Student able to understand the Convergence in	K 5 , K 6

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KAKUTUR-524 324
SPS Nellore Dist A.P.

		probability	
	CO4	Student able to understand the Dominated Convergence theorem	K 2

COs – POs MAPPING

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	2	2	3	2	2	1	2	2
CO2	3	2	2	2	3	2	2	2	3	3	2	3	2
CO3	2	2	2	3	3	2	2	3	2	2	3	2	2
CO4	3	3	2	2	3	2	2	2	3	2	2	2	2
Low:1, Medium:2, High:3													

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VIKRAMA SIMHAPURI UNIVERSITY
KAKUTUR-524 324.
SPS Nellore Dist. (A.P)

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	I
COURSE CODE & TITLE	22RMSCST102: **R PROGRAMMING AND DATA ANALYSIS**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To Understand the Purpose and Function of R Software 2. To Understand Control Stations and Group Manipulations 3. To become familiar with basic methods of R Software		

UNIT	CONTENT	NO. OF HOURS
I	Familiarizing with R environment, R atomic types, methods of creating vectors, combining vectors and repeating vectors, different ways of sub setting vectors using indexing. Arithmetic and logical operations. Creating Matrices, getting values in and out of matrices, performing matrix calculations; Working with multidimensional Arrays; creating data frames, modifying data frames; creating lists, extracting components from a list; Reading CSV files, EXCEL files, SPSS files and working with other data types.	15
II	Writing Scripts and functions in R. writing functions with named, default and optional arguments, functions using as arguments. Control statements in R - conditional control using if, if-else; looping control using for, while, repeat; transfer of control using break and next. Manipulating and processing data - creating subsets of data, use of merge () function, sorting and ordering of data. Group manipulation using apply family of functions - apply, sapply, lapply, tapply.	15
III	Base graphics. Use of high-level plotting functions for creating histograms, scatter plots, box-whiskers plot, bar plot, dot plot, Q-Q plot and curves. Controlling plot options using low level plotting functions - Adding lines, segments, points, polygon, grid to the plotting region; Add text using legend, text, mtext; and Modify/add axes, Putting multiple plots on a single page. Creating faceted graphics with lattice packages; making scatterplot, bar chart and box-and-whisker plot using lattice, changing plot options; ggplot2 - understanding plot elements as layers, using geoms and stats, creating bar chart, scatterplot and line chart.	15
IV	Working with probability distributions - Binomial, Poisson, Normal and other distributions. Summary statistics, hypothesis testing - one and two-sample Student's t-tests, Wilcoxon U-test, paired t-test, correlation and covariance, correlation tests, tests for association-Chi-squared test and goodness-of-_fit tests. Formula notation, one-way and two-way ANOVA and post-hoc testing, graphical summary of ANOVA and post-hoc testing, extracting means and summary statistics; Simple linear regression, multiple linear regression and	15

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<table>
<tr><td></td><td colspan="2">curvilinear regression, Stepwise, Forward, Backward procedures and analysis of residuals.</td><td></td></tr>
<tr><td>REFERENCES</td><td colspan="3">1.Mark Gardener (2012), Beginning R - The Statistical Programming Language, Wiley India PvtLtd.
2. Andrie de Vries and Joris Meys (2015), R Programming for Dummies, Wiley India Pvt Ltd.
3. Jared P. Lander (2014), R for Everyone - Advanced Analytics and Graphics, Pearson Education Inc.</td></tr>
<tr><td rowspan="5">COURSE OUTCOME</td><td colspan="2">On the successful completion of course students will be able to</td><td>Knowledge</td></tr>
<tr><td>CO1</td><td>Student familiar with Reading CSV files, EXCEL files, SPSS files and working with other data types</td><td>K 1 , K 6</td></tr>
<tr><td>CO2</td><td>Student ready to Creating faceted graphics with lattice packages</td><td>K2 , K 6</td></tr>
<tr><td>CO3</td><td>Student working with probability distributions, ANOVA, Linear Regression</td><td>K 3 , K 4</td></tr>
<tr><td>CO4</td><td>Student working with stepwise regression analysis procedures and analysis of residuals.</td><td>K 1 , K 6</td></tr>
<tr><td>COs – POs MAPPING</td><td colspan="3"></td></tr>
</table>

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	3	3	3	2	3	2	3	1	2	2
CO2	2	2	3	2	2	2	3	2	3	2	2	3	2
CO3	2	3	2	2	2	2	3	3	2	3	2	2	3
CO4	3	3	3	2	3	2	2	3	2	2	2	2	3

Low:1, Medium:2, High:3

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	I
COURSE CODE & TITLE	22RMSCST103: **THEORY OF ESTIMATION**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To discuss about a procedure of "guessing" properties of the population from which data are collected 2. To determine the approximate value of a Population Parameter on the basis of a Sample Statistic 3 .To discuss about different estimation methods		

UNIT	CONTENT	NO. OF HOURS
I	Point estimation- properties of estimates -Consistency and its different forms -Sufficient condition for consistency - Factorization theorem – Sufficient Statistic - Distributions admitting sufficient statistic, procedure for finding minimal sufficient statistic.	15
II	The information measure Cramer - Rao (CR) inequality - Kiefer Chapman - Robbins (KCR) inequality - Bhattacharya inequality - minimum variance bound estimator- Invariant (equivariant) estimators (concepts only)	15
III	Uniformly minimum variance unbiased estimators (UMVUE)- condition for the existence of UMVUE- Completeness and Bounded completeness- Relation between complete statistic and minimal sufficient statistic- Rao - Blackwell Theorem- Lehmann Scheffe s theorem.	15
IV	Methods of estimation method of moments- method of maximum likelihood and its properties-large sample properties of MLE - Method of minimum chi- square and its properties Methods of least squares Optimum properties of least square estimates in linear model.	15

REFERENCES	1. Goon, A.M, Gupta,M.K, and Das Gupta, B.C(1980) : An outline of Statistical Theory, Vol. II,The World Press, Calcutta. 2. Lehmann, E.L(1983) : Theory of Point Estimation, Wiley Eastern Ltd, 1983. 3. Mood, A.M., Graybill, F.A and Boers, D.C(1974) : Introduction to Theory of Statistics, Mc Graw-Hill Book Company. 4. Rao, C.R(1998): Linear Statistical Inference and its Applications, Wiley Eastern Ltd,. 5. Casella, G and Berger, R.L(2002):Statistical Inference , Duxubury Process, Belmont, USA.

COURSE OUTCOME	**On the successful completion of course students will be able to**		**Knowledge**
	CO1	Students must familiar with Point Estimation	K 2 , K 4

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	CO2	Cramer - Rao Inequality	K 2
	CO3	Uniformly minimum variance unbiased estimators	K 2 , K 4
	CO4	Methods of Estimation - Method of Moments	K 2 , K 4

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	3	2	2	2	3	1	2	2
CO2	2	2	2	3	2	2	3	2	1	3	2	2	2
CO3	2	2	2	3	2	2	3	2	2	2	2	2	2
CO4	3	2	3	3	2	2	2	3	3	3	2	2	2

Low:1, Medium:2, High:3

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KAKUTUR-524 324.
SPS Nellore Dist. (A.P)

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	M.Sc. Statistics	SEMESTER	I
COURSE CODE & TITLE	22RMSCST104(a): **DISTRIBUTION THEORY**		
NUMBER OF CREDITS	4	HOURS/WEEK	6
COURSE OBJECTIVES	1. Discuss about to find the distributions and properties for various functions of random variables 2. To discuss about Sampling distributions and their inter-relationships 3. To discuss about Properties of order statistics 4. Multiple and Partial Correlation Coefficients		

UNIT	CONTENT	NO. OF HOURS
I	Brief Review of Basic Distribution Theory; Joint, Marginal and Conditional p.m.functions andp.d.functions. Rectangular, Lognormal, Exponential, Gamma, Beta, Cauchy, Laplace and Weibull Distributions; Functions of Random Variables and Their Distributions Using Jacobian Transformations and Other Tools.	15
II	Sampling Distributions: Review of Central Chi Square, t and F Distributions. Relation between t and F, F and χ^2; Fisher's Z-distribution, fisher's Z-transformation.Non-Central Chi Square, t and F Distributions and Their Properties.	15
III	Order Statistics and Their Uses; Joint and Marginal Distributions of Order Statistics:Distribution of Range. Extreme Values and Their Asymptotic Distributions (Statements Only).	15
IV	Multiple and Partial Correlation Coefficients, Multiple Linear Regression, Inter Relationship Among Partial, Multiple Correlation and Regression Coefficients. Null Distributions of Simple, Partial and Multiple Correlation Coefficients. Compound binomial distribution and compound Poisson distribution.	15

REFERENCES

1. ChaudaryB (1983): The Elements of Complex Analysis, Wiley Eastern.
2. Curtiss. I.H (1978): Introduction to the functions of Complex variables, Marcel Dekker
3. David H.A (1981): Order Statistics, II Edition, and John Wiley.
4. Dudewicz E.J and Mishra S.N (1988): Modern Mathematical Statistics, Wiley, International Students Edition.
5. Feller W (1966): Introduction to probability theory and its applications, Vol. III, second edition. Wiley Eastern.
6. Johnson, N.L and Kotz, S.M. (1972): Distributions in Statistics, Vol. I, II & III. Houghton and Miffin.
7. Mukhopadhyay, P (2002), Mathematical Statistics, Books and Allied (p) Ltd., Kolkata.
8. Pitman J. (1993): Probability, Narosa Publishing House.
9. Rao C.R (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.
10. Rohatgi V.K. (1984): An Introduction to probability theory and mathematical

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statistics.

11. Sharma J.N (1996), Functions of Complex Variable, Krishna Prakasam Media, Meerut.
12. S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics. Sulthan and Chand Company.
13. Yule, U and M.G. Kendall: An introduction to the theory of Statistics.

COURSE OUTCOME

	On the successful completion of course students will be able to	Knowledge
CO1	Students know about discrete and Continuous Probability Distributions	K 2
CO2	They identify the difference between Central and Non-Central Distributions	K 2 , K 4
CO3	Student Understand how to use non-central distributions in real life problems	K2 , K4,K 5
CO4	Student must familiar with Non-Linear Regression, Wald Test, Lagrange Multiplier Test and Likelihood Ratio Test	K 2 , K 5

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	2	3	3	3	2	1	2	3
CO2	2	2	2	3	2	2	2	3	2	2	2	3	2
CO3	2	2	2	3	2	3	2	3	2	2	2	2	2
CO4	3	2	2	2	3	2	3	2	3	2	3	2	3

Low:1, Medium:2, High:3

HEAD
Department of Statistics
VIKRAMA SIMHAPURI UNIVERSITY
KAKUTUR-524 324.
SPS Nellore Dist. (A.P)

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	I
COURSE CODE & TITLE	22RMSCST104(b): **LINEAR ALGEBRA**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To introduce the notions of abstract vector spaces and linear transformations and properties of inner product spaces. 2. To study Important results generalized inverse of a matrix, Moore-Penrose Generalized Inverse 3. To study the classification of quadratic forms, Hermitian forms 4. To study the Spectral Decomposition of a Real Symmetric Matrix		

UNIT	CONTENT	NO. OF HOURS
I	Finite Dimensional Vector Spaces : Vector Spaces and Subspaces , Linear Dependence and Independence, Basis and Dimension of a Vector Space , Completion Theorem , Inner Product Spaces, Ortho Normal Basis and Gram-Schmidt Orthogonalization Process , Orthogonal Projection of a Vector	15
II	Algebra of matrices : Elementary Transformations , Rank and Inverse of a Matrix , Idempotent Matrices ,Partitioned Matrices , Kronecker Product, Rao's Generalized Inverse of Matrix ,Moore - Penrose Generalized Inverse , Solutions of Simultaneous Equations .	15
III	Linear Transformations and Properties: Orthogonal and Unitary Transformations, Real Quadratic Forms, Reduction and Classification of Quadratic Forms, Hermitian Forms, Sylvester's Law of Inertia, Canonical Reduction of Quadratic Form.	15
IV	Characteristic Roots and Vectors : Cayley – Hamilton Theorem; Minimal Polynomial , Similar Matrices , Spectral Decomposition of a Real Symmetric Matrix , Reduction of a Pair of Real Symmetric matrices , Hermitian Matrices .	15

REFERENCES

1. 1 Bellman, R. (1970), Introduction to Matrix Analysis, 2nd ed. McGraw Hill, New York.
2. Biswas, S. (1984), Topics in Algebra of Matrices, Academic Publications.
3. Campbell, H.G. (1980), Linear Algebra with Applications, 2nd Edition, Prentice-Hall, Englewood Cliffs (new Jersey), 1980.
4. Graybill, F.A. (1983). Matrices with applications in statistics, 2nd ed. Wadsworth, Belmont (California).
5. Hadley, G. (1987), Linear Algebra, Narosa Publishing House.
6. Halmos, P.R. (1958), Finite-dimensional Vector Spaces 2nd ed. D.Van Nostrand Company, Inc.
7. Hoffman, K. and Kunze, R, (1971). Linear Algebra, 2nd ed., Prentice

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8. Narayan, S. (1970), Theory of Matrices, S. Chand &Company, New Delhi.
9. Rao, A.R. and Bhimasankaram, P. (1992), Linear Algebra, Tata McGraw Hill Publishing Company Ltd.
10. Rao, C. R. (1985). Linear statistical inference and its applications, Wiley Eastern Ltd., New Delhi.
11. Searle, S. R. (1982). Matrix Algebra useful for Statistics, John Wiley and Sons. Inc.

