Department of Statistics
Central University of Rajasthan

(REVISED SYLLABUS 2022)

SYLLABUS
for

Integrated M. Sc. STATISTICS
M. Sc. STATISTICS

Proposed to be implemented for the batches 2020 onwards.

(Note: The Integrated M. Sc. Semester VII to X will be same for M. Sc. Semester I to IV. However, the same may be offered together or separately as required.)

Department of Statistics
School of Mathematics Statistics and Computational Sciences
Central University of Rajasthan
Bandarsindri, NH-8, Kishangarh, Ajmer, Rajasthan-305801

Programme Objective:

The main objective of Integrated M.Sc. in Statistics programme in CURaj is to facilitate higher secondary passed students to learn, practice and make career in the art of information analysis for the purpose of decision making on concerned problems. Analysis can be done by using well accepted principle and scientific methods developed in Statistics. As these students have chosen the statistics at an early stage of their learning, they have an opportunity of better understanding fundamentals of statistics and equip themselves to work as a professional statistician. Training in statistical computing will enhance their job opportunities and professional skills.

Learning outcome of this program,

Post Graduates of the Integrated M.Sc. Statistics program will be able to:

- Have a broad background in Statistics, an appreciation of how its various sub disciplines are inter-related, acquire an in-depth knowledge about topics chosen from those offered through the department.
- Develop the ability to effectively and aptly use techniques of representing and dealing with random phenomenon by using basic principles and statistical concepts.
- Learn art of gathering information by sampling and designing experiments and analyzing it and also to be able to assist practitioners for drawing inferences by using their experimental outcomes.
- Be able to independently read statistical literatures including survey articles, scholarly books, and online sources.
- Have the versatility to work effectively in a broad range of companies (including R&D sectors of financial, pharmaceutical, market research, software development companies, consultancy, etc.), or analytic, scientific, government, financial, health, teaching and other positions or continue for higher education.

Revised Course Outline

Integrated M.Sc. Statistics/ M.Sc. Statistics

Semester VII/I

Course Code	Title	Credit	Hours per week		
			Lectures	Tutorial	Practical
STA 401	Measure and Probability Theory	4	3	0	1
STA 402	Distribution and Decision Theory	4	3	0	1
STA 403	Sampling Theory and Methods	4	3	0	1
STA 404	Real Analysis and Linear Algebra	4	3	0	1
STA 405	Research Methodology	3	2	1	0
STA 481	Statistical Computing using R	3	1	0	2
STA 482	Self-Learning-I	2	2	0	0

Semester VIII/II

Course Code	Title	Credit	Hours per week		
			Lectures	Tutorial	Practical
STA 406	Theory of Estimation and Testing of Hypothesis	4	3	0	1
STA 407	Regression Analysis	4	3	0	1
STA 408	Stochastic Processes	4	3	0	1
STA 483	Introduction to Python	4	3	0	1
	Elective Paper -I	3	2	0	1
	Elective Paper -II	3	2	0	1
STA 484	Self-Learning-II	2	2	0	0

Semester IX/III

Course Code	Title	Credit	Hours per week		
			Lectures	Tutorial	Practical
STA 501	Time Series and Forecasting	4	3	0	1
STA 502	Advanced and Applied Multivariate	4	3	0	1
STA 503	Planning and Analysis of Industrial Experiments	4	3	0	1
	Elective Paper -3	3	2	0	1
	Elective Paper -4	3	2	0	1
	Open Elective	3	2	0	1
STA 581	Self-Learning-III	2	2	0	0

Semester X/IV

Course Code	Title	Credit	Hours per week		
			Lectures	Tutorial	Practical
STA 582	Major Project	20	-	-	-

Elective Courses for Semester VIII/II

Course Code	Title	Credit	Hours per week		
			Lectures	Tutorial	Practical
STA 521	Data Mining	3	3	0	0
STA 522	National Development Statistics	3	3	0	0
STA 523	Principal and Practices of Insurance	3	3	0	0
STA 524	Survival Analysis	3	3	0	0
STA 525	Statistical Methods for Bio-Computing	3	3	0	0
STA 526	Computer Intensive Statistical Methods	3	3	0	0
STA 527	Reliability Analysis	3	3	0	0
STA 528	Extreme Value Theory	3	3	0	0

Course code from STA 521-STA 527 refer to elective courses for VIII semester (Integrated M.Sc Statistics)

Elective Courses for Semester IX/III

Course Code	Title	Credit	Hours per week		
			Lectures	Tutorial	Practical
STA 541	Econometrics	3	3	0	0
STA 542	Life and Health Insurance	3	3	0	0
STA 543	Statistical Quality Management	3	3	0	0
STA 544	Machine Learning	3	3	0	0
STA 545	Bayesian Inference	3	3	0	0

Course code from STA 541-STA 545 refers to elective courses for IX Semester (Integrated M.Sc. Statistics)

SEVENTH SEMESTER

Course Name: Measure and Probability Theory		**Course Code: STA 401**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20+20 Marks	Theory: 3
Tutorial: 2 hours/ week	Total: 100 Marks	Practical: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Basic probability
2. Convergence of sequence and series

Course Objective:

1. The main purpose is to introduce Probability Theory under axiomatic approach and develop further theory and concepts including the limit behaviours.

Course Outcomes: After completion of this course student will able to

1. Recognize the concept of field, sigma field, probability space, probability measure.
2. Understand the concept of convergence of sequences of random variables.
3. Apply various inequalities to solve complex statistical problems.
4. List various types of random variables.
5. Apply different probability theorems and laws for solving different mathematical problems.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Classes of sets, field and sigma fields, limit of sequences of subsets, sigma field generated by a class of subsets, Borel field, Borel sigma field. Measure, probability measure, probability space, properties of probability measure-continuity, mixture of probability measures. Lebesgue and Lebesgue - Steltjes measures on R.	20
2.	Distribution functions of discrete rvs, continuous and mixed type rv, decomposition of a df. Expectation of rv and its properties. Properties of Expectations. Characteristic function, simple properties.Inversion theorem and uniqueness property. Inequalities: Jensen's, Markov, Chebychevs, Holders and Lyapounov inequalities with its applications.	15
3.	Independence of two events and n(>2) events, sequence of independent events. Monotone convergence theorem, Fatous Lemma, Dominated Convergence theorem, Borel - Cantelli Lemma, and their applications. Convergence of sequence of random variables, Convergence in distribution, continuity theorem (Statement only), Almost sure convergence, a characterizing property , convergence in probability, uniqueness of limit, Yule Slutsky results and preservation under continuous transform.(Statements only), convergence in r^{th} mean, interrelationships.	15

4.	Weak and Strong laws of large numbers, Kolmogorov's three series theorem for almost sure convergence (Statement only), Demoivre-Laplace, Liaponove's, Lindeberg-Feller theorems on CLT (Statement only).	10
Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Bhat, B. R. (2007). Modern probability theory. New Age International.	
2.	Rao, B. P. (2009). A first course in probability and statistics. World Scientific.	
3.	Meyer, P.A. (1970) An Introduction to Probability and Its Applications. PHI	
4.	Ross, S. (2010). A first course in probability. Pearson.	
5.	Gun, A. M., Gupta, M. K., & Dasgupta, B. (2003). An outline of statistical theory. World Press Pvt Limited.	
6.	Rohatgi V.K & A.K. MD. EhsanesSaleh (2001): An Introduction to Probability Theory and Mathematical Statistics, 2nd. John Wiley and Sons.	

Course Name: Distribution and Decision Theory		**Course Code: STA 402**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20+20 Marks	Theory: 3
Practical: 2 hours/ week	Total: 100 Marks	Practical:1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Statistical inference
2. Probability distributions.

Course Objective:

1. Concept development and visualization of Decision theory. Also Knowledge of Non parametric statistic and related tests.

