SRI VENKATESWARA UNIVERSITY :: TIRUPATI

SVU COLLEGE OF SCIENCES
Department of Statistics

Re-Structured P.G. Programme (CBCS) as per NEP 2020, National Higher Education Qualification Frame Work (NHEQF) and Guidelines of APSCHE

(With effect from the batch of Students admitted from the academic year 2024-25)

MASTER OF SCIENCES (Statistics)

SEMESTER - I								
S. No	**Course**	**Code**	**Title of the Course**	**H/W**	**C**	**SEE**	**IA**	**Total Marks**
1	CC	101	Probability and Distributions	4	4	70	30	100
2		102	A. Linear Algebra B. Statistical Finance	4	3	50	25	75
3		103	A. Sampling Techniques B. Bayesian Inference	4	3	50	25	75
4	*P	104	Practical-I (ST 102 & ST 103)	6	2	35	15	50
5	SOC	105	A. Statistical Analysis using SPSS and Excel B. Measure Theory	4	3	50	25	75
6		106	A. Stochastic Process B. Computer Programming	4	3	50	25	75
7	*P	107	Practical-II(ST 105 & ST 106)	6	2	35	15	50
			Total	**36**	**20**	**340**	**160**	**500**
8	Audit Course	109	Research Methodology	4	0	0	100	0

- **CC (Core Courses) - 1st Core Course is mandatory and 2nd & 3rd Core Courses Student can choose one from each code**
- ***SOC (Skill Oriented Courses) – Student can choose one from each code**
- ***Practical – I relating to 2nd & 3rd Core Courses and Practical - II relating to 1st & 2nd Skill Oriented Courses (SOC)**

Audit Course – Zero Credits but mandatary with only a Pass

ST 101: PROBABILITY AND DISTRIBUTIONS

Unit-I: Classes of sets, fields, σ -fields, minimal σ -field, Borel σ – field in R^K, sequence of sets, limsup and liminf of a sequence of sets. Measure, Probability measure, properties of a measure, Lebesgue and Lebesgue-Stieltjes measures, Measurable functions, Random variables, sequence of random variables, almost sure convergence, convergence in probability (and in measure). Monotone convergence theorem, Fatou's lemma, Dominated convergence theorem.

Unit-II: Expectation of a random variable, inequalities on expectations, Markov, Holder, Jensen and Liapiunov inequalities. Borel- Cantelli - Lemma, Independence, Weak law and strong law of large numbers for iid sequences, Chebyshev's theorem, khinchine's theorem, Kolmogorov theorems (statements only), convergence in distribution.

Unit-III: Laplace and Weibull distributions.Functions of random variables and their distributions, sampling distributions: central Chi Square, t and F distributions and its properties, applications, 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.

Unit-IV: Multiple and partial correlation coefficients, multiple linear regression, inter relationship among partial and multiple correlation and regression coefficients. Null distributions of simple, partial and multiple correlation coefficients.Order statistics and their distributions, joint and marginal distributions of order statistics, distribution of range. Extreme values and their asymptotic distributions.

References

1. Ash, Robert. (1972). Real Analysis and Probability. Academic Press.
2. Billingsley, P. (P. (1986) Probability and Measure. Wiley.
3. Kingman, J F C and Taylor, S. J. (1966). Introduction to Measure and Probability. Cambridge University Press.
4. Loeve, M (1963), Probability theory
5. Bhatt B.R (1998), Modern Probability theory, Wiley Eastern
6. Rohatgi V.K. (1984): An Introduction to probability theory and mathematical Statistics.
7. Rao C.R (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.
8. Pitman J. (1993): Probability, Narosa Publishing House.
9. Johnson, N.L and Kotz, S.M. (1972): Distributions in Statistics, Vol. I , II & III. Houghton and Miffin.
10. David H.A (1981): Order Statistics, II Edition, and John Wiley.
11. Feller W (1966): Introduction to probability theory and its applications, Vol. III, second edition. Wiley Eastern.

Subject Code	Subject Name	Credits Allotted		Total
ST-101	**Probability and Distributions**	Theory	Practical	4
		4	---	
Course Objective	1. To Explain about classes of sets and Probability measures 2. To discuss on random variables and convergence in probability and the important theorems with proofs. 3. To discuss about inequalities on expectations with their derivations and laws of numbers. 4. To explain about different discrete and continuous distributions and their Properties. 5. To learn about derivations and properties of various sampling distributions. 6. To explain order Statistics and their properties			
Course Out comes	1. Students must have knowledge about random variables, expectations, sets and their properties and inequalities where ever necessary. 2. Students also know the weak law, strong law and central limit theorem and their importance 3. Students know about different continuous and discrete distributions and their properties. 4. They have awareness about central and non central sampling distributions and order Statistics. Idea about simple, partial and multiple correlation coefficients.			