COURSE OUTCOME

	On the successful completion of course students will be able to	**Knowledge**
CO1	Solve the system of linear equations	K 1 , K 2
CO2	Understand the concept of vector space, basis and dimension.	K 1 , K 2
CO3	Analyze the linear Transformation	K 1 ,K 2,K3
CO4	Explain the direct sum decompositions	K 1 , K 2

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	2	2	1	2	2	1	2	2
CO2	2	2	1	2	2	2	1	2	2	2	2	2	1
CO3	2	3	2	2	1	2	3	1	2	3	2	2	3
CO4	2	2	2	1	2	2	2	2	2	2	2	2	2

Low:1, Medium:2, High:3

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	I
COURSE CODE & TITLE	22RMSCST105(a): **SAMPLING TECHNIQUES**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. Discuss about basic concepts of sampling techniques PPS WR/WOR models 2. To study about Hurwitz Thompson estimator, PPS scheme 3. To learn about Ratio and Regression methods and their properties 4. To explain Double sampling for difference estimators using ratio regression and PPS's, Non- sampling error and their remedies		

UNIT	CONTENT	NO. OF HOURS
I	Review of basic concepts of sampling theory such as sampling design, sampling scheme, sampling strategy etc., Sampling with varying probability with and without replacement, PPS WR/WOR methods – Lahiri's sample scheme, Hansen – Hurwitz, Des Raj estimators for a general sample size and Murthy estimator for a sample of size 2, Symmentrized Des Raj estimator.	15
II	Hurwitz – Thompson estimator (HTE) of a finite population total / mean, expression for V(HTE) and its unbiased estimator. IPPS scheme of a sampling due to Midzuno – Sen and JNK Rao (sample size 2 only). Rao – Hartley-Cochran sampling scheme for a sample of size n with random grouping.	15
III	Ratio and Regression methods of estimation, two stage sampling, Multi stage sampling, Cluster sampling. Resampling methods and its applications.	15
IV	Double sampling for difference, ratio, regression and PPS estimators; Large scale sample surveys, Errors in surveys, A mathematical model for errors of measurement, Sampling and Non-sampling errors, Sources and types of non-sampling errors, Remedies for non-sampling errors.	15

REFERENCES

1. Chaudhuri. A and Mukherjee. R (1988): Randomized Response Theory and Techniques,
New York, Marcel Dekker Inc.
2. Cochran W.G (1988): Sampling Techniques III Edition (1977) Wiley.
3. Des Raj and Chandak (1988): Sampling Theory. Narosa.
4. Murthy M.N (1977): Sampling Theory and Methods. Statistical Publishing Society.
5. Sukhatme et al (1984): Sampling Theory of Surveys with Applications. Iowa State
University Press &IARS
6. Mukhopadhyay P (1996): Inferential problems in Survey Sampling, New

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	Age International.		
COURSE OUTCOME	**On the successful completion of course students will be able to**		**Knowledge**
	CO1	Students learnt different sampling techniques of with replacement/ without replacement and Different sampling models	K1 , K2 ,K3
	CO2	Students studied different sampling schemes and estimators	K1 , K2 ,K3
	CO3	Student able to familiar with Two stage sampling and Multi stage sampling	K1 , K2 ,K3
	CO4	Student learn about difference between sampling and non-sampling errors	K1 , K2 ,K3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	2	2	3	2	1	2	3
CO2	2	2	2	3	2	2	3	2	3	2	3	2	2
CO3	2	2	2	2	2	2	2	2	3	3	2	2	2
CO4	3	2	2	2	3	3	2	3	2	3	2	2	2

Low:1, Medium:2, High:3

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22RMSCST106: Practical – I

Practical exercise of all papers such that there must be at least 4 practical problems on each paper (training is expected on manual practice work and practical work on system using available software). (75 marks for practical examination + 25 marks for Record in the Semester I).

Course Objectives

1. To write different problems manually solving through calculators
2. To write problems and solving them on computers using Statistical software like Excel and other relevant software

Course Outcomes

1. Student can able to understand and analyze the Numerical problems related to Probability Theory, Distribution Theory, and Statistical Computing etc., are solved by executing programs on computers

Mapping of Course ST-106

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	3	2	2	2	3	2	2	2	2

Note: 1 – Low 2 – Medium 3 - High

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Course code	--	CYBER SECURITY	L	T	P	C
Components of study		AUDIT COURSE	3		1	4
		Common Course for all PG Courses of Vikrama Simhapuri University College	Syllabus Version		2022	

Learning Outcomes

1. Students after completing this module will be able to understand the basic terminologies related to cyber security and current cyber security threat landscape. They will also develop understanding about the Cyberwarfare and necessity to strengthen the cyber security of end user machine, critical IT and national critical infrastructure.
2. After completion of the module, students will have complete understanding of the cyber-attacks that target computers, mobiles and persons. They will also develop understanding about the type and nature of cyber-crimes and as to how report these crimes through the prescribed legal and Government channels.
3. Students after completing this module will be able to understand the legal framework that exist in India for cyber-crimes and penalties and punishments for such crimes, it will also expose students to limitations of existing IT Act,2000 legal framework that is followed in other countries and legal and ethical aspects related to new technologies.
4. After completing this module, students will understand the aspects related to personal data privacy and security. They will also get insight into the Data Protection Bill,2019 and data privacy and security issues related to social media platforms.
5. Students after completing this module will understand the main components of cyber security plan. They will also get insights into risk-based assessment, requirement of security controls and need for cyber security audit and compliance.

Unit:1	Overview of Cyber Security	12hours

Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies

Unit:2	Cyber Crimes	12hours

Cyber crimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cyber-squatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake news, cyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.

Unit:3	Cyber Law	12hours

Cyber crime and legal landscape around the world, IT Act,2000 and its amendments. Limitations of IT Act, 2000. Cyber crime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media, Cyber Laws of other countries, Case Studies

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Unit:4	Data Privacy and Data Security	12hours

Defining data, meta-data, big data, non-personal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues.

Unit:5	Cyber Security Management, Complaince and Governance	12hours

Cyber security Plan- cyber security policy, cyber crises management plan., Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy

Practical Components

- Platforms for reporting cyber crimes.
- Checklist for reporting cyber crimes online.
- Setting privacy settings on social media platform.
- Prepare password policy for computer and mobile device.
- List out security controls for computer and implement technical security controls in the personal computer.
- Log into computer system as an administrator and check the security policies in the system.

References

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.
4. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.
5. Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1st Edition, Wiley Publication.
6. Auditing IT Infrastructures for Compliance By Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning.

Online Resources:

- https://www.simplilearn.com/tutorials/cyber-security-tutorial/what-is-cyber-security
- https://www.w3schools.com/cybersecurity/
- https://www.javatpoint.com/cyber-security-tutorial
- https://www.tutorialsmate.com/2020/10/types-of-cybercrime.html

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	M.Sc. Statistics	**SEMESTER**	II
COURSE CODE & TITLE	22RMSCST201: **STATISTICAL INFERENCE**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. Perform the appropriate statistical analyses based on the business question and the type of data; 2. Interpret the results of statistical analyses; 3. Make inferences about the population from sample data; 4. Apply inferential statistics to make evidence-based business decisions.		

UNIT	CONTENT	NO. OF HOURS
I	Point Estimation – Concept of Unbiasedness – Consistency – Minimum Variance Unbiased Estimation – Information In A Sample – Cremer-Rao Inequality – Efficiency Of An Estimator – Bhattacharya Bounds – Definition Of Can Estimator.	15
II	Concept Of Sufficiency – Single Parameter Case – Minimal Sufficient Statistics – Exponential Families – Distribution Admitting Sufficient Statistics – Rao-Blackwell Theorem – Completeness	15
III	Methods Of Estimation – Minimum Variance Method – M.L. Method Of Estimation – For Complete Samples M.L. Estimation For Failure Censored And Time Censored Sample – Interval Estimation – Confidence Interval – Shortest Confidence Interval	15
IV	Elements Of Decision Theory – Loss And Risk Functions And Admissibility – Minimum Decision Rules – Randomized Decision Rules.	15

REFERENCES

1. Kendal And Stuart : Advanced Theory Of Statistics Vol-IiChapt 17,18,20ϖ&24
2. Mood, Grybill And Boes : Introduction To The Theory Of Statistics
3. V.K.Rohatgi : An Introduction To Probability Theory And Mathematical Statistics
4. A.M.Goon, M.Gupta And Das Gupta : An Outline Of Statistical Theory Vol-Ii
5. Kapur And Gupta : Fundamental Of Mathematical Statistics
6. Wilks S.S. : Mathematical Statistics
7. B.K.Kale&Sinha : Reliability &Life Testing, Wiley Eastern, India.
8. B.K.Kale (1999): The First Course On Parametric Inference.
9. Book On Spss For Research Work,Himalaya Publications.

COURSE OUTCOME	**On the successful completion of course students will be able to**	**Knowledge**
	CO1 Apply various estimation and testing procedures to deal with real life problems	K 3 , K 4
	CO2 Understand Point Estimation, Consistency, Efficiency of an Estimator, Bhattacharya Bounds	K 2

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	CO3	Minimum Variance Method, Interval Estimation	K 3
	CO4	Elements Of Decision Theory, Loss and Risk Functions	K 1 , K 4

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	3	3	2	2	2	1	2	3
CO2	2	2	3	2	2	2	3	2	2	3	2	2	2
CO3	2	3	2	2	3	2	3	2	3	2	3	2	2
CO4	3	2	3	3	2	2	2	2	3	3	2	1	3

Low:1, Medium:2, High:3

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	M.Sc. Statistics	**SEMESTER**	II
COURSE CODE & TITLE	22RMSCST202: **MULTIVARIATE ANALYSIS**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. The main objective of this course is to introduce students to the analysis of observations on several correlated random variables for a number of individuals. 2. The analysis becomes necessary in Anthropology, Psychology, Biology, Medicine, Education, Agriculture and Economics when one deals with several variables simultaneously. 3. Analyze multivariate data using the different statistical software packages		

UNIT	CONTENT	NO. OF HOURS
I	Multivariate Normal Distribution, Marginal and Conditional Distributions, Characteristics Functions, Maximum Likelihood Estimators of Parameters, Distribution of Sample Mean Vector and Dispersion Matrix, Distribution of Quadratic Forms, Fisher – Cochran Theorem on Ranks of Quadratic Forms (Statement Only) Its Use.	15
II	Hoteling's $T^2$and its applications: T^2Distribution, Application of $T^2$to Single Sample and Two Sample, Optimum Properties of T^2 Test. Mahalanobis D^2 Statistic and its Distribution, Multivariate Analysis of Variance (MANOVA) of One and Two-Way Classified Data.	15
III	Classification and Discrimination: Procedures for Classification of Observational Vector into Two Multivariate Normal Populations, Fisher's Discriminant Function, Classification into More Than Two Multivariate Normal Populations, Wishart Distribution and its Properties, Concept of Sample Generalized Variance and its Distribution.	15
IV	Multivariate Linear Regression Model - Estimation of Parameters, Inferences Concerning the Regression Parameters, Likelihood Ratio Test for the Regression Parameters, Canonical Variates and Correlations, Concept of Principal Components and their Estimates.	15

REFERENCES

1. Anderson, T.W (1983), An introduction to Multivariate Statistical Analysis,Wiley, 2nd Edition.
2. Johnson A.R and Wishern, D.W (1996), Applied Multivariate Statistical Analysis, Prentice Hall of India
3. K.C. Bhuyan (2005): Multivariate Analysis and its Applications, CentralBook Agency (P) Ltd, Kolkata.