Course Outcomes: After completion of this course student will able to

1. Know about Statistical Decision Problem and different decision rules, priors and loss function.
2. Basic idea of Sequential procedures.
3. Application of nonparametric statistics and related test.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Weibull, Pareto, lognormal, Laplace, Cauchy, logistic, Rayleigh distribution their properties and applications. Compound, truncated and mixture distributions. Convolutions of two distributions. Order statistics: their distributions and properties. Joint, marginal and conditional distribution of order statistics. The distribution of sample range and sample median. Extreme values and their asymptotic distribution (statement only) with applications.	15
2.	Non-central chi-square, t and F distributions (pdf with proof). Bivariate distributions, bivariate exponential distribution, bivariate normal distribution, marginal and conditional distribution, mgf, some properties. Plotting of bivariate normal density function. Bivariate exponential distributions	15
3.	Basic elements of Statistical Decision Problem. Expected loss, decision rules (nonrandomized and randomized), decision principles (conditional Bayes, frequentist), inference as decision problem, optimal decision rules.	15
4.	Bayes and minimax decision rule. Admissibility of minimax rules and Bayes rules, prior distribution, and its types. Posterior distribution, Loss functions, Bayes estimator.	15

Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/Text Books:		
1.	Berger, J. O. (2013). Statistical decision theory and Bayesian analysis. Springer Science & Business Media.	
2.	Bernardo, J. M., & Smith, A. F. (2009). Bayesian theory (Vol. 405). John Wiley & Sons.	
3.	Robert, C. P. (2007). The Bayesian choice: from decision-theoretic foundations to computational implementation (Vol. 2). New York: Springer.	
4.	Ferguson, T. S. (2014). Mathematical statistics: A decision theoretic approach (Vol. 1). Academic press.	
5.	Casella, G., & Berger, R. L. (2021). Statistical inference. Cengage Learning.	
6.	Rohatgi, V. K., & Saleh, A. M. E. (2015). An introduction to probability and statistics. John Wiley & Sons.	

Course Name: Sampling Theory and methods		**Course Code: STA 403**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
Practical: 2 hours/ week	Total: 100 Marks	Practical: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Descriptive Statistics
2. Probability and probability distributions
3. Statistical Inference
4. Knowledge of R

Course Objective: After successfully completing this course, students should ordinarily expect to be able to:

1. Describe different types of population approaches.
2. Describe different methods of sampling designs
3. Describe different methods of estimation under double sampling scheme
4. Describe non-sampling errors in a sample survey

Course Outcomes: After completion of this course student will able to

1. Understand the concepts of super population, various standard sampling designs and solve problems related to them.
2. Understand the concepts of unequal probability sampling, PPS sampling (PPSWOR/WR) and solve problems related to them.
3. Understand the concepts of double sampling, methods of estimation under double sampling and solve problems related to them.
4. Understand the concepts of cluster sampling, two-stage sampling and solve problems related to them.
5. Understand the non-sampling errors and handling the non-response in sample surveys and solve related problems.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Fixed population and super-population approaches. Distinct features of finite population sampling, Review of basic methods of simple random sampling and stratified random sampling. Post stratification, Deep stratification, Controlled sampling, estimators along with basic statistical properties, exercises.	15
2.	Unequal probability sampling: PPSWR/WOR methods (including Lahiri's scheme) and Des-Raj estimator, Murthy estimator (for n=2). Horvitz Thompson Estimator of finite population total/mean, Expression for Variance (HTE) and its unbiased estimator, Issue of non-negative variance estimation, exercises.	17
3.	Review of the use of supplementary information for estimation, concept of double sampling, two-phase sampling, stratification estimator, ratio, product and regression estimators with their properties under double sampling, Some unbiased ratio type estimators for population mean, exercises.	13

4.	Review of cluster sampling (equal cluster size), cluster sampling (unequal cluster size), concept of two-stage sampling, non-sampling error with special reference to non-response problems and its treatments, exercises.	15
Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Cochran, W.G. (2007): Sampling Techniques , Third Edition, Wiley India Pvt. Ltd., New Delhi.	
2.	Murthy, M. N. (1977): Sampling Theory and Methods, Statistical Publishing Society, Kolkata.	
3.	Cochran, W.G.(2007): Sampling Techniques , Third Edition, Wiley India Pvt. Ltd., New Delhi. 2. Murthy, M. N. (1977): Sampling Theory and Methods, Statistical Publishing Society, Kolkata.	
4.	Singh, D. and Chaudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi.	
5.	RaghunathArnab (2017): Survey Sampling Theory and Applications, Academic Press, Elsevier.	
6.	Mukhopadhyay P (2008): Theory and methods of survey sampling. Prentice-Hall of India, New Delhi.	
7.	Latpate, R., Kshirsagar, J.,Gupta V. and Chandra, G. (2021). Advanced Sampling Methods, Springer.	
E-Resources:		
1.	https://nptel.ac.in/courses	
2.	http://mospi.nic.in/	

Course Name: Real Analysis and Linear Algebra		**Course Code: STA 404**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 4
	Total: 100 Marks	Total: 4

Course Pre-requisites: Student must have knowledge of

1. Set Theory
2. Basic of Abstract Algebra
3. Basic concept of calculus

Course Objective:

1. The main purpose is to provide mathematical foundation for statistics courses to enhance their knowledge in Real Analysis and Linear algebra.

Course Outcomes: After completion of this course student will able to

1. Relate applicability of real analysis and linear algebra in the various disciplines of statistics
2. Understand special matrices, their properties and applications in statistics.
3. Employ the results from real analysis to solve various problems of probability theory.
4. Apply matrix theory for solving advanced statistical problems.
5. Use theory of stationary values for optimizing complex objective functions.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Differentiation of real valued functions of real variables, geometric interpretation of derivative, computation of standard derivatives, applications to monotone functions, successive derivatives, Rolle's theorem and Mean value theorem, Taylor series with remainder and infinite Taylor series, L'Hospital Rule, Maxima-Minima, Leibniz Theorem.	15
2.	Riemann Integration and its elementary properties, Integrability of functions with finitely many points of discontinuity, Mean-value theorem for Riemann integration, Fundamental theorem of integral calculus, computation of some standard integrals, Integration by parts and change of variable theorem, Interchange of order of integration and limits.	15
3.	Matrix of Linear Transformation in different bases, Similar Matrices, Annihilating polynomials, Minimal polynomial of a linear operator, Algebraic and Geometric Multiplicity, Eigen space, Diagonalizable linear transformation, Tringularization.	15
4.	Functions of several variables, Maxima-minima, Inner product spaces, orthonormal basis. Quadratic forms, reduction and	15

	classification of quadratic forms, positive definite quadratic form, Rank and signature of quadratic form.	
Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Searle, S. R. (1982). Matrix Algebra Useful for Statistics; John Wiley, New York.	
2.	RamachandraRao, A. and Bhimasankaram, P. (1992): Linear Algebra, Tata McGraw hill.	
3.	Trench William (2003). Introduction to Real Analysis , Pearson Education	
4.	Krishnamurthy V., Mainra V.P. and Arora J. L. (2009) An introduction to Linear Algebra, East-West Press Pvt Ltd	
5.	Rudin, W. (1985). Principles of Mathematical Analysis, McGrawhill, New York.	
6.	Malik, S.C. and Arora, S. (1998). Mathematical Analysis, New Age, New Delhi.	
7.	Bartle,R.G.(1975) The Elements of Real Analysis, 2/e, John Wiley.	
8.	Strang, G. (1980). Linear Algebra and its Application, 2nd edition, Academic Press, LondonNew York.	
9.	Trench William (2003). Introduction to Real Analysis , Pearson Education	

Course Name: Research Methodology		**Course Code: STA 405**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

1. Sample survey
2. Statistical methods, applied statistics

Course Objective:

1. To provide scientific approaches to develop the domain of human knowledge through empirical studies.
2. To enable the student researchers to understand basic concepts and aspects related to research, data collection, analyses and interpretation

Course Outcomes: After completion of this course student will able to

1. Understanding of research problem and research designs.
2. Developed a clear understanding of different methods of data collection
3. Construct a questionnaire
4. Processing and analysis of data
5. Interpreting the statistical results and report writing.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Introduction: Meaning, objection and motivation in research, types of research, research approach, significance of research. Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research. Research problems: definition, selection and necessity of research problems.	10
2.	Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Review of the literature, searching the existing literature, reviewing and developing a theoretical as well conceptual framework. Writing about the literature reviewed	10
3.	Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.	10
4.	Survey Methodology and Data Collection, inference and error in surveys, the target populations, sampling frames and coverage error, methods of data collection, non-response, questions and answers in	15

	surveys, Develop a questionnaire. Processing Data Analysis and Interpretation: Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation. Different steps in writing report, layout of the research report.	
Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Kothari, C.R. (2015). Research Methodology: Methods and Techniques, 3rd Edition reprint, New Age International Publishers.	
2.	Kumar, R. (2011). Research Methodology: A Step-by-Step Guide for Beginners, SAGE publications.	
3.	Cochran, W.G. and Cox, G.M. (1959). Experimental Design. Asia Publishing House.	