ST-102(A): Linear Algebra

Unit-I: Algebra of matrices; Elementary transformations; Rank and Inverse of a matrix; Nullity; Partitioned matrices; Kronecker product; Generalized inverse of matrix; Moore-Penrose generalized inverse; Solutions of simultaneous equations.

Unit-II: Finite dimensional Vector Spaces; VectorSpaces and Subspaces; Linear dependence and independence; Basis and dimension of a vector space; Completion theorem; Inner product Spaces; Orthonormal basis and Gram-Schmidt orthogonalization process; Orthogonal projection of a vector.

Unit-III: Linear transformationsand properties; Orthogonal and unitary transformations; Real quadratic forms; Reduction and classification of quadratic forms; Hermitian forms; Sylvesters law of inertia; Canonical reduction of quadratic form.

Unit-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.

References

1. Graybill, F.A. (1983). Matrices with applications in statistics, 2nd ed. Wadsworth, Belmont (California).
2. Rao, C. R. (1985). Linear statistical inference and its applications, Wiley Eastern Ltd., New Delhi.
3. Searle, S. R. (1982). Matrix Algebra useful for Statistics, John Wiley and Sons. Inc.
4. Bellman, R. (1970), Introduction to Matrix Analysis, 2nd ed. McGraw Hill, New York.
5. Campbell, H.G. (1980), Linear Algebra with Applications, 2nd Edition, Prentice-Hall, Englewood Cliffs (new Jersey), 1980.
6. Biswas, S. (1984), Topics in Algebra of Matrices, Academic Publications.
7. Hadley, G. (1987), Linear Algebra, Narosa Publishing House.
8. Halmos, P.R. (1958), Finite-dimensional Vector Spaces 2nd ed. D.Van Nostrand Company, Inc.
9. Hoffman, K. and Kunze, R, (1971). Linear Algebra, 2nd ed., Prentice Hall
10. Rao, A.R. and Bhimasankaram, P. (1992), Linear Algebra, Tata McGraw Hill Publishing Company Ltd.
11. Rao, C.R. and Mitra, S.K. (1971), Generalized Inverse of Matrices and its Applications, John Wiley and Sons, Inc.
13. Narayan, S. (1970), Theory of Matrices, S. Chand &Company, New Delhi.

Subject Code	Subject Name	Credits Allotted		Total
ST-102(A)	**Linear Algebra**	Theory	Practical	4
		4	---	
Course Objective	1. To Prepare Students about algebra of matrices and vector spaces. 2. To explain about roots vectors and linear transformations with an examples			
Course Out comes	Students understood for estimation of elementary transformations in matrix and their solutions. Students learnt about characteristic roots and vectors with numerical examples. They also know theoretical proofs of theorems.			

ST-102(B): Statistical Finance

Unit I

Basic concepts of financial markets and financial systems. Functions of financial markets. Interest rates, continuous compounding, present value analysis - effective interest rate, present value and future value. Modeling returns: lognormal model, random walk model, modeling through geometric Brownian motion process. (10 hrs)

Unit II

Portfolio theory – mean variance portfolio theory. Risk and return, risk free interest rate. One risky asset and one risk free asset. Two risky assets. Sharpe's ratio, tangency portfolio, optimal mix of portfolio. Market portfolio, beta, security market line, and capital

asset pricing model (CAPM) and their assumption.
Value at Risk (VaR) – Nonparametric and parametric estimation of VaR , VaR for a derivative and for a portfolio of assets. (10 hrs)

Unit III

Forward contracts and Futures. Call and put options, European option and American options, short and long positions. Financial derivatives, options, pricing via arbitrage, law of one price. Risk neutral valuation, arbitrage theorem. Risk neutral probabilities- Binomial model, and multi-period model. (10 hrs)

Unit IV

The Black-Scholes formula and assumptions. Properties of the Black-Scholes option cost. Delta, gamma and other Greeks.
Volatility and estimating the volatility parameter. Implied volatility. Pricing American options. Call options on dividend-paying securities. (10 hrs)

References

1. Sheldon M. Ross (2003): "*An elementary introduction to Mathematical Finance*", Cambridge University Press.
2. David Ruppert (2004) *"Statistics and Finance an Introduction"* – Springer International Eddition.
3. John C. Hull (2008) "*Options, Futures and other derivatives*", Pearson Education India.
4. Cuthbertson K and Nitzsche D (2001): "*Financial Engineering - Derivatives and Risk Management*", John Wiley & Sons Ltd.
5. David G Luenberger(1998): "*Investment Science*", Oxford University Press.
6. Paul Wilmott (2000): "*Quantitative Finance*", John Wiley & Sons.