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4. Morrison, F (1985): Multivariate Statistical Methods, Mc Graw Hill Book Company.
5. Ksheera Sagar, A.M (1972), Multivariate Analysis, Marcel Dekker.
6. Rao, C.R (1973), Linear Statistical Inference and its applications, 2nd edition, Wiley.

COURSE OUTCOME

	On the successful completion of course students will be able to	Knowledge
CO1	Student understand account for important theorems and concepts in multivariate analysis	K 2
CO2	Student can Summarize and interpret multivariate data	K 3
CO3	Student can able to conduct statistical inference about multivariate means including hypothesis testing, confidence region calculation, etc.	K 4
CO4	Student can understand the link between multivariate regression techniques and corresponding univariate techniques	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3
CO1	2	3	1	3	3	2	2	2	3	2	3	2	1
CO2	2	2	2	3	3	2	2	2	3	2	2	3	2
CO3	2	2	3	2	2	3	3	2	2	3	1	2	2
CO4	2	1	3	3	2	2	2	3	3	2	2	2	2

Low:1, Medium:2, High:3

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	M.Sc. Statistics	**SEMESTER**	II
COURSE CODE & TITLE	22RMSCST203: **PROBABILITY THEORY - II**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. The objective of the course is to impart necessary knowledge about theoretical aspects of two and multidimensional random variables and their distributions. 2. The course is also oriented towards the formulation of probability distributions and densities with their practical applications. 3. The course also introduces central and non-central distributions and distributions of quadratic forms.		

UNIT	CONTENT	NO. OF HOURS
I	Characteristic function - Definition and properties Inversion formula and its application Characteristic Function and Moments Bochner s theorem (statement only) Simple problems. Weak and complete convergence of distribution functions Helly's First and Second limit theorems	15
II	Law of large numbers: Kolmogrov Inequality Weak law of large numbers (Khinchin s and Kolmogrov) - Kolmogrov Strong law of large numbers Glinvenko-Cantelli Theorem (statement only)	15
III	Central Limit Theorem :iid case Lindeberg-Levy and Liapounov s form - Lindeberg - Feller form Infinitely Divisible distributions definition, elementary properties and examples canonical representation (without proof)	15
IV	Conditioning: Radon Nikodym theorem and derivative (without proof) - Conditional expectation definition properties (probability and expectation properties) - conditional probability and its applications Definition and properties of Martingales and Sub-martingales Martingale convergence theorem	15

REFERENCES	1. Ash, R.B (1972) : Real Analysis and Probability, Academic Press . 2. Billingsley .P.(1979): Probability and Measure , Wiley 3. Kingman and Taylor (1966) : Probability Theory , Narosa. 4. Tucker. H.G. (1967) : A Graduate course in probability , Academic Press 5. Loeve. M.(1985) : Probability theory , 3/e, Von Nostrand . 6. Burrill, C.W. (1972): Measure, Integration and Probability, Mc Graw Hill		
COURSE OUTCOME	**On the successful completion of course students will be able to**		**Knowledge**
	CO1	To discuss about Characteristic functions and related theorems	K1

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KAKUTUR-524 324.
SPS Nellore Dist. (A.P)

	CO2	To discuss on weak law of large numbers and Strong law of large numbers	K 1
	CO3	To discuss about Central Limit Theorem	K 1 , K 2
	CO4	To discuss about Martingales and Sub-martingales Martingale convergence theorem	K 1 , K 2

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	2	2	3	2	2	2	2	3
CO2	1	2	3	2	3	2	2	2	1	3	1	2	2
CO3	1	2	2	3	2	2	2	3	2	2	3	2	2
CO4	2	3	2	3	2	2	3	2	2	3	2	2	2

Low:1, Medium:2, High:3

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	M.Sc. Statistics	**SEMESTER**	II
COURSE CODE & TITLE	22RMSCST204(a) : **STOCHASTIC PROCESSES**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To explain stochastic process and their classification according to space and domain 2. To discuss about Birth and death process, Renewal theory and its applications, stochastic process and their importance, Markov chains, Poisson process, Renewal theory, Branching process etc.		

UNIT	CONTENT	NO. OF HOURS
I	Introduction to Stochastic Processes (SP's): Classification of SP's according to State Space and Time Domain. Countable State Markov Chains (MC's), Chapman – Kolmogorov Equations, Calculation of n – Step Transition Probability and its Limit. Stationary Distribution, Classification of States, Transient MC, Random Walk and Gambler's Ruin Problem.	15
II	Discrete State Space Continuous Time MC: Kolmogorov – Feller Differential Equations, Poisson Process, Birth and Death Process; Applications to Queues and Storage Problems. Wiener Process as a Limit of Random walk, First– Passage Time and Other Problems.	15
III	Renwal Theory: Elementary Renewal Theorem and Applications. Statement and Uses of Key Renewal Theorem, Study of Residual Life Time Process: Weakly Stationary and Strongly Stationary Process; Moving Averages and Auto Regressive Process.	15
IV	Branching Process: Galton – Watson Branching Process, Probability of Ultimate Extinction, Distribution of Population Size. Martingale in Discrete Time, Inequality, Convergence and Smoothing Properties. Statistical Inference in MC and Markov Process.	15

REFERENCES

1.Adke, S.R and Manjunath, S.M (1984): An Introduction to Finite Markov Processes, Wiley

2.Bhat, B.R (2000): stochastic Models: Analysis and Applications, New Age International,

3.Cinlar, E (1975): Introduction to Stochastic Processes, Prentice Hall.

4.Feller, W (1968): Introduction to Probability and its Applications, Vol. 1, Wiley Eastern.

5.Harris, T.E (1963): The Theory of Branching Processes, Springer – Verlag.

COURSE OUTCOME	**On the successful completion of course students will be able to**		**Knowledge**
	CO1	Students understood stochastic processes	K 2
	CO2	Students understood discrete state space	K 2

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KAKUTUR-524 324.
SPS Nellore Dist. (A.P)

	CO3	Students understood concept of renewal theory	K 2
	CO4	Students understood the concepts of branching process	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	3	2	2	2	2	2	1	3	2
CO2	2	2	3	2	2	3	2	3	2	2	2	3	2
CO3	2	2	3	2	3	2	3	2	2	2	3	2	2
CO4	3	2	2	3	2	2	2	2	2	1	2	2	3

Low:1, Medium:2, High:3

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	II
COURSE CODE & TITLE	22RMSCST204(b): **THEORY OF LINEAR ESTIMATION AND ANALYSIS OF VARIANCE**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To discuss about matrix algebra and its components 2. To study about linear estimation methods and its fitting 3. To explain ANOVA and its testing process 4. To discuss about ANCOVA		

UNIT	CONTENT	NO. OF HOURS
I	Matrix algebra- Fundamental definitions, determinants, rank of a matrix, inverse of a matrix, orthogonal matrix, idempotent matrix, characteristic roots and vectors of a matrix. Numerical computation of characteristic roots and vectors for a positive definite matrix. Reduction of a positive definite matrix to a diagonal form using an Orthogonal matrix and non-singular matrix. Cayley-Hamilton theorem, trace of a matrix. Quadratic forms, reduction of quadratic forms using orthogonal transformation, statement of Cochran's theorem for quadratic forms.	15
II	Theory of linear estimation, linear models, estimability of linear parametric function, best linear unbiased estimator, Gauss-Markov set-up, Gauss-Markov theorem, generalized linear model, generalized Gauss-Markov theorem (Atken's theorem).	15
III	Decomposition of sum of squares in analysis of variance one way classification, two way classification with equal and unequal number of observations per cell. Multiple comparisons; Fisher's least significance difference test and Duncan's multiple range test, Fixed, random and mixed effect models.	15
IV	Analysis of covariance of one way and two way classification, applications to standard designs- CRD, RBD.	15

REFERENCES

1. Datta, K.B. (2000)., Matrix and Linear Algebra
2. Rangaswamy, R,(1995), A text book of Agricultural Statistics., New Age international Publishers Limited.
3. Kempthorne,O,(1951)., The design and Analysis of Experiments., Wiley Eastern Private Limited
4. Rao, C.R,(1983)., lnear Statistical inference and its applications., Wiley Eastern Ltd
5. Joshi, D.D.(1987), Linear Estimation and Design of experiments., Wiley

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Eastern Ltd.

6. Biswas, S.(1984). Topics in Algebra of Matrices, Academic Publication

COURSE OUTCOME

	On the successful completion of course students will be able to	Knowledge
CO1	Students learnt how to solve different numerical computations in matrix form	K1 , K2 ,K3
CO2	Students must know about different estimation methods	K1 , K2 ,K3
CO3	Student find how to solve experimental designs	K1 , K2 ,K3
CO4	Students learnt how to solve different numerical computations in matrix form	K1 , K2 ,K3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	2	2	3	2	1	2	3
CO2	2	2	2	3	2	2	3	2	3	2	3	2	2
CO3	2	2	2	2	2	2	2	2	3	3	2	2	2
CO4	3	2	2	2	3	3	2	3	2	3	2	2	2

Low:1, Medium:2, High:3

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	II
COURSE CODE & TITLE	22RMSCST205(a): **LINEAR MODELS AND APPLIED REGRESSION ANALYSIS**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To discuss about linear regression models and their assumptions 2. To study about different criteria for model selection and their Goodness of fit measures 3. To explain Non normal disturbances and their consequences and statistical analysis of residuals 4. To discuss about Non-linear regression estimation methods		

UNIT	CONTENT	NO. OF HOURS
I	Two and Three Variable Linear Regression Models; General Linear Model:Assumptions; OLS Estimation; BLUE; Tests of Significance of Individual Regression Coefficients; Testing the Equality Between Two Regressions Coefficients; Test of Significance of Complete Regression.	15
II	Criteria for Model Selection; Goodness of Fit Measures; $R^2$and Adjusted R^2Criteria; C_p Criterion; Testing the General Linear Hypothesis; Chow Test for Equality between Sets of Regression Coefficients in Two Linear Models; Test for Structural Change; Restricted Least Squares Estimation; Generalized Mean Squared Error Criterion.	15
III	Non-Normal Disturbances and their Consequences; Test for Normality; Jarque-BeraTest; Shapiro-Wilk Test, Minimum Absolute Deviation (MAD) Estimation; Box-Cox Transformations.	15
IV	Non-Linear Regression; Non-Linear Least Squares Estimation; Maximum Likelihood Estimation; Idea of Computational Methods; Gradient Methods, Steepest Descent Method; Testing General Nonlinear Hypothesis; Wald Test, Lagrange Multiplier Test and Likelihood Ratio Test.	15

REFERENCES

1. Draper, N and Smith, B (1981): Applied Regression Analysis, Second Edition.
2. Guajarati, D (1979): Basic Econometrics, MC Graw Hill.
3. Johnston, J (1984): Econometric Methods, III rd edition. MC Graw Hill.
4. Judge, C.G., Griffiths, R.C. Hill, W.E., Lutkephol, H and Lee, T.C (1985): The Theory and Practice of Econometrics, John Wiley and Sons.