Course Name: Statistical Computing using R		**Course Code: STA 481**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 2 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
Practical: 2 hours/ week	End Semester Examination: 100 Marks	Practical: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Introduction to R, control statement in r.
2. Applied statistics, linear model, testing of hypothesis and ANOVA.

Course Objective:

After successfully completing this course, students should ordinarily expect to be able to use R for Writing functions, statistical programming, computation graphics, statistical modeling and analysis of different type of statistical data by using R in an effective way.

Course Outcomes: After completion of this course student will able to

1. Explain about Variables, Constants and Data Types in R Programming
2. Describe R functions, create a user-defined function in R
3. Perform a simulation study.
4. Compute advance statistical analysis and interpret the results.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Review of introduction tor r, functions, basic mathematical operations, variables, data types, vectors, conclusion, advanced data structures, data frames, lists, matrices, arrays, classes. Function, R programming structures, control statements, loops.	8
2.	Descriptive Statistics, Correlation and Covariance, simple linear regression, testing of hypothesis, ANOVA.	15
3.	Numerical methods- Root finding, fixed point iteration, Newton Raphson method, secant method, bisection method, numerical iteration, Trapezoidal rule – Simpson's rule, adaptive quadrature.	12
4.	Simulation: Simulating iid uniform samples, congruential generator, seeding, simulating, discrete random variable, inversion method for continuous random variables, rejection method, generation of normal variates: rejection with exponential envelope, Box-Muller algorithm.	10

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation

ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Kundu, D. (2004). Statistical computing: Existing methods and recent developments. Narosa publishing house, New Delhi.	
2.	Monahan, J. F. (2011). Numerical methods of statistics. Cambridge University Press.	
3.	Tattar, P. N., Ramaiah, S., & Manjunath, B. G. (2016). A Course in Statistics with R. John Wiley & Sons.	
4.	Lander, J. P. (2014). R for everyone: Advanced analytics and graphics. Pearson Education.	
5.	Rizzo, M. L. (2019). Statistical computing with R. Chapman and Hall/CRC.	
E-Resources:		
1.	Matloff, N. (2009). The art of R programming. http://heather. cs. ucdavis. edu/~ matloff/132/NSPpart. pdf>. Acesso em, 1(03), 2018.	

EIGHTH SEMESTER

Course Name: Theory of Estimation and Testing of Hypothesis		**Course Code: STA 406**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 40 Marks	Theory: 3
Practical: 2 hours/ week	Total: 100 Marks	Practical: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Standard probability distribution

Course Objective:

2. The main purpose is to make an individual understand basic theoretical knowledge about fundamental principles of statistical inference.

Course Outcomes: After completion of this course student will able to

1. Recognize different methods of parameter estimation
2. Recall various properties of estimators
3. Apply different statistical test procedures for different testing of hypothesis problems
4. Compare different statistical test through power comparison.
5. Analyze various real life data sets using tests of hypothesis

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Criteria of a good estimator: unbiasedness, consistency, efficiency and sufficiency. Concept of mean squared error. Fisher-Neyman factorization theorem, Family of distributions admitting sufficient Statistic. Point estimation, Maximum likelihood method (MLE), moments, Least squares method. Method of minimum chi-square and percentiles. Properties of maximum likelihood estimator (with proof). Successive approximation to MLE, Method of scoring and Newton-Raphson method.	10
2.	Cramer-Rao inequality and its attainment, Cramer-Huzurbazar theorem (statement only), Completeness and minimal sufficient statistic, Ancillary statistic, Basu theorem, Uniformly minimum variance unbiased estimator (UMVUE). Rao-Blackwell and Lehmann-Scheffe theorems and their applications, Review of convergences of random variables and their implications, Delta method and its application, Asymptotic efficiency and asymptotic estimator, consistent asymptotic normal (CAN) estimator.	15
3.	Statistical Hypothesis, critical region, types of errors, level of significance, power of a test, Test function, Randomized and non-randomized tests, Most powerful test and Neyman-Pearson lemma. MLR family of distributions, unbiased test. Uniformly most powerful test. Uniformly most powerful unbiased test. Likelihood ratio test with its properties.	10

4.	Sequential estimation and testing, SPRT, OC curve, ASN function, Wald's equation and problems.	10
5.	Confidence interval, confidence level, construction of confidence intervals using pivots, Determination of confidence intervals based on large and small samples, uniformly most accurate one sided confidence interval and its relation to UMP test for one sided null against one sided alternative hypotheses.	15

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

Reference/ Text Books:

1.	Casella, G., & Berger, R. L. (2021). Statistical inference. Cengage Learning.	
2.	Mukhopadhyay, P. (2012). Theory of Probability. New Central Book Agency.	
3.	Rao, C. R., Rao, C. R., Statistiker, M., Rao, C. R., & Rao, C. R. (1973). Linear statistical inference and its applications (Vol. 2, pp. 263-270). New York: Wiley.	
4.	Rohatgi, V.K. (1976): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern	
5.	Goon, A. M., Gupta, M. K., & Dasgupta, B. (2000). An Outline of Statistical Theory , Vol. II.	
6.	Hogg, R. V., & Craig, A. T. (1965). Introduction To Mathematical Statistics 2. Auflage. Macmillan.	
7.	Kale, B. K. (2005). A first course on parametric inference. Alpha Science Int'l Ltd..	
8.	Lehmann, E. L., & Lehmann, E. L. (1986). Testing statistical hypotheses (Vol. 2). New York: Wiley.	

Course Name: Regression Analysis	**Course Code: STA 407**	
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 3 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20+20 Marks	Theory: 3
Practical: 2 hours/ week	Total: 100 Marks	Practical: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Correlation
2. Simple linear regression
3. Linear algebra
4. Exponential family of distributions

Course Objective:

1. The main purpose is to provide the theoretical foundations for the Linear Estimation Theory and Regression Analysis.

Course Outcomes: After completion of this course student will able to

1. Develop the linear predictive models and their extensions in nonlinear models, generalized models.
2. Diagnose and apply corrections to some problems with the generalized linear model found in real data.
3. Address practical problems and give a sound scientific interpretation to the results.
4. Assess the model using standard criterions.
5. Use standard statistical software to develop models and analyze data that arise from different fields.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Theory of linear estimation, estimable function, multiple regression model, least squares estimator and its properties, variance and covariance of least squares estimator, BLUE, estimation space, error space, Gauss-Markov theorem in linear estimation. Confidence interval estimation, prediction interval, distribution of quadratic forms for normal variables: related theorems (statements only), hypothesis testing for model for general linear hypothesis, testing of individual regression coefficients. Residual analysis: different types of residuals, residual plots.	15
2.	Dummy variables and their use in regression analysis. Multicollinearity: Consequences, detection and remedies, ridge regression. Variable Selection Procedures: R-square, adjusted R-square, Mallows' Cp, forward, backward and stepwise selection methods, AIC, BIC. Variance stabilizing transformations.	15
3.	Fundamental concept of generalized linear model (GLM), exponential family	15

	of random variables. Link functions such as Logit, Probit, binomial, inverse Gaussian, gamma. Nonlinear models, ML estimation in nonlinear models. Large sample tests about parameters, goodness of fit, analysis of deviance. Variable selection: AIC and BIC.	
4.	Logistic regression: logit, probit and cloglog model for dichotomous data with single and multiple explanatory variables, ML estimation, large sample tests about parameters. Hosmer-Lemeshow test, ROC curve. Poisson regression: ML and Quasi-likelihood estimation of parameters, testing significance of coefficients, goodness of fit test.	15
Internal Assessment:		
Part A	Continuous Internal Assessment I	
	Continuous Internal Assessment II	
Part B	Assignments: Students should perform theoretical/experimental assignments.	
Reference/ Text Books:		
1.	Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). Introduction to linear regression analysis. John Wiley & Sons.	
2.	Kutner, M. H., Nachtsheim, C. J., Neter, J., & Wasserman, W. (2004). Applied linear regression models (Vol. 4, pp. 563-568). New York: McGraw-Hill/Irwin.	
3.	Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). Applied logistic regression (Vol. 398). John Wiley & Sons.	
4.	McCullagh, P., & Nelder, J. A. (2019). Generalized linear models. Routledge.	
E-Resources:		
1.	https://nptel.ac.in/courses/111105042	

Course Name: Stochastic Processes		Course Code: STA 408
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20+20 Marks	Theory: 3
Practical: 2 hours/ week	End Semester Examination: 100 Marks	Term Work: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Random variables
2. Conditional probability
3. Generating functions

Course Objective:

1. The main objective of the paper is to provide theoretical foundations of Stochastic Processes and to introduce different Stochastic/Random Processes and their applications.