Course Outcomes:

1: The ability to model the returns.
2: The ability to understand the basic concepts of financial system.
3: The ability to explain portfolio theory.
4: The ability to understand Black Scholes properties and assumptions.
5: The ability to deal with forward contracts and futures

ST 103(A): Sampling Techniques

Unit-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.

Unit-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.

Unit-III: Ratio and Regression methods of estimation, Two stage sampling, Multi stage sampling, Cluster sampling. Resampling methods and its applications.

Unit-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.

References

1. Chaudhuri. A and Mukerji. R (1988): Randomized Response Theory and Techniques, New Yory, 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. Sing D and Chudary F.S (1986): Theory and Analysis of Sample Survey Designs. New Age International Publishers.
7. Hedayat A.S and Sinha B.K. (1991): Design and Inference in Finite Population Sampling. Wiley.
8. Mukhopadhyay P(1996): Inferential problems in Survey Sampling. New Age International.
9. Wolter K.M (1985): Introduction to Variance Estimator. Springer. Verlag.
10. Hansen M.M and Hurwitz W.M and Mandow W.G (1954): Sample Survey Methods and Theory, Vol. I and Methods and Applications Vol. II, John Wiley and Sons.
11. Philli. I. Good (2013):Introduction to statistics through resampling methods and R, 2nd edition.

Subject Code	Subject Name	Credits Allotted		Total
ST-103 (a)	**Sampling Techniques**	Theory	Practical	4
		4	----	
Course Objective	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.			
Course Out comes	1. Students learnt different sampling techniques of with replacement/ without replacement and Different sampling models. 2. Students studied Non-Sampling errors and different remedies.			

ST 103(B): Bayesian Inference

Unit-I

Limitations of empirical and logical theories of probability, Subjective probability, determination of subjective probability, likelihood function, prior distribution, posterior distribution. Bayes' theorem, methods of construction of priors and computation of the posterior distribution.

Natural conjugate family of priors for a model. Hyper parameters of a prior from conjugate family. Conjugate families for (i) exponential family models, (ii) models admitting sufficient statistics of fixed dimension.

Unit-II

Enlarging the natural conjugate family by (i) enlarging hyper parameter space (ii) mixtures from conjugate family, choosing an appropriate member of conjugate prior family. Non informative, improper and invariant priors. Jeffrey's invariant prior.

Unit-III

Bayesian point estimation: As a prediction problem from posterior distribution. Bayes estimators for (i) absolute error loss (ii) squared error loss (iii) 0-1 loss function. Generalization to convex loss functions. Evaluation of the estimate in terms of the posterior risk.

Unit-IV

Bayesian interval estimation: Credible intervals. Highest posterior density regions. Interpretation of the confidence coefficient of an interval and its comparison with the interpretation of the confidence coefficient for a classical confidence interval.

Bayesian testing of hypothesis: Specification of appropriate form of the prior distribution for a Bayesian testing of hypothesis problem. Prior odds, Posterior odds, Bayes factor for various types of testing hypothesis problems depending upon whether the null hypothesis and the alternative hypothesis are simple or composite. Specification of the Bayes tests in the above cases.

References:

1. Bernando J.M. and Smith A.F.M.: Bayesian Theory, John Wiley.
2. Berger J.O. (1988): Statistical Decision Theory and Bayesian Analysis, Springer- Verlag, New York Inc.
3. Degroot M.H.: Optimal Statistical Decisions, McGrow Hill.
4. Ghosh J.K., Delampady M. and Samanta T. (2006): An Introduction to Bayesian Analysis: Theory and Methods, Springer.
5. Leonard T. and Hsu J.S.J. (1999): Bayesian Methods: An Analysis for Statisticians and Interdisciplinary Researchers, Cambridge University Press.
6. Robert C.P. and Casella G.: Monte Carlo Statistical Methods, Springer-Verlag.