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COURSE OUTCOME	**On the successful completion of the course, students will be able to**		**Knowledge**
	CO1	learnt about different linear and non-linear regression models and their appropriate computational procedures	K 1 , K 2
	CO2	R^2, Adjusted R^2 and C_p criteria for model selection	K 2 , K 3
	CO3	Non-Normal Disturbances, Test for Normality	K 2 , K 3
	CO4	Non-Linear Regression, Wald Test, Lagrange Multiplier Test and Likelihood Ratio Test	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	2	2	3	2	1	2	3
CO2	2	2	2	3	2	2	3	2	3	2	3	2	2
CO3	2	2	2	2	2	2	2	2	3	3	2	2	2
CO4	3	2	2	2	3	3	2	3	2	3	2	2	2
Low:1, Medium:2, High:3													

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	II
COURSE CODE & TITLE	22RMSCST205(b): **STATISTICAL PATTERN RECOGNITION**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. Understand the core theories and algorithms of statistical pattern recognition 2. Understand the state-of-the-art of statistical pattern recognition, 3. Perform parametric classifier design, 4. Perform nonparametric classifier design		

UNIT	CONTENT	NO. OF HOURS
I	Pattern Recognition as a problem of testing. Error probability. Upper bounds on error probability. Other hypothesis tests including sequential test. Linear classifiers—Linear discriminant function for Minimum error, Minimum MSE.	15
II	Non Parametric decision making – Histograms, Kernel and Window estimators, Nearest neighbor classification techniques. Adaptive decision boundaries and discriminant functions. Clustering-Hierarchical clustering and partitioned clustering.	15
III	Artifical neural networks – nets with and without hidden layers. Back – propagation algorithm, Image analysis – Scene Segmentation and labeling, counting objects, perimeter measurement, projections, least squares and Eigen vector line fitting, shape of regions and Morphological Operations.	15
IV	Feature selection and extraction – Distance measures, clustering transformation and feature ordering,clustering in feature selectio , feature selection through entropy minimization. Binary feature selection—sequential and parallel algorithms.	15

REFERENCES

1. Introduction to Statistical Pattern Recognition by K. Fukunana (1990). Academic press.
2. Pattern Recognition and Image Analysis by E.Gose, R. Johnson Baugh and S. Jost-PHI.
3. Pattern Recognition and Scene Analysis by R.O. Duda and P.E. Hart (1973) John Wiley

COURSE OUTCOME

	On the successful completion of the course, students will be able to	**Knowledge**
CO1	Perform feature selection and dimension reduction,	K1 , K2 ,K3
CO2	Perform unsupervised data clustering,	K1 , K2 ,K3
CO3	Understand the applications such as face	K1 , K2 ,K3

		recognition, face detection, object detection, gesture recognition, speech recognition, etc.	
	CO4	Student able to learn about binary feature selection and different algorithm like sequential and parallel.	K1 , K2 ,K3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	2	2	3	2	1	2	3
CO2	2	2	2	3	2	2	3	2	3	2	3	2	2
CO3	2	2	2	2	2	2	2	2	3	3	2	2	2
CO4	3	2	2	2	3	3	2	3	2	3	2	2	2
Low:1, Medium:2, High:3													

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	M.Sc. Statistics	**SEMESTER**	II
COURSE CODE & TITLE	22RMSCST206: **PRACTICAL – II**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	Practical exercise of all papers such that there must be at least 4 practical problems on each paper (training is expected on manual practice work and practical work on system using available software). (75 marks for practical examination + 25 marks for Record in the Semester II).		

UNIT	CONTENT	NO. OF HOURS
I	PRACTICAL – II	15
II	PRACTICAL – II	15
III	PRACTICAL – II	15
IV	PRACTICAL – II	15

REFERENCES

1. Mood, Grybill And Boes : Introduction To The Theory Of Statistics.
2. Sharma, S (1996), Applied Multivariate Techniques, Wiley.
3. Kingman and Taylor (1966) : Probability Theory , Narosa
4. Draper, N and Smith, B (1981): Applied Regression Analysis, Second Edition.

COURSE OUTCOME

	On the successful completion of the course students will be able to	Knowledge
CO1	Students know about the solving of Numerical problems related to Statistical Inference, Linear Models and Applied Regression Analysis, Probability Theory – II and Statistical Multivariate Analysis.	K 2 ,K 3 ,K 4

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	3	2	2	2	3	2	2	2	2

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	II
COURSE CODE & TITLE	22RPEL201: **PERSONALITY ENHANCEMENT AND LEADERSHIP**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. Empowerment 2. Power of Positive Thoughts 3. Goal Setting and Work-Life Balance 4. Effective Communication Skills 5. Public Speaking and Presentation Skills 6. Interpersonal Skills and Building Rapport 7. Improving Memory and Present Moment Awareness 8. Leadership Development and Motivating people 9. Stress Management and Managing Emotions 10. Thinking Skills & Creativity 11. Problem Solving and Decision making 12. Time Management and Increasing Personal Effectiveness.		

UNIT	CONTENT	NO. OF HOURS
I	The concept personality Dimensions of theories of Freud & Erickson-personality - significant of personality development. The concept of success and failure: What is success? - Hurdles in achieving success - Overcoming hurdles - Factors responsible for success - What is failure - Causes of failure. SWOT analyses.	12
II	Concept - Significance - Factors affecting attitudes - Positive attitude - Advantages - Negative attitude - Disadvantages - Ways to develop positive attitude - Difference between personalities having positive and negative attitude. Concept of motivation - Significance - Intemal and extemal motives - Importance of self-m6tivation- Factors leading to de-motivation.	12
III	Term self-esteem - Symptoms - Advantages - Do's and Don'ts to develop positive self-esteem - Low selfesteem - Symptoms - Personality having low selfesteem - Positive and negative self-esteem. Interpersonal Relationships - Defining the difference between aggressive, submissive and assertive behaviours - Lateral thinking.	12
IV	Definition and meaning, Importance, Leadership and Management, Leader vs Manager, Essential qualities of an effective leader. Theories of Leadership: Trait theory, Behavioral theories, Contingency theory.	12

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V	Types of Leaders - Importance of Leadership - Leadership Skills - Building and Leading Efficient Teams - Leadership styles: Tradilional, Transactional, Transformational, Inspirational and servant leadership and Emerging issues in leadership: Emotional Intelligence and leadership, Trust as a factor, Gender and Leadership. Leadership Qualities of Abraham Lincoln, Mahatma Gandhi, Prakasam Pantulu, Dr. B.R. Ambedkar and J.R.D. Tata.	12

REFERENCES

1. Girish Batra, Experiments in Leadership, Chennai: Notion Press,2018.
2. Mitesh Klatri, Awaken the Leader in You, Mumbai: Jaico Publishing House,2013
3. Camegie Dale, Become an Effective Leader, New Delhi: Amaryllis, 2012
4. Hall, C.S-, Lindzey. G. & Campbell, J.B Theories of Personality. John Wiley & Sons
5. Organizational Behaviour, M. Parikh and R. Gupta, Tata-Mcgraw-Hill Education Pvt Ltd
6. Organizational Behavior, D. Nelson, J.C Quick and P. Khandelwal, Cengage Publication

COURSE OUTCOME

On the successful completion of the course, students will be able to		**Knowledge**
CO1	Personality Enhancement drives motivation and inspiration filled with energy and passion.	K 1 , K 2
CO2	Personality Enhancement develops to seek continuous self-improvement and brings out noticeable and immediate measurable result to the organization.	K 1 , K 2
CO3	This course enhances change in the behavior of delegates and ultimately satisfies the productivity to the organization.	K 1 , K 2
CO4	Students understood the types of leaders, leadership styles, leadership qualities from the freedom fighters, and industrial / corporate experts.	K 1 , K 2

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	2	2	3	2	1	2	3
CO2	2	2	2	3	2	2	3	2	3	2	3	2	2
CO3	2	2	2	2	2	2	2	2	3	3	2	2	2
CO4	3	2	2	2	3	3	2	3	2	3	2	2	2

Low:1, Medium:2, High:3

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PROGRAMME	M.Sc. Statistics	**SEMESTER**	III
COURSE CODE & TITLE	22RMSCST301: **ECONOMETRICS**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To explain about heteroscedasticity, multicollinearity and their sources, consequences and tests 2. To discuss about Autocorrelation, different orders of Autocorrelation and their estimation procedures 3. To explain different lag models and their estimate procedures 4. To discuss about simultaneous linear equations model and their different methods and estimation		

UNIT	CONTENT	NO. OF HOURS
I	Quick Review of Inference in General Linear Model; **Multicollinearity:** Sources and Consequences, Detection, Farrar-Glauber Test; Remedies, Ridge Family of Estimators and its Properties; **Heteroscedasticity:** Sources and Consequences; Tests for Heteroscedasticity; Glejser's Test Goldfeld-Quandt Test; Remedies, Estimation Under Heteroscedasticity.	15
II	Sources and Consequences; First Order Auto Regressive Scheme; Durbin-Watson Test; Remedies; Estimation Under Autocorrelation; Stochastic Regressors; Errors-in-Variables Linear Model; IV and ML Estimation Methods.	15
III	**Finite Distributed lag models;** Arithmetic Lag; Inverted V-Lag; Almon'sPolynomial Lag and Shiller's Lag Models; **Infinite Distributed Lag Models;** Geometric Lag Model; OLS and IV Methods of Estimation; Koyck's Two Step and Wallis Three Step Procedures; Pascal Lag Model.	15
IV	**Simultaneous Linear Equations Models:** Identification; Rank and Order Conditions; Indirect Least Squares, IV and LIML Methods; Two Stage Least Squares; k-Class Estimators; Three Stage Least Squares and FIML Methods of Estimation.	15

REFERENCES

1. Guajarati, D (1979): Basic Econometrics, Mc Graw hill.
2. Intrilligator, M.D (1980): Econometric Models, Techniques and Applications, Prentice Hall.
3. Johnston, J (1984): Econometric Methods, III rd Edition, MC Graw Hill.
4. Judge, C.G., Griffith, W.E., Hill, R.C.,Lutkepohl, H., and Lee, T. (1985): Theory and Practice of Econometrics, John Wiley.

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COURSE OUTCOME	**On the successful completion of the course students will be able to**		**Knowledge**
	CO1	Students learnt heteroscedasticity and multicollinearity and their estimation procedures	K 2 , K 3
	CO2	Students learnt autocorrelation and their estimation procedures	K 2 , K 3
	CO3	Students able to understand and learn how to use different lag models	K 2 , K 3
	CO4	Students understood about simultaneous linear equations model with their estimation methods	K 2 , K 3

K1-Remembering, K2- Understanding, K3-Applying, K4: Analyzing, K5- Evaluating, K6-Creating

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	3	3	2	3	2	1	3	2
CO2	2	2	2	3	2	2	3	2	3	2	3	2	2
CO3	2	3	3	2	2	2	2	2	2	2	3	2	2
CO4	3	2	3	2	2	2	3	2	3	3	3	2	3

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PROGRAMME	M.Sc. Statistics	**SEMESTER**	III
COURSE CODE & TITLE	22RMSCST302: **DESIGN OF EXPERIMENTS**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. Theory of probability and statistics will be explained with regards to this course 2. The effect of more than one factor will be explained by ANOVA method 3. To calculate factor levels that optimizes the outcome of an experiment 4. To learn the factorial design of experiments 5. Regression model for factorial analysis will be developed		

UNIT	CONTENT	NO. OF HOURS
I	Linear Model; Estimability of Linear Parametric Functions; BLUE, Gauss-Markoff Theorem; Generalized Gauss-Markoff Theorem, ANOVA Model, ANOVA for Two Way and Three-Way Classifications, ANCOVA Technique for One Way and Two-Way Classifications.	15
II	Latin Squares and Their Construction, Mutually Orthogonal Latin Squares; Missing Plot Technique in Latin Square Design, Graeco-Latin Square Design; Analysis of Factorial Experiments Involving Factors with Two and Three Levels in Randomized Blocks.	15
III	Necessity of Confounding, Types of Confounding, Complete and Partial Confounding in 2^n, 3^2 and 3^3 Factorial Designs, Analysis of Confounded Factorial Designs; Fractional Replication, Split Plot Design.	15
IV	Incomplete Block Designs; BIBD, Analysis of a BIBD, Types of BIBD, Construction of BIBD's using Mutually Orthogonal Latin Square, Youden Square, Two – Associate PBIB design, Analysis of PBIBD; Concept of Lattice Design.	15

REFERENCES

1. Angela Dean and Daniel Ross (1999), Design and Analysis of Experiments, Springer-Verlag.
2. Aloke Day (1986), Theory of Block Designs, Wiley Eastern, Pvt. Ltd., New Delhi.
3. C.D. Montgomery (1976), Design and Analysis of Experiments, Wiley & Sons, New York
4. D.D. Joshi (1987), Linear Estimation and Design of Experiments, Wiley Eastern, Pvt. Ltd., New Delhi.
5. D.Raghava Rao (1971), Construction and combinatorial problems in

Design of Experiments, Wiley & Sons

6. F. Pukelshiem (1993), Optimal Design of Experiments, Wiley & Sons
7. M.C. Chakbravarthy, (1962), Mathematics of Design of Experiments, Asia Publishing House, Calcutta.