1. Differentiate discrete and continues random variables and its distribution.
2. Recognize various probability models and their properties.
3. Understand concept of compound, mixture and truncated random variables.
4. To simulate the realizations of complex experiments.
5. Use various distributions for variety of real life situations.

Course Content:

Unit No.	Unit Contents	No. of Hours
1.	Definition of stochastic process, classification of stochastic processes according to state space and time domain, finite dimensional distributions. Examples of various stochastic processes. Definition of Markov chain. Examples of Markov chains, Formulation of Markov chain models, initial distribution, transition probability matrix, Chapman-Kolmogorov equations, calculation of n-step transition probabilities. Simulation of Markov Chain.	15
2.	Classification of states, irreducible Markov chain, period of the state, random walk and Gambler's ruin problem, first entrance theorem, first passage time distribution. Long-Run proportions and limiting probabilities, relation with mean recurrence time, stationary distribution.	15
3.	Continuous time Markov Chain: Poisson process and related inter-arrival time distribution, compound Poisson process, Pure birth process, pure death process, birth and death process, problems, Renewal processes, Elementary renewal theorem (statement only) and its applications	15
4.	Galton-Watson Branching process. Generating functions and its properties, moments. Probability of ultimate extinction. Distribution of population size and association results. Simulation of branching process. Martingales, stopping times. Introduction to Brownian motion process and its basic properties.	15

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentati

		on
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Bhat B. R. (2000). Stochastic Models: Analysis and Applications. New Age International.	
2.	Kulkarni, V. G. (2016). Modeling and analysis of stochastic systems. Chapman and Hall/CRC.	
3.	Medhi J. (2009). Stochastic Process. New Age International Publications.	
4.	Cinlar E. (2013). Introduction to Stochastic Process. Courier Corporation.	
5.	Ross S. (1996): Stochastic Processes. Wiley.	
6.	Hoel, P. G., Port, S. C., & Stone, C. J. (1986). Introduction to stochastic processes. Waveland Press.	
7.	Pinsky, M., & Karlin, S. (2010). An introduction to stochastic modeling. Academic press.	

Course Name: Introduction to Python		Course Code: STA 483
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 2 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20+20 Marks	Theory: 2
Practical: 2 hours/ week	Total: 100 Marks	Practical: 1
		Total: 3

Course Pre-requisites: Student must have knowledge of

1. Basic mathematical operations
2. Vector and matrix operations

Course Objective:

1. This Python course is designed for students to learn to code from scratch and become comfortable with programming in Python. Students will learn the syntax, principles, and thought processes that programming entails.

Course Outcomes: After completion of this course student will able to

1. Understand the programming basics (operations, control structures, data types, etc.)
2. Understand and begin to implement code
3. Understand python looping, control statements and string manipulations.
4. Create various data structures for storing data.
5. Understand the programming basics (operations, control structures, data types, etc.)

Course Content:

Unit No.	Unit Contents	No. of Hours
1.	Introduction to Python, installation and working with Python, id, keywords, import, module, help, variables, operators, data input/output, data types, lists, dictionaries, data import and export, tuples, sets, operations functions, functional programming. String operations. Installation of libraries.	15
2.	Control structure: while, for loops. Break, if-else, continue, pass statements. Programing: obtaining arithmetic mean and variance of given data, identification of prime numbers, sorting the data in ascending order, etc. Defining functions.	15
3.	Pandas: creation of data frames, create an empty data frame, create a data frame from lists/ dict of ndarrays/list of dicts., row selection, addition, and deletion, merging/joining, concatenating objects, summarizing data, table-wise function application, row or column wise function application, importing data form csv to data frame, percent_change, covariance, correlation, data ranking	15

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.".	
2.	Beazley, D., & Jones, B. K. (2013). Python cookbook: Recipes for mastering Python 3. " O'Reilly Media, Inc.".	
E-Resources:		
1.	https://www.tutorialspoint.com/python_pandas/python_pandas_tutorial.pdf	

ELECTIVES offered in VIII-SEMESTER

Course Name : Data Mining (Elective)	**Course Name: STA 521**	
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total : 3

Course Pre-requisites: Student must have knowledge of

1. Normal, Chi-square, t, and F distributions, t-test

Learning Outcome:

Upon successful completion of this course, the student will be able to:

1. Understand approach of data mining.
2. Recognize the competency in the use of data mining to the decision-support level of organizations.
3. Apply different data mining techniques to address real life problems.
4. Design and Implement data-mining solutions for different applications.
5. Proficiency in evaluating and comparing different models used for Data Mining.

Course Content

Unit No.	**Unit Contents**	**No. of Hours**
1	Data Mining: Introduction, Techniques, Issues and challenges, applications, Data pre-processing, Knowledge representation Association Rule Mining: Introduction, Methods to discover association rules, Association rules with item constraints	**10**
2	Decision Trees: Introduction, Tree construction principle, Decision tree construction algorithm, Pruning techniques, Integration of pruning and construction	**10**
3	Cluster analysis: Introduction, clustering paradigms, Similarity and distance, Density, Characteristics of clustering algorithms, Center based clustering techniques, Hierarchical clustering, Density based clustering, Other clustering techniques, Scalable clustering algorithms, Cluster evaluation, Rough set theory, use of rough set theory for classification & feature selection. ROC Curves: Introduction, ROC Space, Curves, Efficient generation of Curves, Area under ROC Curve, Averaging ROC curves, Applications	**12**
4	Advanced techniques: Web mining - Introduction, Web content mining, Web structure mining, Web usage mining; Text mining- Unstructured text, Episode rule discovery from text, Text clustering; Temporal data mining – Temporal association rules, Sequence mining, Episode discovery, time series analysis; Spatial data mining – Spatial mining tasks, Spatial clustering, Spatial trends.	**13**

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

References

1. Han, J., Pei, J., & Tong, H. (2022). Data mining: concepts and techniques. Morgan kaufmann.
2. Hastie, T., Tibshirani, R., Friedman, J. H., & Friedman, J. H. (2009). The elements of statistical learning: data mining, inference, and prediction (Vol. 2, pp. 1-758). New York: springer.
3. Mastering Data Mining: M. Berry and G. Linoff, John Wiley & Sons., 2000

Course Name: National Development Statistics (Elective)	**Course Code: STA 522**

Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

1. Normal, Chi-square, t, and F distributions, t-test

Objective:
The main objective is to make individual understand the significance and role of statistics in national development.

Learning Outcome:
Upon successful completion of this course, the student will be able to:

1. Understand the concept of Economic development parameters.
2. Differentiate the population growth of develop and developing countries.
3. Apply different techniques of poverty measurement.
4. Know various institutions responsible for the collection of data in India.
5. Understand various issues in the measurement of poverty.

Course Content

Unit No.	**Unit Contents**	**No. of Hours**
1	Economic development: Growth in per capital income and distributive justice, Indices of development, Human Development index, quality of life. Estimation of national income-product approach, income approach and expenditure approach	12
2	Population growth in developing and developed countries, Population projection using Leslie matrix, Labour force projection.	10
3	Poverty measurement-different issues, measures of incidence and intensity, combined measures e.q. indices due to Kakwani, Sen etc.	13
4	MOSPI- Statistical System of India: NSSO, CSO, NSSTA, NITI Ayoge, Different Institutions and committees are responsible for planning and execution of National Building.	10

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

References

1. Chatterjee, S.K.: Quality of life.
2. Chaubey, P. K.: Poverty Analysis, New Age International (P) Limited, Publishers. New Delhi.
3. Human Development Annual Report.
4. Sen, Amartya.: Poverty and Famines, Oxford University Press.
5. CSO. National Accounts Statistics- Sources and Health.
6. UNESCO: Principles of Vital Statistics Systems.