Course Outcomes:

1: Explain in detail the Bayesian framework for data analysis and its flexibility and be able to demonstrate when the Bayesian approach can be beneficial.

2: Develop, analytically describe, and implement both single and multi parameter

probability models in the Bayesian framework.
3: Demonstrate the role of the prior distribution in Bayesian inference and be able to articulate the usage of non-informative priors and conjugate priors.
4: Show high level Interpretation of Bayesian Analysis Results and be able to readily perform Bayesian model evaluation and assessment.
5: Demonstrate the necessary skills to: fit hierarchical models, provide thorough technical specifications for these models.
6: Perform Bayesian computation using Markov chain Monte Carlo methods

ST 104: Practical-I (ST 102 & ST 103)

ST 105(A): Statistical Analysis using SPSS and Excel

Unit-I: Review of Excel, sorting, filtering and construction of charts. Curve fitting and interpretation of the output. Statistical functions in Excel - Calculating theoretical probability using Binomial, Poisson and Normal distributions. Matrix operations- Transpose, Product and Inverse operations using Excel. Pivot tables and look up functions.

Unit-II: Data Analysis Pak in Excel, descriptive statistics, tests of hypothesis, ANOVA, Correlation and Regression, Random Number Generation from different distributions, Binomial, Poisson, Uniform, Normal and from discrete distributions with given mean and variance. Forecasting Using Excel – Moving Averages and Exponential Smoothing, Use of functions, Linest, Logest, Forecast , Growth, Trend for trend analysis. The use of solver for optimization – Application to LPP.

Unit-III: Introduction to SPSS, Different Menu's in SPSS, creating a data file, opening excel files,variables and labels,selecting casesby filtering,recoding of data, merging of files, Sorting of Cases and Variable, SPSS Output and its transfer to excel and word. Analysis categorical data- Scales of Measurements, Data reliability-test rest method, Cronbach's alpha.

Unit-IV: Using SPSS Analysis tools, descriptive statistics, cross tabs (with stress on procedures and syntax). Post-hoc analysis for multiple comparisons using Tukey's test, Duncan's Multiple Range Test, Dunnet's test and Scheffe's test with interpretation. Selection of variables in Multiple Linear Regression – stepwise procedures and analysis of residuals. Procedure for Binary Logistic regression, Factor analysis, Linear Discriminant analysis and Cluster analysis.

ST 105(B): Measure Theory

Unit –I

Field and Sigma Field. Measure and Probability Measure. Outer Measurability of Sets. Class of Measurable Sets. Construction of Outer Measure using Sequential Concerning Classes. Lebesgue Measure. Construction of Non-Measurable Sets.

Unit –II

Measurable Function as a Random Variable. Simple Functions. Sequences and Algebra of Measurable Functions. Approximation Theorem of Measurable Functions. Concepts of Almost Everywhere (a.e) and Almost Uniform Convergence. Egoroffs Theorem. Lusin Theorem.

Unit –III

Convergence in Measure. Fundamental in Measure. F.Riesz Theorem for Convergence in Measure. Integral of a Measurable Function w.r.t a Measure. Bounded Convergence Theorem. Fatou's Lemma, Monotone Convergence Theorem. General Lebesgue Integral and Lebesgue Dominated Convergence Theorem.

Unit –IV

Linear and Orthogonal Transformation of a Matrix. Eigen Values and Eigen Vectors of a Linear Transformation. Quadratic Forms and Their Reduction to Canonical Form. Signature of a Matrix. Positive Definite Matrix.

References

1. Burril, C.W. : Measure Theory and Probability
2. Halmos, P.R. : Measure Theory
3. Royden, H.L : Real Analysis
4. Munroe, M.E. : Introduction to Measure and Integration
5. Kingman .J.F.C. : Introduction to Measure and Probability
And Taylor,S.J.
6. Data, K.B. : Matrix and Liner Algebra
7. Hadley, G. : Liner Algebra
8. Sushma, V. : Liner Algebra

ST 106 (A): Stochastic Process

Unit-I: Introduction to stochastic processes (sp's): classification of sp's according to state apace 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.

Unit-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.

Unit-III: Renewal 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.

Unit-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.