COURSE OUTCOME

	On the successful completion of the course students will be able to	**Knowledge**
CO1	Student understand the importance of Design of Experiments	K 2
CO2	Given a number of factors which affects the experiment, the student should be able to determine the most important factor	K 2
CO3	Student learn the factorial design of experiments Design a learn regression model for an experiment and construct confidence intervals for each parameter	K 2 , K 3
CO4	Student asses the importance of curvature in regression and construct response surface	K 2 , K 3

K1-Remembering, K2- Understanding, K3-Applying, K4: Analyzing, K5- Evaluating, K6-Creating

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	3	2	2	3	2	2	3	2	2
CO2	2	2	2	3	2	3	2	3	3	2	3	2	2
CO3	2	3	3	3	2	3	2	2	3	2	3	3	3
CO4	3	2	2	2	2	3	3	2	2	3	2	2	3

Low:1, Medium:2, High:3

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DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

PROGRAMME	M.Sc. Statistics	**SEMESTER**	III
COURSE CODE & TITLE	22RMSCST303: **OPERATIONS RESEARCH - I**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. Operations Research is the discipline of applying advanced analytical methods to help make better decisions. 2. By using techniques such as mathematical modeling to analyze complex situations 3. Operations Research gives executives the power to make more effective decisions and build more productive systems.		

UNIT	CONTENT	NO. OF HOURS
I	Introduction, Definition and scope of Operations research; phases in Operations Research; models and their solutions. Concept of Optimal Solution, General Linear Programming Problem (LPP), Properties to Solution of LPP, Graphical Method, Simplex Method.	15
II	**Non-linear programming** - Kuhn Tucker conditions. Wolfe's algorithm for solving quadratic programming problems. Integer programming – Branch and bound algorithm and cutting plane algorithm.	15
III	**Project Management:** Flows in networks max-flow-min-cut theorem. Project Management; PERT and CPM, probability of project completion, PERT – crashing.	15
IV	**Game Theory:** Decision making in the face of competition, two-person games, pure and mixed strategies, existence of solution and uniqueness of value in zero- sum games, finding solution in 2x2, and 2xm, and mxn games. Non – zero sum games, co-operative and competitive games, equilibrium solutions and their existence in bi-matrix games. Nash equilibrium solution.	15

REFERENCES

1. Taha H.A (1982) Operational Research: An Introduction; Macmillan.
2. Hiller F. Sand Lieberman G.J. (1962) Introduction to Operations Research; Holden Day
3. Kanti Swarup; Gupta P.K and Singh M.M (1985) Operations Research; Sultan Chand.
4. Philips D.T, Ravindran A and Solberg J Operations Research, Principles and Practice.
5. Curchman C.W; Ackoff R.L and Arnoff E.L(1957) introduction to Operations Research; John Wiley
6. Hadley G (1964) Non-Linear and Dynamic programming Addison Wesley.

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

7. Mckinsey J.C.C (1952) Introduction to the theory of games Mc Graw Hill.
8. P.K. Gupta; D.S. Hira Operations Research S. Chand.

COURSE OUTCOME

	On the successful completion of the course students will be able to	Knowledge
CO1	Student understand the concept of Operations Research, Graphical Method and Simplex Method	K 2 , K 3
CO2	Student able to understand the concepts Non-Linear Programming and Integer Programming	K 2 , K 3
CO3	Student conceptualize optimum event management through Network scheduling	K 3
CO4	Student familiar with Game Theory, Pure and Mixed Strategies, Two Person Zero Sum Game	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	3	3	2	2	3	3	1	2	3
CO2	2	3	2	3	3	3	2	2	3	2	3	2	2
CO3	2	3	3	2	3	2	3	3	3	2	3	2	3
CO4	3	2	3	3	2	3	3	2	2	3	3	2	2

Low:1, Medium:2, High:3

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

PROGRAMME	M.Sc. Statistics	**SEMESTER**	III
COURSE CODE & TITLE	22RMSCST304(a) : **DEMOGRAPHY AND OFFICIAL STATISTICS**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To study about demography and their importance, different reproduction 2. To explain population Genetics, CSO, NSSO and their scope and contents in population census in India		

UNIT	CONTENT	NO. OF HOURS
I	Nature, Scope and limitations of demography; Sources of Demographic data in India; Measures of Mortality; life-tables; construction of abridged life table; Measures of fertility Stochastic models for reproduction, Reproduction rates: GRR and NRR; Concepts of Migration and Urbanization.	15
II	Population Projections: Stable and Stationary populations, Lotka's model; Use of Leslie matrix. Population estimates; Chandrasekhar and Deming's method, component method, Stochastic models of population growth, Exponential and logistic population growth models: Birth and death model, Birth- death and migration model.	15
III	Population Genetics: Concepts of Genotypes and Phenotypes; Basic Mating from Single gene cross, Punnet Square method, Mendal's laws of heredity; Random mating; Hardy-Weinberg Equilibrium law; Calculation of Gene frequencies, Estimation of Gene frequencies in ABO blood group system.	15
IV	Statistical systems in India; CSO, NSSO and their functions; scope and content of population Census in India; Methods of conducting population census, Economic census and Agricultural census in India and defects; Sources of forest statistics.	15

REFERENCES

1. Suddender Biswas (1988), Stochastic Process in Demography and Applications, Wiley Eastern Ltd, New Delhi.
2. K.B. Pathak and F. Ram (1992), Techniques of Demographic Analysis, Himalayan Publishing House, Bombay.
3. OscarKempthorne (1973), An Introduction to Genetic Statistics, Jagmohan Book Agency, New Delhi
4. B.N. Gupta (1994), Statistics, SahityaBhavan, Agra.
5. B.L. Agrawal (1994), Basic Statistics, 2nd Edition, Wiley Eastren, New Delhi.
6. Asthana (1970), Indian Official Statistics.

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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

COURSE OUTCOME	**On the successful completion of the course students will be able to**		**Knowledge**
	CO1	Students know the growth rates	K 2
	CO2	Students understood about gene frequencies	K 2
	CO3	Students learnt about population census methods	K 2 , K 3
	CO4	Student able to collect data from CSO and NSSO	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	3	2	3	2	3	2	2	2
CO2	2	3	2	3	2	2	3	2	3	2	2	3	3
CO3	1	3	1	2	2	3	3	3	2	3	3	1	2
CO4	2	3	3	3	2	3	3	3	2	3	2	3	3

Low:1, Medium:2, High:3

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

PROGRAMME	M.Sc. Statistics	**SEMESTER**	III
COURSE CODE & TITLE	22RMSCST304(b) : **STATISTICAL MODELLING**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To study about Statistical Modelling and Orthogonal data 2. To explain mixed effects model, ANOVA and Linear regression		

UNIT	**CONTENT**	**NO. OF HOURS**
I	Standard Gauss – Markov models: Estimability of parameters, Best linear unbiased estimator (BLUE), method of least square and Gauss – Markov theorem, Variance and Covariance of BLUE.	15
II	Fixed, Random and Mixed effect models, Analysis of variance of one way and two-way classifications. Orthogonal and Non orthogonal data. Analysis of variance of Orthogonal and Non orthogonal data.	15
III	Introducing of one-way random effects linear models and estimation of Variance components.	15
IV	Bi-variate and multiple linear regression, polynomial regression, use of orthogonal polynomial. Linear and non-linear regression models.	15

REFERENCES

1. Cook, R.D. and Weisberg"s (1982). Residual and influence in Regression. Chapman and Hall.
2. Draper, N.R. and Smith, H.(1998). Applied regression analysis, Third Ed. John Wiley.
3. Grust, R.F. and Mason, R.L.(1980). Regression analysis and its applications-A data oriented approach, Marcel and Dekkar.
4. Rao, C.R.(1973). Linear Statistical Inference and its application, new age international publication.
5. Rao, C.R. and Kleffe, J.(1988). Estimation of variance component and applications, North Holland.
6. Weisberg, S.(1985). Applied linear regression, Wiley, John
7. Searle, S.R. , Caselle, G. and Mccullocb, C.E. (1992). Variance components, Wiley John.

COURSE OUTCOME

On the successful completion of the course students will be able to		**Knowledge**
CO1	Students know the growth rates, life tables, GRR, NRR and growth models	K 2
CO2	Students understood about gene frequencies, genotypes, phenotypes etc	K 2
CO3	Students learnt about population census methods, organizations in India and their functions	K 2 , K 3
CO4	Students learnt about Linear and non-linear regression models	K 2 , K 3

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Department of Statistics
VIKRAMA SIMHAPURI UNIVERSITY
KAKUTUR-524 324.
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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	3	2	3	2	3	2	2	2
CO2	2	3	2	3	2	2	3	2	3	3	2	3	3
CO3	1	3	1	2	3	3	3	3	2	3	3	1	2
CO4	2	3	3	3	2	3	3	3	2	3	2	3	3

Low:1, Medium:2, High:3

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

PROGRAMME	M.Sc. Statistics	**SEMESTER**	III
COURSE CODE & TITLE	22RMSCST305 : **COMPUTER PROGRAMMING AND DATA ANALYSIS USING SPSS**		
NUMBER OF CREDITS	4	**HOURS/WEEK**	6
COURSE OBJECTIVES	1. To understand the purpose and function of Excel 2. To understand forecasting using Excel 3. To become familiar with basic methods of SPSS software		

UNIT	CONTENT	NO. OF HOURS
I	Data Analysis Using Spread Sheets: Data Analysis Pak in Excel, Descriptive Statistics, Tests of Hypothesis, ANOVA, Correlation and Regression, Random number Generation from Different Distributions, Binomial, Poisson, Uniform and Normal Distributions with Mean and Variance.	15
II	**Forecasting:** Forecasting Using Excel, Moving Averages and Exponential Smoothing, Use of Functions,Linest, Longest, ForecastGrowth. Trend for Trend Analysis, The Use of Solver for Optimization Application to LPP.	15
III	Data Handling Using SPSS: Opening Excel Files in SPSS. Variables, Label's and Values. Merging of Files, Selecting Cases Recoding and Sorting of Data. Analysis Tools, Descriptive Statistics, Cross Tabs, Stress on Procedures and Syntax. Formulae and Procedure Key for Multiple Comparisons using Tukey's Test, Duncan's Multiple Range Test, Dunnet's Test and Scheffe's Test with Interpretation.	15
IV	Selection of Variables in Multiple Linear Regression – Stepwise, Forward and Backward Procedures and Analysis of Residuals. Multivariate Tools: Factor Analysis, Various Methods of Factor Extraction, Rotation and Interpretation of Factors. Discriminate Analysis – Objective, Criterion and Interpreting the Model Coefficients. Syntax for the above Procedures.	15

REFERENCES

1. Foster.J. J(2001), Data Analysis Using SPSS for Windows 8.0-10.0, A Biinner's Guide
2. Johnson and Wichern, Multivariate Analysis, Prentice Hall
3. Sarma, K.V.S (2010), Statistics Made Simple, Do It Yourself On PC, Prentice Hall Of India.
4. Steel R .GD and J.H Torrie (1980), Principlesand Procedures ofStatistics. A Bio-Metrical Approach,McGraw Hill International Edition.