Course Name : Principles & Practice of Insurance (Elective)		Course Code: STA 523
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

1.

Objective:
The main objective is to introduce the basics and concepts of insurance.

Learning Outcome:
Upon successful completion of this course, the student will be able to:

1. Understand the present status of insurance.
2. Classify in between life and non-life insurance.
3. Know different types of investing and saving schemes in various funds.
4. Recollect the concepts from actuarial science.
5. Understand the function of regulatory bodies like IRDA.

Course Content

Unit No.	Unit Contents	No. of Hours
1	Origin, Development and Present Status of Insurance, Risk Management, List out the Benefit and Cost of Insurance, Fundamental Key Principles of Insurance, Types of Insurance Contracts, Classification of Insurance.	**10**
2	Classification of insurance in life and non-life insurance, micro insurance, social insurance and general insurance (motor, marine, fire, miscellaneous), Types of insurance plans: whole life, term, endowment.	**15**
3	Types of investments and saving, Insurance, Shares, Bonds, Annuities, Mutual and Pension Fund.	**12**
4	Basics of Under-writing, Claims Management, Reinsurance, Legal and Regulatory Aspects of Insurance. Seminar/Assignments: Each student will have to prepare his/ her presentation/ making assignments based on any topic from Actuarial Science and presents it. The topics will cover cases studies covering various aspects of the principles of insurance including IRDA regulations, publications, the 1938 Act 2006 and accounting standards.	**13**

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

References

1. Principles and Practice if Life Insurance, ICAI, New Delhi
2. Black & Skipper: Life and Health Insurance, Pearson Education

3. Harrington, Scott E. & Gregory R. : Risk Management and Insurance: 2nd ed., Tata McGraw Hill Publicating Company Ltd. New Delhi

Course Name : Survival Analysis (Elective)	**Course Code: STA 524**	
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 3 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

1.

Objective:
The main objective of this paper is to introduce different concepts and applications of survival analysis.

Learning Outcome:
Upon successful completion of this course, the student will be able to:

1. Understand the need of life time distributions and their properties.
2. Identify the different type of censoring.
3. Estimate parameters in presence of censoring.
4. Implement different parametric and nonparametric estimators for estimating survival function.
5. Analyse the lifetime event data.

Course Content

Unit No.	**Unit Contents**	**No. of Hours**
1	Survival Characteristics and Parametric Models: Survival function, quantiles, hazard rate, cumulative hazard function, and mean residual life, Parametric models for study of event time data: Exponential, Weibull, extreme value, gamma, Pareto, logistic, log-logistic, normal, log–normal and mixture models - their survival characteristics. Parametric Inference: Longitudinal studies. Censoring mechanisms- type I, type II and left right and interval censoring. Likelihood function under censoring and estimation. Tests based on LR, MLE.	**10**
2	Nonparametric Inference: Actuarial and Kaplan–Meier estimators. Treatment of ties. Self-consistency property and asymptotic properties of K–M estimator (statement). Point wise confidence interval for S(t). Nelson-Aalen estimator of cumulative hazard function and estimation of S(t) based on it. Two–sample methods. Comparison of survival functions: Log rank and Tarone-Ware tests.	**10**
3	Semi-parametric Inference: Explanatory variables- factors and variates. Cox proportional hazards model. The partial likelihood and estimation of regression coefficients and their standard errors. Breslow's estimator, Statement of asymptotic properties of the estimator. Confidence interval for regression coefficients. Wald, Rao and likelihood tests for β. Accelerated life model. Model selection criteria and comparison of nested models (-2logL, AIC, BIC). Using information on prognostic variables in a competing risks model.	**15**

4	Concept of frailty. Shared frailty models. Identifiability of frailty models. Various frailty models. Gamma, positive stable, inverse Gaussian, power variance function, compound Poisson and compound negative binomial shared frailty models. Frailty regression models. Bivariate and correlated frailty models. Additive frailty models. Reversed hazard rates, Cox's proportional reversed hazards model.	**10**

Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

References

Books Recommended

1. Cox, D.R. and Oakes, D. (1984). Analysis of Survival Data, Chapman and Hall.
2. Deshpande, J.V. and Purohit S.G. (2005). Life Time Data: Statistical Models and Methods, Word Scientific.
3. Duchateau, L. and Johnson, P. (2008). The Frailty Model. Springer: New York.
4. Gross A.J. and Clark, V. A. (1975) Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and Sons.
5. Hanagal, D. D. (2011). Modeling Survival Data Using Frailty Models. CRC Press: New York.
6. Hougaard, P. (2000). Analysis of Multivariate Survival Data. Springer: New York.
7. Wienke, A. (2011). Frailty Models in Survival Analysis, CRC Press: New York.

PAPER NAME : Statistical Methods for Bio-Computing (Elective)		Course Code: Course Name: STA 525
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

1. Probability distributions, Statistical Inference, Bayesian Inference

Objective:

The use of statistical methods and tools from applied probability to address problems in computational Biology.

Learning Outcome:

Upon successful completion of this course, the student will be able to:

1. Understand the need of molecular and morphological data.
2. Identify the alignment of biological sequences.
3. Estimate a good distance function.
4. Apply simulation techniques for the modelling of biological sequence.
5. Design various clustering algorithms.

Course Content

Unit No.	Unit Contents	No. of Hours
1	Type of genetic data: - Molecular and morphological data. Differences and advantages of molecular data on, morphological data, Character data and distance data, their relative merits and demerits. Concept of entropy, entropy as a measure of uncertainty, entropy of single and combined scheme/s, Measure of information content based on entropy. Relative entropy its similarity with likelihood ratio. Applications of these to biological sequences.	**11**
2	(Alignment of biological sequences): Pairwise and local alignment of biological Sequences (DNA/protein sequences). How biological sequences are different from mathematical sequences? The scoring matrices for alignment algorithms PAM and BLOSUM matrices. Algorithm for global alignment (Needleman Wunch algorithm). Local alignment algorithms (Smith - Waterman) Gap Model, dynamic programming algorithms for alignment with gaps such as linear gap model, affine gap model. Introduction to heuristic alignment algorithms such as BLAST, FASTA..	**11**
3	Molecular phylogeny Analysis: Tree of life, gene and species tree. Distance based methods for reconstruction of phylogenetic tree such as UPGMA, weighted UPGMA, transformed distance method, nearest neighbor joining method. Comparison of trees generated using different distance function Requisites of a good distance function. Character	**11**

	based methods for molecular phylogeny, maximum likelihood method and maximum parsimony method. Assessing trees via bootstrap. Probabilistic approach to phylogeny. Probabilistic models of evolution, Felsenteins algorithm for likelihood computation. Juke Canter model and Kimura and other probabilistic models for evolution.	
4	Applications of Markov and Hidden Markov models to biological sequence Analysis. Markov chain as a classifier, use of Markov chain Model for demarcation of a region in Biological sequence analysis. Application of these in genetic sequence analysis such as detection of CPG Island. Testing whether given stretch of sequence is coming from CPG Island (use of Markov model for discrimination) Markov model based classification clusterization, testing order of a Markov model, testing homogeneity of two Markov models, Use of these test to design clustering algorithm. Hidden Markov/chains. Difference between these and simple Markov chains. Analysis of Hidden Markov Models/chains. Verterb is algorithm, Forward and backward algorithm for hidden Markov model. Parameter estimation in hidden Markov model when path is known as well as unknown, BaumWelch algorithm.	**12**

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

References

1. Alexander Isaac: (2001). Introduction to Mathematical Methods Bioinformatics. Springer.
2. Durbin R., Eddy S. Krogh A. Michelson G. (1998). Biological Sequence Analysis, Cambridge University Press.
3. 3. Robin S., Rudolph F, Schboth S. (2003) DNA Words and models Statistics of Exceptional Words, Cambridge University Press.

PAPER NAME : Computer Intensive Statistical Methods (Elective)		**Course Code: STA 526**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

1. Statistical inference
2. Nonparametric inference
3. Regression analysis

Course Objective:

The main objective of this paper is to make students understand computational intensive methods for doing statistical inference.

Learning Outcome:

Upon successful completion of this course, the student will be able to:

1. Understand the necessity of resampling methods.
2. Recall missing data imputation techniques to impute missing values.
3. Develop programing codes for computationally intensive methods.
4. Evaluate different statistical algorithms using cross validation.
5. Apply various Bayesian techniques to analyze real life problems.