References

1. Adke, S.R and Manjunath, S.M (1984): An Introduction to Finite Markov Processes, Wiley Eastern.
2. Bhat, B.R (2000): stochastic Models: Analysis and Applications, New Age International, India.
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.
6. Hoel, P.G., Port, S.C and Stone, J.C (1972): Introduction to Stochastic Processes, Houghton Miffin & Co.
7. Jagers, P (1974): Branching Process with Biological Applications, Wiley.
8. Karlin, S and Taylor, H.M (1975): A First Course in Stochastic Processes, Vol. 1, and Academic Press.
9. Medhi, J (1982): Stochastic Processes, Wiley Eastern.
10. Parzen, E (1962): Stochastic Processes, Holden – Day.

Subject Code	Subject Name	Credits Allotted		Total
ST-103 (b)	**Stochastic Process**	Theory	Practical	4
		4	----	
Course Objective	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.			
Course Out comes	1. Students understoodstochastic processes, Markov chains, Poisson process, Renewal theory, Branching process, etc.			

ST 106(B): Computer Programming

Unit-1

Introduction to Fortran 77, Data Type, Operators and Expressions, Assignment Statement, Arithmetic and Logical Operation, List Directed and Format-Directed Input/Output Statement. Control Statements, Arrays, Dimension Statement, User Defined Function, Function Subprograms, Subroutine Subprograms, Builtin-Functions.

Unit-2

Introduction to C++. Structure of a C++ Program. Creating the Source Files. Compiling and Linking, C++ Programming Basics: Input/Output, Data Types, Operators, Expressions, Control Structures, Library Functions, Functions In C++ : Passing Arguments to and Returning Values From Functions, Inline Functions, Default Arguments, Function Overloading.

Unit-3

Classes and Objects : Specifying and Using Class and Object, Arrays Within A Class, Arrays of Objects, Object As A Function Arguments, Friendly Functions, Pointers to Members, Constructors and Destructors. Operator Overloading and Type Conversions. Inheritance: Derived Class and Their Constructs, Overriding Member Functions.

Unit – 4

Pointers to Objects, This Pointer, Pointers to Derived Classes, Virtual Functions, Streams, Stream Classes, Unformatted Input/Output Operations, Formatted Console Input/Output Operations, Managing Output with Manipulators, Opening and Closing A File. File Pointers and Their Manipulations, Error Handling During File Operations.

References

Ram Kumar : Introduction to Fortran-77 Tata McGraw Hill
Rajaraman, V : Computer Programming in Fortran 77, Prentice-Hall India
William, E. M. & Cwiakala, M. : Programming with Fortran-77, Tata McGraw Hill
I.S. Robert Lafore : Object Oriented Programming using C++, Sams
Publications :
E. Balagurusamy : Object Oriented Programming with C++, Tata
McGraw Hill
Byron S. Gottfried : Object Oriented Programming using C++, Tata
McGraw Hill

ST 107: Practical-II(ST 105 & ST 106)

ST 108: OOTC

ST 109: Research Methodology

UNIT – I: Introduction to Research:

Meaning and importance of Research, Types of Research, Research Design and Stages Selection and Formulation of Research Problem, Objective(s) and Hypothesis Developing Research Plan – Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Design.

Data Collection: Sources of Data – Primary and Secondary, Types of Data – Categorical (nominal and ordinal), Numerical (discrete, continuous, ratio and interval) Methods of Data Collection: Survey, Interviews (in-depth or Key Informant interviews), Focus Group Discussion (FGD), Observation, Records or Experimental Observations.

UNIT – II: Data Processing and Analysis:

Statistical Graphics – Histograms, Frequency Polygon, Ogive, Dotplots, Stemplots, Bar Graphs, Pareto Charts, Pie Charts, Scatterplots, Boxplots Descriptive Analysis – Frequency Distributions, Measures of Central Tendency, Measures of Variation/Dispersion, Skewness and Kurtosis, Measures of Relative Standing Qualitative Approaches Including Grounded Theory, Ethnography, Narrative Inquiry, Phenomenology and Case-Study.

UNIT – III: Scientific Writing & Research Ethics:

Structure and Components of Scientific Reports – Types of Report – Technical Reports and Thesis – Significance – Different steps in the preparation – Layout, Structure and Language of Typical Reports – Illustrations and Tables – Bibliography, Referencing and Foot Notes.

UNIT-IV: Preparation of the Project Proposal

Title, Abstract, Introduction – Rationale, Objectives, Methodology – Time frame and Work Plan – Budget and Justification – References. Research Ethics Committees/Institutional Review Board – Roles and Importance Intellectual Property rights – Commercialization, Royalty Reproduction of Published Material – Citation and Acknowledgement, Plagiarism.