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DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

COURSE OUTCOME	**On the successful completion of the course students will be able to**		**Knowledge**
	CO1	Students familiar with reading Excel files , SPSS files and working with other data types	K 2 , K 3
	CO2	Ready to creating faceted graphics with lattice packages	K 2 , K 3
	CO3	Working with probability distributions , ANOVA and Linear Regression	K 2 , K 3
	CO4	Students understand and learnt about how to use SPSS in real time experiments	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	3	2	3	2	3	2	2	2
CO2	2	3	2	3	2	2	3	2	3	3	2	3	3
CO3	1	3	1	2	3	3	3	3	2	3	3	1	2
CO4	2	3	3	3	2	3	3	3	2	3	2	3	3

Low:1, Medium:2, High:3

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

PROGRAMME	M.Sc. Statistics	SEMESTER	III
COURSE CODE & TITLE	22RMSCST306: PRACTICAL – III		
NUMBER OF CREDITS	4	HOURS/WEEK	6
COURSE OBJECTIVES	Practical exercise of all papers such that there must be at least 4 practical problems on each paper (training is expected on manual practice work and practical work on system using available software). (75 marks for practical examination + 25 marks for Record in the Semester II).		

UNIT	CONTENT	NO. OF HOURS
I	PRACTICAL – III	15
II	PRACTICAL – III	15
III	PRACTICAL – III	15
IV	PRACTICAL – III	15

REFERENCES

1. Mood, Grybill And Boes : Introduction To The Theory Of Statistics.
2. Sharma, S (1996), Applied Multivariate Techniques, Wiley.
3. Kingman and Taylor (1966) : Probability Theory , Narosa
4. Draper, N and Smith, B (1981): Applied Regression Analysis, Second Edition.

COURSE OUTCOME

On the successful completion of the course students will be able to		Knowledge
CO1	Students know about the solving of Numerical problems related to Econometrics, Operations Research, Design of Experiments, Demography and Official Statistics and SPSS.	K 2, K 3, K 4

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	3	2	3	2	3	2	2	3	2

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023.

PROGRAMME	M.Sc. Statistics	SEMESTER	III
COURSE CODE & TITLE	22RMSCST307(a) : STATISTISC FOR BIOLOGICAL AND EARTH SCIENCES		
NUMBER OF CREDITS	4	HOURS/WEEK	6
COURSE OBJECTIVES	1. To discuss about statistical measures and correlation measures 2. To discuss on random variables, probability distributions and curve fitting 3. To discuss about tests of Significance and ANOVA 4. To discuss about different statistical tools		

UNIT	CONTENT	NO. OF HOURS
I	Statistical measures: Statistical diagrams and graphs; Frequency distributions; Measures of central tendency: Arithmetic mean, Median and Mode; Measures of variation: Range, Quartile Deviation, Mean Deviation, Standard deviation, Coefficient of variation; Karl Pearson's coefficient of Skewness.	15
II	Random Variable and Probability Distributions: Definition of Probability, Additive and Multiplicative laws of probability (statements only), Random variable, Binomial, Poisson, Normal and Exponential distributions (properties and applications), Curve Fitting: Principle of least squares; Fitting of a straight line, Exponential curve and Power curve; Correlation and Regression Analysis: Karl Pearson's coefficient of correlation, Spearman's Rank correlation coefficient; Simple linear regression; Multiple and Partial correlation coefficients; Multiple linear regression; Yules coefficient of Association.	15
III	Tests of Significance: Basic concepts; Z- test for proportions and means; Applications of t, χ^2 and F tests; Paired t-test; Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) techniques for one way and two-way classifications (single observation per cell), Confidence limits.	15

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KAKUTUR-524 324.
SPS Nellore Dist. (A.P.)

IV	Special Statistical Tools: Experimental designs CRD, RBD and LSD and their analysis; concept of critical difference; Duncan's Multiple range test; Elements of Principal components Analysis, Factor Analysis; Cluster Analysis and Discriminant analysis; Hotelling's T^2 and Mahalanobis D^2 statistics; Multivariate Analysis of Variance (MANOVA); Canonical correlations; Concept of Probit analysis.	15

REFERENCES

1. Bailey, N.T.J.(1959), Statistical Methods in Biology, The English Universities Press Ltd.,
2. Pillai, S.K., and Sinha, H.C.(1968), Statistical Methods for Biological workers, Ram Prasad and sons, Agra.
3. Basu, S.P.(1996), Quantitative Genetics Research techniques, Kalyani publishers, New Delhi.
4. Misra, B.N., and Misra, M.K.(1998), Introductory Practical Biostatistics, Naya Prakash, Kolkata.
5. Johnson, R.A., and Wichern, D.W.(2001), Applied Multivariate Statistical Analysia, Third edition, Prentice Hall of India, New Delhi.
6. Federer, W.T.(1969), Experimental Designs and its appliucations

COURSE OUTCOME

	On the successful completion of the course students will be able to	**Knowledge**
CO1	Students must have knowledge about the concepts of measures of central tendency and dispersion	K 2 , K 3
CO2	Students must have knowledge about the concepts of random variables and probability distributions	K 2 , K 3
CO3	Students understand and learnt about how to use ANOVA and ANCOVA in real time experiments	K 2 , K 3
CO4	Students must gain the ability to understand the concepts of experimental designs like CRD, RBD and LSD, also the concept of critical difference	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	3	2	3	2	3	2	2	2
CO2	2	3	2	3	2	2	3	2	3	3	2	3	3
CO3	1	3	1	2	3	3	3	3	2	3	3	1	2
CO4	2	3	3	3	2	3	3	3	2	3	2	3	3

Low:1, Medium:2, High:3

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PROGRAMME	M.Sc. Statistics	SEMESTER	III
COURSE CODE & TITLE	22RMSCST307(b) : STATISTICS FOR SOCIAL AND BEHAVIOURAL SCIENCES		
NUMBER OF CREDITS	4	HOURS/WEEK	6
COURSE OBJECTIVES	1. The objective of this course is to show the student how statistics are used. 2. The major emphasis of this course is an understanding of statistical measures, sampling and hypothesis testing.		

UNIT	CONTENT	NO. OF HOURS
I	Statistical Measures: Measures of Central Tendency: Arithmetic Mean, Median and Mode; Measures of Variation: Range, Quartile Deviation, Standard Deviation, Coefficient of Variation, Measures of Skewness.	15
II	Probability and Distributions: Concept of Probability, Laws of Probability (statements only); Random Variable; Probability Distributions: Binomial, Poisson and Normal distributions (properties and applications)	15
III	Tests of Significance: Basic concepts; Random sampling techniques; Standard error of statistic; Large sample tests for proportions and means; Small sample tests: Applications of t, χ^2 and F tests; Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) techniques for one way and two-way classifications (single observation per cell); Nonparametric tests: Wilcoxon Signed Rank test, Median test and Mann-Whitney U-test.	15
IV	Special statistical tools: Computation of Linear and Compound Growth rates and their tests of significance; Chow test for Structural change; Granger Causality test; Stepwise regression; R^2 and $\bar{R}^2$ statistics; Multiple Range tests: LSD. test and Duncan's test: ANOVA for Ranked data; Krushkal-wallis test, Friedman test; Elements of Factor Analysis and Discriminant analysis.	15

REFERENCES

1. Gupta, S.C.(1997), Fundamentals of Statistics, Himalayan Publishers, Mumbai.
2. Kshirasagar, A.M. (1972), Multivariate Analysis, Marcel Decker, New

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York.

3. Gujarati, D. (1995), Basic Econometrics, Mc Graw Hill.
4. Ferguson, C.A. (1971), Statistical Analysis in Psychology and Education, McGraw Hill.
5. Johnson, R.A., and Wichern, D.W. (2001), Applied Multivariate Statistical Analysis, Third Edition, Prentice-Hall of India (p) Ltd., New Delhi.

COURSE OUTCOME

	On the successful completion of the course students will be able to	Knowledge
CO1	The student will gain an appreciation of the proper use of statistics and statistical terms in textbooks, newspapers, magazines and in research reports.	K 1 , K 2
CO2	Student acle to apply measure of central tendency and dispersion in real time applications	K 2
CO3	Student familiar in understanding different probability distributions	K 2
CO4	Student able to do statistical testing and its significance using some statistical tools	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	3	2	3	2	2	2	2	2
CO2	2	3	2	3	2	2	3	2	3	3	2	3	3
CO3	1	3	1	2	3	2	3	3	2	2	3	1	3
CO4	2	3	3	3	2	3	3	2	2	3	2	2	3

Low:1, Medium:2, High:3

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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	M.Sc. Statistics	SEMESTER	IV
COURSE CODE & TITLE	22RMSCST401: TIME SERIES ANALYSIS AND FORECASTING METHODS		
NUMBER OF CREDITS	4	HOURS/WEEK	6
COURSE OBJECTIVES	1. Student can understand how to build a time series model and know about its analysis 2. Student can understand how to forecast the date using different regression techniques 3. Student able to familiar in using different Exponential Smoothing Methods. 4. Student must know the analytical skills using time series data.		

UNIT	CONTENT	NO. OF HOURS
I	Review of Time Series Analysis. Growth models: Modified Exponential Curve, Gompertz curve, Logistic Curve and their Fitting; Measurement of Cyclical Component: Harmonic Analysis, Auto Regression Series: Markoff and Yule's Series, Periodogram and Correlogram Analysis, Measurement of Irregular Component: Variate Difference Method.	15
II	Need and Uses of Forecasting, Classification and Characteristics of Forecasts, Forecasting Based on Regression Techniques: Simple and Multiple Linear Regression and Non-Linear Regression Techniques, Moving Averages, Smoothing Methods: Simple and Double, Multi Average Methods; Explanatory Version Time Series Forecasting, Test for Trend Seasonality.	15
III	Exponential Smoothing Methods: Trend Adjusted Exponential Smoothing, Double and Triple Exponential Smoothing, Winter's Method, Chow's Adaptive Control Methods, Brown's One Parameter Adaptive Method: Box-Jenkins Three Parameter Smoothing, Harrison's Harmonic Smoothing Methods, Tracking Signal.	15
IV	Box-Jenkin's Time Series Methods: 1. Moving Average(MA) 2. Auto Regressive (AR) 3. ARMA and 4.AR Integrated MA (ARIMA) Models, Estimation of ARIMA Model Parameters, Forecasting with ARIMA Models, Diagnostic Checking of the Model: Analysis of Residuals, Forecasting Using Transfer Function Model, Concept of Kalman's Filters.	15

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Department of Statistics
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KAKUTUR-524 324.
SPS Nellore Dist. (A.P.)

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

REFERENCES

1. Anderson, T.W (1971): The Statistical Analysis of Time Series, John Wiley, New York.
2. Bovas, Abraham and Johannes Ledolter (1983): Statistical Methods for Forecasting, John Wiley & Sons. New York.
3. Box, G.E.P and Jenkkins, G.M (1976): Time Series Analysis Forecasting and Control, Holden Day, San Francisco.
4. Gupta. S.C and V.K. Kapoor (1995): Fundamentals of Applied Statistics, Sulthan& Chand Sons. New Delhi.
5. Markidakis, S Steven C. Wheel Wright and Victor E. McGee (1983): Forecasting: Methods and Applications, 2nd Edition, New York, John Wiley & Sons.
6. Sullivan, William G. and Wayne Claycambe. W (1977): Fundamentals of Forecasting. Prentice Hall. Virginia.
7. Wheel Wishart, S.C; and S. Markidakis (1980): Forecasting Methods for Management. III edition, New York. John Wiley.

