(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS03CSTA51	Title of the Course	DESIGN AND ANALYSIS OF EXPERIMENTS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To familiarize the students with the statistical technique viz. Design of Experiments, for planning, designing and analyzing the experiment so that valid information can be drawn effectively and with great efficiency. 2. To familiarize with various methods of designing experiments.

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction to designed experiments, General block designs and its information matrix, its criteria for connectedness, balancedness and orthogonality. Intra block analysis and recovery of inter block information for BIBD and PBIBD (2).	25
2.	Galois field, MOLS and Finite Geometries for construction of BIBDs, derived BIBDs. Properties of BIBDs. Construction of You den square design and Row Column design and their analysis	25
3.	Factorial Experiments 2-level and 3-level factorial experiments in randomized blocks. Confounding and fractional factorial experiments.	25
4.	Application Areas Missing plot technique – general theory and application to BIBD. Split plot and split block experiments, Analysis of covariance in general Markov model, Response Surface experimental designs and ANOVA.	25
...		

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage

1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	know how to plan, design and conduct experiments efficiently and effectively using various designs.
2.	make use of the basics of Design of Experiments such as randomization and blocking.
3.	identify common and important types of experimental designs with respective advantages and disadvantages.
4.	perform a correct statistical analysis of different types of designs.

Suggested References:

Sr. No.	References
1.	Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer.
2.	Petersen, R. G. (1985). Design and Analysis of Experiments, Marcel Dekker, Inc., New York.
3.	Montgomery, D. C. (2001). Design and Analysis of Experiments, Wiley.
4.	Cochran, W. G. and Cox, M. C. (1992). Experimental Designs, 2nd ed., Wiley.
5.	Hinkelmann, K. and Kempthorne, O. (2005). Design and Analysis Of Experiments, Vol 1 &2, Wiley
6.	D. G. Kabe, S. M. Shah. Design and Analysis of Expts (Queen's Uni.)
7.	Das, M. N. and Giri, N. C. (1979). Design and Analysis of Experiments, Wiley Eastern Limited, New Delhi
8.	Aloke D. (1986). Theory Of Block Designs, Wiley.
9.	Chakrabarti, M. C. (1970).Mathematics of Design And Analysis Of Experiments, Asia Publishing House

On-line resources to be used if available as reference material
On-line Resources

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(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS03CSTA52	Title of the Course	MULTIVARIATE ANALYSIS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To introduced various multivariate distributions, such as multivariate normal, Wishart, Hotelling's T-square and Wilk's lamda. distributions their properties and application in testing of hypotheses 2. To describe various properties of these distributions. 3. To discuss applications of these distributions in testing of hypotheses concerning normal means and covariance matrices.

Course Content

Unit	Description	Weightage* (%)
1.	Multivariate Normal Distribution (characterization) and its properties. Random sampling from a multivariate normal distribution. Maximum likelihood estimation of parameters, Distribution of the MLEs. Symmetric Multivariate Normal Distribution (SMND). Distribution of sample intra-class correlation coefficient in a random sample from a SMND. Application in testing and interval estimation	25
2.	Wishart matrix, its distribution and properties. Distribution of generalized variance. Wilk's lamda distribution. Null and non-null distribution of simple correlation matrix. Null distribution of partial and multiple correlation coefficients. Application in testing and interval estimation.	25
3.	Distribution of Hotelling's T-square statistic. Application in tests on mean vector for one and more multivariate normal populations and also on equality of the components of mean vector in a multivariate normal population. Roy's Union-Inter section principle.	25
4.	Test concerning covariance matrices and Test for identical populations of k-independent MNDs Multivariate linear regression model, estimation of parameters, tests of linear hypotheses about regression coefficients using LRT. Multivariate analysis of variance (MANOVA) of one and two way classified data.	25

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	have knowledge of Multivariate Normal Distribution (MND), its properties and be able to estimate the parameters of MND.
2.	know and be able to apply Hotelling's T^2 statistic to test hypotheses concerning Mean of MND.
3.	be able to use LRT principle to construct tests concerning parameters of one and more independent MNDs.
4.	have basic knowledge on MANOVA, Multivariate Regression Analysis (MRA) and inferential problems related to MRA.

Suggested References:	
Sr. No.	References
1.	Anderson, T.W. (1958). Introduction to Multivariate Statistical Analysis, Wiley, NY
2.	Giri, N C. (1977). Multivariate Statistical Inference. Academic press, NY
3.	Kshirsagar, A. M. (1972). Multivariate Analysis, Marcel Dekker,NY
4.	Johnson, R.A. and Wichern, D.W. (1992). Applied Multivariate Statistical Analysis 3rd Ed.,PHI

5.	Mardia, K.V., Kent, J.T., and Bibby, J.M. (1979). Multivariate Analysis, Academic Press, NY
6.	Muirhead, R. J. (1982). Aspect of Multivariate Statistical Theory,Wiley, NY
7.	Rao, C.R.(1973). Linear Statistical Inference and its Applications, 2nd ed. Wiley,NY
8.	Saber, G.A.F.(1984). Multivariate Observations, Wiley, NY
9.	Siotani, M., Hayakawa, T., and Fujikoshi, Y.(1985). Modern Multivariate Analysis

On-line resources to be used if available as reference material
On-line Resources

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(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS02CSTA53	Title of the Course	PRACTICALS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. 2. …

Course Content		
Unit	Description	Weightage* (%)
1.		25
2.		25
3.		25
4.		25
...		