Course Content :

Unit No.	**Unit Contents**	**No. of Hours**
1	Resampling Techniques: Re sampling paradigms, bias-variance trade-off. Bootstrap methods, estimation of sampling distribution, confidence interval, variance stabilizing transformation. Jackknife and cross-validation. Jackknife in sample surveys. Jackknife in regression under heteroscedasticity. Permutation tests.	11
2	Missing Values and Imputations Techniques: Missing values and types of missingness, imputations methods for missing values, single and multiple imputations. EM Algorithm and Applications: EM algorithm for incomplete data, EM algorithm for mixture models, EM algorithm for missing values, stochastic EM algorithm.	11
3	Smoothing techniques: Kernel estimators, nearest neighbor estimators, orthogonal and local polynomial estimators, wavelet estimators. Splines. Choice of bandwidth and other smoothing parameters.	11
4	Bayesian computing, Markov Chain Monte Carlo. Simulation using MCMC, Particle filtering, MCMC methods for missing values.	12

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/

		Viva/Presentation
ESE	End Semester Examination	Written

Reference/Text Books:

1. Buuren, Stef van (2012). Flexible Imputation of Missing Data. Chapman and Hall.
2. Chihara, L. and Hesterberg, T. (2011) Mathematical Statistics with Resampling andR. Wiley.
3. Davison, A.C. and Hinkley, D.V. (1997) Bootstrap methods and their Applications. Chapman and Hall.
4. Efron, B. and Tibshirani. R.J. (1994); An Introduction to the Bootstrap. Chapman
5. and Hall.
6. Christensen R, Johnson, W., Branscum A. and Fishman, G.S. (1996) Monte Carlo:Concepts, Algorithms, and Applications. Springer.
7. Gilks, W. R., Richardson, S., and Spiegelhalter, D. (eds.) (1995) Markov Chain MonteCarlo in Practice. Chapman and Hall.
8. Good, P. I. (2005) Resampling Methods: A Practical Guide to Data Analysis. BirkhauserBosel.
9. Hanson T. E. (2011). Bayesian Ideas and Data Analysis: An Introduction for Scientistsand Statisticians, Chapman Hall.
10. Jim, A. (2009). Bayesian Computation with R, 2nd Edn, Springer.
11. Kennedy W. J. Gentle J. E. (1980) Statistical computing. Marcel Dekker.
12. McLachlan, G.J. and Krishnan, T. (2008) The EM Algorithms and Extensions. Wiley.
13. Rubinstein, R.Y. (1981); Simulation and the Monte Carlo Method. Wiley.
14. Shao J. and Tu, D. (1995); The Jackknife and the Bootstrap. Springer Verlag.
15. 14. Tanner, M.A. (1996); Tools for Statistical Inference, Third edition. Springer.

PAPER NAME :Reliability Analysis		Course Code: STA 546
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

1. Probability distributions

Course Objective :

To impart the concept of reliability and how statistical and probabilistic theories are applied to model and explain life of a mechanical component along with prediction of the same.

Course Outcomes:

1. Model and explain the operation time of a mechanical component.
2. To predict the reliability of a component, system and of a finished product. Explain the nature of the lifetime of an item as well.

Course Content:

Unit-1	Unit Contents	No. of Hours
1	Reliability concepts and measures, components & systems: coherent systems, reliability of the coherent systems. Cuts and paths, modular decomposition, bounds on system reliability; structural and reliability importance of components.	**10**
2	Reliability estimation based on failure time in various censored life tests. Stress-strength reliability and its estimation. IFR, IFRA, NBU, DMRL and NBUE and their duals, loss of memory property of the exponential distribution. Closures of these classes under formation of Coherent systems.	**15**
3	Univariate shock models and life distribution arising out of them. Bivariate shock models, common bivariate exponential distribution and their properties. Maintenance and replacement policies; availability of repairable systems.	**10**
4	Students will be required to do practicals, based on topics listed below, using R software: 1. Components and System Reliability 2. Reliability of the coherent system 3. Reliability estimation based on failure time 4. Maintenance and replacement policies 5. Modeling of a repairable system	**10**

Assessment:			
CIA	Continuous Internal Assessment I	Written	
	Continuous Internal Assessment II	Written/Assignment/	

		Viva/Presentation	
ESE	End Semester Examination	Written	
Reference/Text Books:			
1. Sinha, S. K. and Kale, B. K. (1983): Life Testing and Reliability Estimation, Wiley Eastern Limited. 2. Barlow R.E. and Proschan F. (1985): Statistical Theory of Reliability and Life testing: Holt, 3. Rinehart and Winston. 4. Lawless J.F. (1982): Statistical model and Methods of Life time data, John Willey. 5. Bain L.J. and Engelhardt (1991): Statistical Analysis of Reliability and Life testing Models, Marcel Dekker. 6. Nelson, W. (1982): Applied Life Data Analysis, John Willey.			7.

NINETH SEMESTER

Course Name: Time Series Analysis & Forecasting		**Course Code: STA 501**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
Practical: 2 hours/ week	Total: 100 Marks	Practical: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Linear model
2. Linear Algebra
3. Basic of stochastic process

Course Objective:

1. The main purpose is to teach the time series modeling and the concept of forecasting and future planning.

Course Outcomes: After completion of this course student will able to

1. Understand the concepts of stationarity of a time series and solve related problems.
2. Test the stationarity of a time series
3. Understand the theory related to linear and nonlinear time series models and fit an appropriate linear time series model for the data.
4. Understand the theory related to multivariate time series model VAR(1) and analyze data using VAR(1) models.
5. Use information criteria for the selection of models and forecast the value.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Basics of Time series: A model building strategy, Time series and Stochastic process, Portmanteau tests for noise sequences, transformation to obtain Gaussian series, stationarity, Auto correlation, meaning and definition–causes of auto correlation-consequence of autocorrelation test for auto–correlation. Study of Time Series model and their properties using correlogram, ACF and PACF. Yule walker equations.	15
2.	Time Series Models: White noise Process, Random walk, Unit root hypothesis, Co-integration, Dicky Fuller test unit root test, augmented Dickey – Fuller test, MA, AR, ARMA and ARIMA models, Box-Jenkins's Methodology for fitting of AR(1), AR(2), MA(1), MA(2) and ARIMA(1,1) process. Model diagnosis of fitted model and forecasting (by using software).	15
3.	Non-linear time series models, ARCH and GARCH Process, order identification, estimation and diagnostic tests and forecasting. Study of ARCH (1) properties. GARCH process for modeling volatility.	15

4.	Multivariate Time series: Introduction, Cross covariance, and correlation matrices, testing of zero cross correlation and model representation. Basic idea of Stationary vector autoregressive, Time Series with orders one, Model Structure, Granger Causality, stationarity condition, Estimation, Model checking.	15
Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Box, G. E., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (2015). Time series analysis: forecasting and control. John Wiley & Sons.	
2.	Chatfield, C. (2003). The analysis of time series: an introduction. Chapman and hall/CRC.	
3.	Tsay, R. S. (2005). Analysis of financial time series. John wiley & sons.	
4.	Tsay, R. S. (2013). Multivariate time series analysis: with R and financial applications. John Wiley & Sons.	
5.	Montgomery, D. C., Johnson, L. A., & Gardiner, J. S. (1990). Forecasting and time series analysis. McGraw-Hill Companies.	
6.	Chatfield, C. (2000). Time-series forecasting. Chapman and Hall/CRC.	
7.	Brockwell, P. J., & Davis, R. A. (Eds.). (2002). Introduction to time series and forecasting. New York, NY: Springer New York.	
8.	Chatfield, C. (2013). The analysis of time series: theory and practice. Springer.	
9.	Hamilton, J. D. (2020). Time series analysis. Princeton university press.	
10.	Cryer, J. D., & Chan, K. S. (2008). Time series analysis: with applications in R (Vol. 2). New York: Springer.	

Course Name: Advanced and Applied Multivariate Analysis		**Course Code: STA 502**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 20 + 20 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
Practical: 2 hours/ week	Total: 100 Marks	Practical: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Descriptive Statistics
2. Probability and probability distributions
3. Statistical Inference
4. Linear Algebra and linear model
5. Knowledge of R

Course Objective: After successfully completing this course, students should ordinarily expect to be able to:

1. Understand the main features of multivariate data.
2. Understand the characteristics of multivariate quantitative research
3. Understand the principles and characteristics of multivariate statistical techniques and methods efficiently and effectively.