COURSE OUTCOME

On the successful completion of the course students will be able to		Knowledge
CO1	Acquire knowledge of various advanced Timeseries models, estimation methods and related Timeseries theories	K 2 , K 3
CO2	Conduct Forecasting analysis of data	K 3
CO3	Understand Auto-covariance, auto-correlation function and Vector Autoregression	K 2
CO4	Apply statistical techniques to model relationships between variables and make predictions	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	2	3	2	2	2	3	3
CO2	3	2	2	3	3	3	3	2	2	2	3	2	1
CO3	2	2	3	2	2	3	2	3	3	3	2	2	2
CO4	3	2	3	2	3	3	2	3	3	2	2	3	2

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Department of Statistics
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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	M.Sc. Statistics	SEMESTER	IV
COURSE CODE & TITLE	22RMSCST402: BUSINESS ANALYTICS		
NUMBER OF CREDITS	4	HOURS/WEEK	6
COURSE OBJECTIVES	1. The objective of this course is to show the student how Business Analytics was used 2. The major emphasis of this course is an understanding of statistical data visualization, Application measures and analysis		

UNIT	CONTENT	NO. OF HOURS
I	Concepts of business analytics: Definition of business analytics, categorization of analytical methods and models, applications of analytics in business. Analyzing distributions-percentiles, quartiles, Z-scores, empirical rule, identification of outliers and box plot. Measures of association between variables.	15
II	Data visualization and linear regression: Preparation of tables and charts in analytics, advanced chars, GIS charts, principles of effective data dash boards, applications of data dash boards. Linear regression in business analytics: Two variable regression case with a case study. Multiple regression in analytics with a case study, logistic regression with a case study. Categorical independent variables and their analysis through a case study, quadratic regression model, piecewise linear regression model. Best set regression analysis with case study.	15
III	Predictive analytics and Data Mining: Notation of predictive analytics, applications of predictive analytics, case studies in predictive analytics, data mining techniques, classification analysis, clustering methods, decision tree, model comparison and evaluation, regression trees, market basket analysis.	15
IV	OLTP and OLAP: Concepts of OLTP and LTP, characteristics of OLTP, OLTP model, concepts of OLAP, benefits of OLAP, OLAP architecture, distinguish between OLTP and OLAP, data warehousing, spreadsheet models, influenced diagrams, spreadsheet design and implementing the model in a spread sheet, what if analysis and auditing spread sheet models.	15

HEAD
Department of Statistics
VIKRAMA SIMHAPURI UNIVERSITY
KAKUTUR-524 324.
SPS Nellore Dist. (A.P.)

VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

<table>
<tr><td>REFERENCES</td><td colspan="3">1. Albright and Winston,2015, Business Analytics Data Analysis and Decision Making, CENGAGE Learning, ISBN-13: 9788131526613.
2. Camm, Cochran, Fry, Ohlmann, Anderson, Sweeney and Williams, 2015, Essentials of Business Analytics, CENGAGE Learning, ISBN-9781285187273.
3. James R. Evans, Business Analytics, Second Edition,Pearson Education, ISBN-13: 978-0321997821
4. Sahil Raj, 2015, Business Analytics, CENGAGE Learning, ISBN-13: 9788131527887</td></tr>
<tr><td rowspan="5">COURSE OUTCOME</td><td colspan="2">On the successful completion of the course students will be able to</td><td>Knowledge</td></tr>
<tr><td>CO1</td><td>Students know the rules of business analytics and association between the data</td><td>K 1 ,K 2</td></tr>
<tr><td>CO2</td><td>Students understood about linear regression in business analytics with examples</td><td>K 1 ,K 2,K3</td></tr>
<tr><td>CO3</td><td>Students learnt about understanding and prediction through case studies</td><td>K 1 ,K 2,K3</td></tr>
<tr><td>CO4</td><td>Student able to understand how to use business analytics in real time</td><td>K 1 ,K 2</td></tr>
<tr><td>COs – POs MAPPING</td><td colspan="3">
<table>
<tr><th>CO/PO</th><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th><th>PO7</th><th>PO8</th><th>PO9</th><th>PO10</th><th>PSO1</th><th>PSO2</th><th>PSO3</th></tr>
<tr><td>CO1</td><td>1</td><td>3</td><td>2</td><td>2</td><td>2</td><td>3</td><td>2</td><td>2</td><td>2</td><td>2</td><td>1</td><td>3</td><td>3</td></tr>
<tr><td>CO2</td><td>2</td><td>2</td><td>1</td><td>3</td><td>3</td><td>2</td><td>1</td><td>2</td><td>2</td><td>3</td><td>2</td><td>2</td><td>1</td></tr>
<tr><td>CO3</td><td>2</td><td>3</td><td>2</td><td>2</td><td>1</td><td>2</td><td>3</td><td>1</td><td>2</td><td>3</td><td>2</td><td>3</td><td>3</td></tr>
<tr><td>CO4</td><td>2</td><td>3</td><td>3</td><td>1</td><td>3</td><td>2</td><td>2</td><td>2</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td></tr>
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HEAD
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Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	**IV**
COURSE CODE & TITLE	**22RMSCST403: OPERATIONS RESEARCH - II**		
NUMBER OF CREDITS	**4**	**HOURS/WEEK**	**6**
COURSE OBJECTIVES	1. To perform Dynamic programming and their applications and computation procedure with illustration 2. To discuss different Queuing models and steady state solutions with examples 3. To understand Replacement problems such as block and age replacement problems, individual and group replacement policies with examples 4. To discuss different Sequencing methods through examples		

UNIT	CONTENT	NO. OF HOURS
I	Bellman's principle of optimality, general formulation, computational methods and application of Dynamic programming. Multi-stage decision processes and Dynamic programming and Goal Programming.	15
II	Queuing Models, Specifications and Effectiveness Measures. Steady State Solutions of M/M/1 and M/M/C Models with Associated Distributions of Queue Length and Waiting Time .M/G/1 Queue and Pollack-Khinchine Result. Steady State Solutions of M/Ek/1 and Ek/M/1 Queues and Bulk Queues.	15
III	Replacement problems; block and age replacement policies; dynamic programming approach for maintenance problems; replacement of items with long life. Group and individual replacement policies.	15
IV	Sequencing and Scheduling Problems: '2' Machine 'n' Job, '3' Machine 'n' Job, 'm' Machine 'n' Job Problems with Identical Machine. Sequence for all Jobs, '2' Job 'n' Machine Problem with Different Routings.	15

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2. Hadley G (1964) Non-Linear and Dynamic programming Addison Wesley.
3. Hiller F. Sand Lieberman G.J. (1962) Introduction to Operations Research; Holden Day

HEAD
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5. McKinsey J.C.C(1952) Introduction to the theory of games Mc Graw Hill.
6. Murthy. K.G(1976), Linear and combinatorial programming, John Wiley.
7. Philips D.T, Ravindran A and Solberg J Operations Research, Principles and Practice
8. P.K. Gupta; D.S. Hira Operations Research S. Chand.
9. S.D. Sharma (2008), Operations Research, Kedar Nath and Ram Nath publications, Meerut
10. Taha H.A (1982) Operational Research: An Introduction; Macmillan

COURSE OUTCOME

	On the successful completion of the course students will be able to	**Knowledge**
CO1	Students understood about Bellman Principle of Optimality, Dynamic Programming and Goal Programming	K 2 , K 3
CO2	Student understand Queuing Models, Steady State Solutions, Pollack-Khinchine Result	K 2 , K 3
CO3	Student able to know how to apply replacement problems, Group and individual replacement policies	K 2 , K 3
CO4	Student learnt about Sequencing and Scheduling Problems	K 2 , K 3

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3	3	2	2	2	3	2	2	1	3	2
CO2	2	2	3	2	3	2	3	2	3	2	2	3	2
CO3	2	2	2	3	2	3	2	2	2	3	2	3	3
CO4	3	2	3	3	2	2	3	2	3	2	2	2	3

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PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	**IV**
COURSE CODE & TITLE	**22RMSCST404(a): STATISTICAL PROCESS AND QUALITY CONTROL**		
NUMBER OF CREDITS	**4**	**HOURS/WEEK**	**6**
COURSE OBJECTIVES	1. To Understand the Purpose and Function of Statistical Quality Control 2. To Understand the differences between Attributes and Variables 3. To become familiar with basic methods of Statistical Process Control		

UNIT	CONTENT	NO. OF HOURS
I	Basic concepts of quality, causes of variation, principle of Shewart's control chart, control chartsfor attributes and variables. Control limits and probability limits. Process monitoring and control,process capability, modified control chart. Capability indices C_p, C_{pk}, and C_{pm}. Concept of Six sigma and its relationship with process capability.	15
II	The OC and ARL of Shewart's control charts. Control by gauging, Moving Average and Exponentially Weighted Moving Average charts. CUSUM charts using V-mask and decision interval methods. Multivariate control charts – Control Ellipsoid, Hotelling's T_2 chart.	15
III	Acceptance sampling plans for attribute inspection – Type-A and Type-B OC curves. Single, double and sequential sampling plans and their properties. Sampling plans with rectifying inspection concept of AOQ, AOQL. Design of Single sampling plan with given ATI. Plans for inspection by variables with one-sided and two-sided specifications.	15
IV	Sampling plans for continuous inspection-construction of Dodge CSP-1, CSP-2 and Multi level plans and their properties. Chain sampling and its applications. Design of Skip lot sampling plan and its ASN. Sampling plans with inspection error- derivation of AOQ and ATI in presence of errors.	15

HEAD
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KAKUTUR-524 324.
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<table>
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1. Montgomery D.C (2009), Introduction to Statistical Quality Control, 6/e, John Wiley and Sons, New York.
2. Edward G. Schilling, Dean V. Neubauer, (2009), Acceptance sampling in quality control Second Edition, Taylor & Francis.
3. Mittage, H.J and Rinne, H (1993): Statistical Methods of Quality Assurance, Chapmann Hall, London, UK.
4. Ott. E.R (1975), Process Quality Control, Mc Graw Hill.
5. Phadke, M.S (1989), Quality Engineering through Robust Design, Prentice Hall.
6. Duncan, A.J (1974), Quality Control and Industrial Statistics, 3rd Ed., New York, Irwin.
7. Philip J. Ross (1989), Taguchi techniques for quality engineering, McGraw Hill

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<tr><td rowspan="5">COURSE OUTCOME</td><td colspan="2">On the successful completion of the course students will be able to</td><td>Knowledge</td></tr>
<tr><td>CO1</td><td>Student identify the causes of variation, principle of Shewhart's control chart</td><td>K 1 , K 2</td></tr>
<tr><td>CO2</td><td>Student understand about CUSUM charts and Multivariate control charts</td><td>K 2</td></tr>
<tr><td>CO3</td><td>Student familiar with Acceptance sampling plans for attribute inspection, AOQ, AOQL</td><td>K 2 , k 3</td></tr>
<tr><td>CO4</td><td>Student know how to use Sampling plans for continuous inspection and Skip lot sampling plan</td><td>K 2</td></tr>
<tr><td>COs – POs MAPPING</td><td colspan="3">
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PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	**IV**
COURSE CODE & TITLE	**22RMSCST404(b): STATISTICS FOR RESEARCH, INDUSTRY AND COMMUNITY DEVELOPMENT**		
NUMBER OF CREDITS	**4**	**HOURS/WEEK**	**6**
COURSE OBJECTIVES	1. To understand Response surface models, and non-stepwise, partially linear parametric regression models with their applications 2. To discuss Simulation models, demand analysis and their related tools 3. To explain social server, steps in social server measurements with examples		

UNIT	CONTENT	NO. OF HOURS
I	Response Surface Designs: First and Second Order Response Surface models; Rotatable designs; concept of connected design; outliers and Winsorized t - statistic; Stepwise regression; Specification of Random Coefficients Regression model; Specification of variance components model; MINQUE Theory; Non parametric regression, the partially linear regression model.	15
II	Simulation: Scope and limitations; Simulation models; Generation of Random Numbers; Monte-Carlo simulation; Simulation of Queueing, Inventory Systems; Networks and Job sequencing. Data Envelopment Analysis (DEA): Non parametric approach to productive efficiency; Input, output correspondences for Frontier production function; Mathematical Programming forproductive efficiency: Farrell and Timmer approaches with reference to Cobb-Douglas production function.	15
III	Demand Analysis: Laws of Demand and Supply; price and partial elasticities of demand; Pigous method for Time Series and Family Budget data; Engel's curve; Pareto law of Income distribution; Production Functions: Basic concepts; Isoquants; Cobb-Douglas, CES and Translog Production functions and their properties and estimation; Tools for Data Mining.	15
IV	Social Surveys for Community Development: Objects, Types of Social Survey; Steps in social survey; Gallop polls; Psephology, Data collection; Kinds of measurement; Scaling methods:Thurstone, Likert and Guttman methods; Concepts of Validity and Reliability; Methods of calculating reliability coefficients; Test Reliability; ANOVA for Ranked data: Kruskal-Wallis and Friedman tests; Elements of cluster analysis, Factor analysis., path coefficient analysis and Discriminant analysis.	15

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2. Montgomery, C.D. (1976), Design and Analysis of Experiments, Wiley & Sons, New York
3. Johnston, J., and Dinardo, J. (1997), Econometric Methods, Fourth Edition, Mc Graw-Hill International Editions, New York
4. Judge., C.G., et.al (1985), Theory and Practice of Econometrics, John Wiley.
5. Taha, H.A. (1992), Operations Research, An Introduction, Fourth Edition</td></tr>
<tr><td rowspan="5">COURSE OUTCOME</td><td colspan="2">On the successful completion of the course students will be able to</td><td>Knowledge</td></tr>
<tr><td>CO1</td><td>Students have done Simulation models, response surface models, demand analysis, social survey and their related measures.</td><td>K 1 , k 2</td></tr>
<tr><td>CO2</td><td>Student able to understand Non parametric approach to productive efficiency</td><td>K 2</td></tr>
<tr><td>CO3</td><td>Student learnt about Production functions and their properties and estimation</td><td>K 2</td></tr>
<tr><td>CO4</td><td>Student able to familiar with Social Surveys for Community Development</td><td>K 1 , K 2</td></tr>
<tr><td>COs – POs MAPPING</td><td colspan="3">
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PROGRAMME	M.Sc. Statistics	SEMESTER	IV
COURSE CODE & TITLE	22RMSCST405: BIO-STATISTICS		
NUMBER OF CREDITS	4	HOURS/WEEK	6
COURSE OBJECTIVES	1. Explore the basic principles of statistics and some of its common uses. 2. Understand the basic principles of probability, descriptive statistics, and data analysis. 3. Understand how to generate descriptive statistics from data.		

UNIT	CONTENT	NO. OF HOURS
I	Structure of Biological assay, Types of Biological assays: Direct assays, Potency ratio, Fieller's theorem, Behren's distribution, Two generalizations of Fieller's theorem.	15
II	Quantitative dose-response relationships, Linear dose-response regression, Parallel line bioassay, Slope Ratio Bioassay, Quantal responses, Estimation of median effective dose, Transformations: Probit and Logit transformations	15
III	Basic Biological concepts: Gene, Chromosomes, Alleles, Concepts of Geno types and Phenotypes, Family studies, Basic mating from single gene cross, Matrix approach to basic matings of single gene cross, Checker board method, Mendal's law of heredity: Geneotypes and Pheno type ratios, Branching system methods.	15
IV	Types of matings, Random Mating, Concept of Gene pool, Gene frequency, Hardy–Weinberg law of equilibrium, Calculation of Gene frequencies, Genotypic frequency, Generation matrix approach to inbreeding, Estimation of Gene frequencies in ABO blood group system, Maximum Likelihood Method, Minimum Chi-Square method, Genetic parameters; Heritability Coefficients, Genetic Correlations, Repeatability, selection index; Inbreeding coefficient.	15

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1. D.J. Finney (1971): Statistical Methods in Biological Assay, Charles Griffen and Company, London.
2. D.J. Finney (1971): Probit Analysis, 3rd Edition, S.Chand and Company Ltd, New Delhi.
3. William D. Stansfield. (1969): Theory and Problems of Genetics, Schaum's Outline Series, MC Graw Hill, New York.

HEAD
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5. J.P. Jain (1992): Statistical Techniques in Quantitative Genetics, 2nd Edition, Hindustan Publishing House, New Delhi.
6. Basu, S. B. (1996), Quantitative Genitics Research Technique, Kalyani Publishers, New Delhi.

COURSE OUTCOME

	On the successful completion of the course students will be able to	Knowledge
CO1	Apply basic statistical concepts commonly used in Health and Medical Sciences	K 1 ,K 2
CO2	Use basic analytical techniques to generate results	K 1 ,K 2
CO3	Interpret results of commonly used statistical analyses in written summaries	K 2, K 3
CO4	Demonstrate statistical reasoning skills correctly and contextually	K 1 ,K 2

COs – POs MAPPING

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CO2	2	2	1	3	3	2	1	2	2	3	2	2	1
CO3	3	3	3	3	1	2	2	1	2	3	3	3	3
CO4	2	2	3	1	3	3	2	2	3	3	3	2	2

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PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	**IV**
COURSE CODE & TITLE	**22RMSCST406: PRACTICAL – IV**		
NUMBER OF CREDITS	**4**	**HOURS/WEEK**	**6**
COURSE OBJECTIVES	Practical exercise of all papers such that there must be at least 4 practical problems on each paper (training is expected on manual practice work and practical work on system using available software). (75 marks for Practical examination + 25 marks for Record and Viva-Voce in the Semester IV).		

UNIT	**CONTENT**	**NO. OF HOURS**
I	Practical – IV	15
II	Practical – IV	15
III	Practical – IV	15
IV	Practical – IV	15
REFERENCES		

COURSE OUTCOME	**On the successful completion of the course students will be able to**	**Knowledge**
CO1	Students know about the solving of Numerical problems related to Time Series and Forecasting Methods	K 2 , K 3
CO2	To exercise different practical problems manually through calculators on Statistical Quality Control	K 2 , K 3
CO3	To discuss practical problems relates to Operations Research	K 2 , K 3
CO4	To exercise different practical problems manually through calculators in Biostatistics	K 2 , K 3

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PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	**IV**
COURSE CODE & TITLE	**22RMSCST407(a): SURVIVAL ANALYSIS**		
NUMBER OF CREDITS	**4**	**HOURS/WEEK**	**6**
COURSE OBJECTIVES	1. The purpose of this course is to provide the knowledge and tools to conduct a complete statistical analysis of survival data. 2. There will be presentation of the prerequisite theoretical background for each technique discussed. 3. The emphasis is on application of the concepts and ideas involved in data analysis and interpretation of results, rather than the underlying statistical theory.		

UNIT	CONTENT	NO. OF HOURS
I	Concepts of time, Order and random Censoring, likelihood in these cases. Life distributions Exponential, Gamma, Weibull, Lognormal, Pareto, Linear Failure rate. Parametric inference (Point estimation, Scores, MLE)	15
II	Life tables, failure rate, mean residual life and their elementary properties. Ageing classes and their properties, Bathtub Failure rate.	15
III	Estimation of survival function Acturial Estimator, Kaplan- Meier Estimator, Estimation under the assumption of IFR / DFR. Tests of exponentiality against nonparametric classes Total time on test, Deshpande test.	15
IV	Two sample problem- Gehan test, Log rank test. Mantel Haenszel test, Tarone Ware tests.Semi- parametric regression for failure rate Cox s proportional hazards model with one and several convariates. Rank test for the regression coefficients.	15

REFERENCES

1. Gross, A.J. and Clark, V.A. (1975) : Survival distribution : Reliability applications in the Biomedical Sciences, John Wiley and Sons.
2. Elandt Johnson, R.E. Johnson N.L.: Survival Models and Data Analysis, John Wiley and sons.
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COURSE OUTCOME	**On the successful completion of the course students will be able to**		**Knowledge**
	CO1	Apply basic statistical concepts commonly used in Health and Medical Sciences	K 1 ,K 2
	CO2	Use basic analytical techniques to generate results	K 1 ,K 2
	CO3	Interpret results of commonly used statistical analyses in written summaries	K 2, K 3
	CO4	Demonstrate statistical reasoning skills correctly and contextually	K 1 ,K 2

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PROGRAMME	**M.Sc. Statistics**	**SEMESTER**	**IV**
COURSE CODE & TITLE	**22RMSCST407(b): INFERENTIAL STATISTICS**		
NUMBER OF CREDITS	**4**	**HOURS/WEEK**	**6**
COURSE OBJECTIVES	1. To understand the concept of probability, testing of hypothesis and different testing procedures 2. To discuss about analysis of variance concepts and know about the usage of ANOVA 3. To explain different experimental designs and non-parametric tests with examples		

UNIT	CONTENT	NO. OF HOURS
I	Concept of Probability, Sample, Statistic, Sampling Distribution. Testing of Hypothesis: Basic concepts for Testing of Hypothesis and Tests of Significance, Procedure for Hypothesis Testing, Level of Significance. Parametric tests based on t^2, chi square and F Distributions: Hypothesis testing (for Small Samples and Large Samples) for Means, Difference between Means, Proportions, Difference between Proportions, Correlation Coefficients and Goodness of Fit.	15
II	Analysis of Variance: One way and Two-Way Classifications, Duncan's Multiple Range Test.	15
III	Experimental Designs: Concepts, Principles of Experimentation. Simple 2-Level Factorial Experiments with 2 and 3 factors.	15
IV	Non-Parametric Tests: Concepts of Non-parametric/Distribution Free Methods, Sign Test, Run Test, Kolmogorov-Smirnov Test, Wilcoxon-Mann-Whitney U Test, Wilcoxon-Signed-Rank Test, Kruskal-Wallis Test(H).	15

REFERENCES

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2. Basic Statistics, (2006) B.L.Agarwal, New Age Publications Pvt.Ltd.,
3. Research Methodology: Methods and Techniques - Second Revised Edition, (2009) C R Kothari,New Age Publications Pvt.Ltd.,

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COURSE OUTCOME	**On the successful completion of the course students will be able to**		**Knowledge**
	CO1	Student must know how to use probability in different testing procedures	K 1 ,K 2
	CO2	Student able to familiar with correlation and ANOVA	K 1 ,K 2
	CO3	Student must know the difference between parametric and non-parametric tests with examples	K 2, K 3
	CO4	Student able to how to apply non parametric tests in real time	K 1 ,K 2

COs – POs MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	2	2	3	3	3	2	2	3	1	2	3
CO2	3	2	1	2	3	2	1	2	3	3	3	2	1
CO3	3	2	2	3	1	2	3	1	2	3	3	2	2
CO4	3	3	2	1	3	3	2	3	2	3	3	3	2

Low:1, Medium:2, High:3

HEAD
Department of Statistics
VIKRAMA SIMHAPURI UNIVERSITY
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VIKRAMA SIMHAPURI UNIVERSITY: NELLORE
DEPARTMENT OF STATISTICS

Syllabus for M.Sc. Statistics (2 Year Course) for V.S. University Constituent College(s) and Affiliated Colleges under the jurisdiction of Vikrama Simhapuri University, Nellore with effect from the Academic Year 2022-2023

MODEL QUESTION PAPER
M.Sc., DEGREE EXAMINATIONS
COURSE: M.Sc., STATISTICS
Common to All Semesters (Semester I, II, III & IV)
All Semester Question Papers are having the same format
Effect from Batch 2022-2024

Time: 3 Hours **Max.Marks:100**

PART-A

Answer Any Four Questions Marks **4x5M=20M**
Each Question Carries 5 Marks

1)
2)
3)
4)
5)
6)
7)
8)

PART-B **4x12.5M=50M**
Answer All Questions (Internal Choice) – Unit I to Unit IV
Each Question Carries 12.5 Marks

UNIT-I

9)

or

10)

UNIT-II

11)

or

12)

UNIT-III

13)

or

14)

UNIT-IV

15)

or

16)

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