Course Outcomes: After completion of this course student will able to

1. Describe basics of multivariate data and understand properties of multivariate normal distribution
2. Describe Wishart distribution, applications of Hotelling's T^2 statistics and Mahalanobis D^2 statistic.
3. Implement discriminant analysis, classification problems, principal components analysis, and canonical correlation analysis effectively.
4. Demonstrate knowledge and understanding of the basic idea behind factor analysis and cluster analysis effectively.
5. Perform classification of multivariate data.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Concept of multivariate data and analysis, random vector and random matrix. Multivariate distribution function, marginal and conditional distribution, sample mean vector, sample dispersion matrix, correlation matrix, covariance matrix, exercises. Multivariate normal distribution and its properties, random sampling from multivariate normal distribution, maximum likelihood estimators of parameters, distribution of sample mean vector, exercises.	20
2.	Wishart distribution and its properties. Hotelling's T^2 and its applications. Hotelling's T^2 statistic as a generalization of square of Student's statistic. Distance between two populations, Mahalnobis D2 statistic and its relation with Hotelling's T^2 statistic, Distribution of	15

	multiple correlation coefficients, their maximum likelihood estimators (MLE). exercises.	
3.	Discriminant analysis, classification problem, Cluster Analysis, exercises.	15
4.	Principle component analysis, Factor Analysis, Canonical correlation, Exercises.	10
Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Anderson, T. W. (1984): Introduction to Multivariate Analysis, John Wiley	
2.	Fang, K., Kotz, S., Ng K. W. (1990): Symmetric Multivariate and Related Distributions, Chapman and Hall	
3.	Härdle, W. K. and Simar, L. (2012): Applied Multivariate Statistical Analysis, Springer, New York	
4.	Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Statistical Analysis, 6th Ed., Pearson Education	
5.	Kotz, S., Balakrishnan N. and Johnson N. L. (2000): Continuous Multivariate Distributions, Volume 1, Models and Applications, John Wiley & Sons,	
6.	Kshirsagar, A. M. (1983): Multivariate Analysis, Marcel Dekker	
7.	Manly, B. F. J., (2004): Multivariate Statistical Methods - A primer, Chapman and Hall / CRC Florida	
8.	Morrison, D.F. (1990): Multivariate Statistical Methods, McGraw Hill Co.	
9.	Timm, N. H. (2002): Applied Multivariate Analysis, Springer, New York	
E-Resources:		
1.	https://onlinecourses.swayam2.ac.in/cec20_ma17/preview	

Course Name: Planning and Analysis of Industrial Experiments		**Course Code: STA 502**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 3 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20+20 Marks	Theory: 3
Practical: 2 hours/ week	Total: 100 Marks	Practical: 1
		Total: 4

Course Pre-requisites: Student must have knowledge of

1. Linear algebra
2. Basic design of experiments

Course Objective:

1. Enable to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions.

Course Outcomes: After completion of this course student will able to

1. Understand the potential practical problems and applications of design of experiments in various fields.
2. Build a deeper understanding, and tools for analysis of experiments.
3. Describe how the analysis of the data from the experiment should be carried out.
4. Use a statistical computing package to analyze real-life data.
5. Appreciate the advantages and disadvantages of a design for a particular experiment.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1.	Basic principle of experimental design, overview of RBD, CRD and LSD. Purpose of analysis of covariance. Practical situations where analysis of covariance is applicable. Model for analysis of covariance in CRD and RBD. Estimation of parameters (derivations are not expected). Preparation of analysis of covariance (ANOCOVA) table, test for $\beta = 0$, test for equality of treatment effects (computational technique only).	15
2.	Contrasts, orthogonal contrasts, Scheffé's method for comparing contrasts; Comparing pairs of treatment means: Tukey's test, Fisher least significant difference method, comparing treatment means with a control. General theory of intra block analysis of block design, connectedness and balancing block design, incomplete block design, intra block analysis of BIBD and its properties.	15
3.	Concepts of factorial designs, main effects, and interaction effects, The two-factor factorial design and its analysis using fixed effect model, The general factorial design, Analysis of replicated and unreplicated 2^k full factorial designs. Blocking and confounding in a 2^k factorial design. Construction and	15

	analysis of 2^{k-p}fractional factorial designs and their alias structures.	
4.	The 3^k full factorial design and its analysis using fixed effect model. Response surface methodology: the method of steepest ascent, analysis of the response surface using first and second order models, characterizing the response surface, ridge systems, multiple responses, designs for fitting response surfaces: simplex design, central composite design (CCD), The concepts of nested and split-plot designs.	15
Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/ Text Books:		
1.	Montgomery, D. C. (2017). Design and analysis of experiments. John Wiley & sons.	
2.	Hinkelmann, K., & Kempthorne, O. (2007). Design and analysis of experiments, volume 1: Introduction to experimental design (Vol. 1). John Wiley & Sons.	
3.	Wu, C. J., & Hamada, M. S. (2011). Experiments: planning, analysis, and optimization. John Wiley & Sons.	
4.	Dean, A., & Voss, D. (Eds.). (1999). Design and analysis of experiments. New York, NY: Springer New York.	
E-Resources:		
1.	http://www.ru.ac.bd/stat/wp-content/uploads/sites/25/2019/03/502_06_Montgomery-Design-and-analysis-of-experiments-2012.pdf	

ELECTIVES for IX-SEMESTER

Course Name : Econometrics		**Course Code: STA 541**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 4
	Total: 100 Marks	Total: 4

Course Pre-requisites: Student must have knowledge of

4. Correlation regression
5. Multivariate data analysis

Course Objective:

The main objective is to introduce branch which is an integration of mathematics, statistics, and economics used to deal with econometric models.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand the properties and problems of econometric models.
2. Recall various estimation and testing of hypothesis procedures in econometric models.
3. Understand the concept of panel data models.
4. Identify the fixed and random effect models.
5. Apply Simultaneous Equation Models to analyse the economic data.

Course Content :

Unit No.	**Unit Contents**	**No. of Hours**
1	Introduction of Econometrics, Multiple Linear Regression Model, Model with non-spherical disturbances, Test of Auto-correlation, restricted regression estimator, Errors in variables, Dummy variables, Logit and Probit Models	**15**
2	Seemingly unrelated regression equation (SURE) model and its Estimation, Simultaneous equations model, concept of structural and reduced forms problem of identification, rank and order condition of identifiability.	**15**
3	Methods of estimation of simultaneous equation model: indirect least squares, two stage least squares and limited information maximum likelihood estimation, idea of three stage least squares and full information maximum likelihood estimation, and prediction	**10**
4	Panel data models: Estimation in fixed and random effect models, Panel data unit root test	**05**

Assessment:

CIA	Continuous Internal Assessment I	Written

	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

Reference/Text Books:

1. Apte, P.G.: Text books of Econometrics, Tata McGraw Hill.
2. Gujarathi, D.: Basic Econometrics; McGraw Hill.
3. Johnston, J.: Econometrics Methods. Third edition, McGraw Hill.
4. Srivastava, V.K. and Giles D. A. E.: Seemingly unrelated regression equations models, Marcel Dekker.
5. Ullah, A. and Vinod, H.D.: Recent advances in Regression Methods, Marcel Dekker.

Course Name: Life & Health Insurance (Elective)		Course Code: STA 542
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

1. Basic mathematics

Course Objective:

The main objective of this paper is to make individuals aware about the mechanisms of life and health insurance.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand the different type of insurance.
2. Recall the concept of conventional non-participating life insurance.
3. Classify the insurance plans under different insurance schemes.
4. Recollect the concepts from actuarial science.
5. Understand the actuarial aspects of insurance plans.

Course Content:

Unit No.	Unit Contents	No. of Hours
1	Introduction to life and health insurance, various types of life and health insurance plans, available insurance policies in the Indian market	07
2	Conventional non-participating life insurance, Linked accumulating non-participating contracts , Non-linked Accumulating Non-participating Contracts Participating Life Insurance, Different Distribution Methods, Profit Distribution Strategies, With-profit polices, Dividends and Bonus Method	15
3	Health insurance data, pricing & reserving, Classification of group and individual insurance plan under life and health insurance, Social security schemes, Method of valuation, Analysis of surplus	08
4	The actuarial role in life office management: Introduction, product pricing, analysis of surplus, monitoring and uploading the assumptions in the control cycle. Further uses of models in Actuarial management. Students are also expected to complete three assignments: 1. Each student is expected to write a brief report on an appropriate/ relevant real life problem related to life insurance/health insurance/ general insurance using statistical tools and techniques. 2. Review one insurance existing policy in Indian market and advise change with comparative analysis.	15

	3. Review some case study reported to different insurance companies administrative or legal authorities of the University.	
Assessment:		
CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written
Reference/Text Books:		

1. Black & Skipper: Life and health insurance, Pearson Education
2. Philip Booth et al.: Modern actuarial theory and practice, Second edition, Chapman and Hall/CRC

PAPER NAME: Statistical Quality Management		**Course Code: STA 543**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

6. Standard probability distributions
7. Sampling methods
8. Testing of hypothesis

Course Objective :

The main objective of this course is to understand the procedure which seeks to improve the quality of the output of a particular industrial process.

Course Outcomes :

1. Learning to identify and remove the cause of defects through different statistical quality management techniques.
2. Learning to minimize the variability in manufacturing and business process.

Course Content:

Unit No.	**Unit Contents**	**No. of Hours**
1	Cumulative Sum Control Charts for Monitoring Process Mean and Process Variability, Tabular and V-Mask Methods, Moving average and Exponentially Weighted Moving Average Control Charts, Acceptance Control Charts, Economic design of X–chart, Multivariate control charts.	10
2	Acceptance sampling plans for inspection by variables for two sided specifications. Continuous Sampling plans. Bayesian sampling plans, Multiple sampling plans, Sequential sampling plan, Designing a variables sampling plan with a specified OC curve, Other variables sampling procedures.	10
3	Specifications and Process Capability, Capability Ratio, Process Capability Indices: Cp, Cpk, Cpm, Cpmk estimation, confidence intervals and test of hypotheses for normally distributed characteristics, Process Capability Analysis for non-normal Distributions.	10
4	Students will be required to do practicals based on topics listed below, using R software: 1. Cumulative sum control chart 2. Moving average control chart 3. Exponentially weighted moving average control chart 4. Sampling plans for variables 5. Process capability analysis procedure	15

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

Reference/Text Books:

1. D.C. Montgomery. (2009): Introduction to Statistical Quality Control. Wiley.
2. Wetherill, G.B. Brown, D.W. (1991): Statistical Process Control Theory and Practice, Chapman & Hall.
3. Wetherill, G.B. (1977): Sampling Inspection and Quality control, Halsteed Press.
4. Duncan A.J. (1974): Quality Control and Industrial Statistics, IV Edision, Taraporewala and Sons.
5. Ott, E. R. (1977): Process Quality Control (McGraw Hill)

Course Name : Machine Learning (Elective)		**Course Code: STA 544**
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

9. Linear algebra
- Multivariate statistics
- Regression

Course Objective:

1. The objective is to familiarize the audience with some basic learning algorithms and techniques and their applications, as well as general questions related to analyzing and handling large data sets.
2. Several libraries and data sets are publicly available, that will be used to illustrate the application of machine learning algorithms.
3. The emphasis will be on machine learning algorithms and applications, with some broad explanation of the underlying principles.
4. To develop the basic skills necessary to pursue research in machine learning.
5. To develop the design and programming skills that will help you to build intelligent, adaptive artifacts.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand different types of learning methods.
2. Recognize different prediction models.
3. Apply different clustering algorithms to real life data.
4. Compare different machine learning algorithms.
5. Perform classification of massive data using appropriate machine learning algorithms.

Course Content:

Unit No.	**Unit Contents**	**No .of Hours**
1	Basics: Introduction to Machine Learning - Different Forms of Learning Classification: Classification tree, SVM, Instance Based Classification, LDA, Multiclass Classification.	15
2	Clustering: Partitional Clustering - K-Means, K-Medoids, Hierarchical Clustering-Agglomerative, Divisive, Distance Measures, Density Based Clustering – DBscan, Spectral Clustering	15
3	Ensemble Methods: Boosting - Adaboost, Gradient Boosting, Bagging - Simple Methods, Random Forest	10
4	Dimensionality Reduction: Multidimensional Scaling, and Manifold Learning Reinforcement Learning: Q-Learning, Temporal Difference Learning	5

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/ Viva/Presentation
ESE	End Semester Examination	Written

Reference/Text Books:

1. Pattern Recognition and Machine Learning. Christopher Bishop.
2. Machine Learning. Tom Mitchell.
3. Pattern Classification. R.O. Duda, P.E. Hart and D.G. Stork.
4. Data Mining: Tools and Techniques. Jiawei Han and Michelline Kamber.
5. Elements of Statistical Learning. Hastie, Tibshirani and Friedman. Springer.

PAPER NAME: Bayesian Inference (Elective)		Course Code: STA 545
Teaching Scheme	**Examination Scheme**	**Credit Allotted**
Theory: 4 hours/ week	End Semester Examination: 60 Marks Internal Assessment: 20 + 20 Marks	Theory: 3
	Total: 100 Marks	Total: 3

Course Pre-requisites: Student must have knowledge of

10. Probability distributions
11. Statistical inference

Course Objective:

To know Bayesian approach to solve statistical decision problems and use Bayesian techniques for computation.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Distinguish between frequentist and Bayesian approach.
2. Employ prior information for analyse of real life data.
3. Choose appropriate prior distributions.
4. Compute Bayes estimates for the population parameters.
5. Apply Bayesian theory in testing of hypothesis problems.

Course Content:

Unit No.	Unit Contents	No. of Hours
1	Basic elements of Statistical Decision Problem. Expected loss, decision rules (non-randomized and randomized). Overview of Classical and Bayesian Estimation. Advantage of Bayesian inference, Prior distribution, Posterior distribution, Subjective probability and its uses for determination of prior distribution. Importance of non-informative priors, improper priors, invariant priors. Conjugate priors, construction of conjugate families using sufficient statistics, hierarchical priors. Admissible and minimax rules and Bayes rules.	15
2	Point estimation, Concept of Loss functions, Bayes estimation under symmetric loss functions, Bayes credible intervals, highest posterior density intervals, testing of hypotheses. Comparison with classical procedures. Predictive inference. One- and two-sample predictive problems.	15
3 & 4	Bayesian approximation techniques: Normal approximation, T-K approximation, Monte-Carlo Integration, Accept-Reject Method, Idea of Markov chain Monte Carlo technique.	15

Assessment:

CIA	Continuous Internal Assessment I	Written
	Continuous Internal Assessment II	Written/Assignment/

		Viva/Presentation
ESE	End Semester Examination	Written

Reference/Text Books:

1. Berger, J. O. : Statistical Decision Theory and Bayesian Analysis, Springer Verlag.
2. Robert, C.P. and Casella, G. : Monte Carlo Statistical Methods, Springer Verlag.
3. Leonard, T. and Hsu, J.S.J. : Bayesian Methods, Cambridge University Press.
4. Bernando, J.M. and Smith, A.F.M. : Bayesian Theory, John Wiley and Sons.
5. Robert, C.P. : The Bayesian Choice: A Decision Theoretic Motivation, Springer.
6. Gemerman, D. : Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, Chapman Hall.
7. Box, G.P. and Tiao, G. C.: Bayesian Inference in Statistical Analysis, Addison-Wesley.

Course Code	**-**
Course Name	**Self-Learning**
Credits	**02**
	Guidelines

- Statistics is application base subject, and all the theory and concepts must me learnt by the students. All the theory papers are being taught by respective course instructor and do the practical as per contents. Here, we need to teach the concept with all the assumptions and theoretical applications. So, we introduce a self-learning course which will be completed in following manners.
- Every instructor needs to give minimum one simulated data sets from each chapter/concept/theory with the key point to be carried out during the solution and prerequisite.
- Evaluation will be regular basis. Student will do the solution immediately after learning the respective chapter/concept/theory and then get evaluated by the respective course instructor. Instructor will also monitor the regularity of the students with the learning of the concept. For this instructor will take the viva and give the marks immediately. The total scaled marks with equal weight of each problem will be final marks for the overall all assessments. It is noted that there will be no internal and end semester assessment of this course.