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	
2.	
3.	
…	

Suggested References:	
Sr. No.	References
1.	
2.	
…	

On-line resources to be used if available as reference material
On-line Resources

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(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS02CSTA54	Title of the Course	PRACTICALS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. 2. …

Course Content		
Unit	Description	Weightage* (%)
1.		25
2.		25
3.		25
4.		25
...		

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	
2.	
3.	
…	

Suggested References:	
Sr. No.	References
1.	
2.	
…	

On-line resources to be used if available as reference material
On-line Resources

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(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS02CSTA55	Title of the Course	COMPREHENSIVE VIVA-VOCE
Total Credits of the Course	01	Hours per Week	04

Course Objectives:	1. 2. …

Course Content		
Unit	Description	Weightage* (%)
1.		
2.		
3.		
4.		
...		

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	
2.	
3.	
…	

Suggested References:	
Sr. No.	References
1.	
2.	
…	

On-line resources to be used if available as reference material
On-line Resources

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(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS03ESTA51	Title of the Course	RELIABILITY AND LIFE TESTING
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. Concept of attribute and variable in context of reliability. 2. Concept of life model. 3. Classification of life model base on property of hazard rate.

Course Content		
Unit	Description	Weightage* (%)
1.	Reliability concepts, remaining life time, mean time between failure (MTBF), hazard function (HF), bath–shape HF, Reliability in terms of HF. Estimation of parameters and tests in these models. Reliability estimation based on failure times in various censored life tests and in tests with replacement of failed items; stress-strength reliability and its estimation.	25
2.	Life distribution; reliability function; hazard rate; common life distributions Exponential, Weibull, gamma, Pareto and lognormal distributions.	25
3.	Reliability concepts and measures; components and systems; coherent systems; reliability of coherent systems; cuts and paths; modular decomposition; bounds on system reliability; structural and reliability importance of components	25
4.	Bayes estimator, for exponential, negative exponential, Weibull and normal life model. Estimation of survival function-Actuarial Estimator, Kaplan-Meier Estimator; Properties of K-M estimator;	25

Teaching-Learning Methodology	On-line/off-line lecture

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage

1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Ability to address problem concerning variable reliability and attribute variability.
2.	Able to classify life model depending on hazard rate.
3.	Dell structure in series arrangement of minimal cut and parallel arrangement of minimal path
4	Can compute bound on reliability by varies methods.

Suggested References:

Sr. No.	References
1.	Harry F. M. and Ray A. W., (1991). Bayesian reliability analysis, Malabar, Fla. : Krieger.
2.	Lee J. B., (1991). Statistical analysis of reliability and life-testing models, CRC Press.
3.	Lee J. B. and Max E., (1991). Statistical analysis of reliability and life-testing models, Marcel Dekker, New York,
4.	Sheldon M. R., (2000). Life-testing and reliability estimation, Academic press.
5.	Richard E. B. and Frank P. (1981). Statistical theory of reliability and life testing, Silver Spring.
6.	Sinha, S. K. and Kale, B. K. (1980). Life-testing and reliability estimation. New York , Wiley,
7.	Rupert G. Miller, JR, Gail Gong and Alvaro Munoz, (1981). Survival Analysis, Johan Wiley & son, Canada

On-line resources to be used if available as reference material
On-line Resources

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(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS03ESTA52	Title of the Course	GENERALIZED LINEAR MODELS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	To introduce the theory of generalized linear models (GLIM), estimation and testing procedure and explain procedure for fitting of Genralized Linear Models for real data.

Course Content		
Unit	Description	Weightage* (%)
1.	Review of Linear Statistical Models, Discrete Response Data, Introduction of Generalized Linear Models (GLMs), Components: Linear Predictor, Link Function, Natural Parameters, Scale Parameters; Exponential Family of Distributions (EFD): Members of EFD: Normal, Lognormal, Exponential, Gamma, Binomial, Poisson, Negative Binomial; Steps for Model Fitting, Mean and Variance of EFD; Frequent Inference: Estimation of Parameters through Iteratively Reweighted Least Square (IRLS) and Algorithms, Form of Adjacent Dependent Variable and Weights, Analysis of Deviance, Nested Model and Non-Nested Model; Goodness of Fit Criteria: RSquare, Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Bayesian Information Criterion (BIC); Step Wise Selection; Testing of Parameters through Wald Test; Confidence Intervals; GLMs Residuals: Residual Analysis, Pearson Residual, Anscombe Residual, Deviance Residual. Model Checking: Hat Matrix, Outlier, Leverage, Influence	25
2.	Binary Data: Models for Binary Data: Group Data and Ungroup Data, Linear Predictor, Link Function: Logit, Probit and Complementary Log Log; Prospective Study and Retrospective Study, Likelihood Function, Estimation of Parameters through IRLS Method; Deviance; Probit Model, Residual Analysis Polytomous Data: Introduction of Multinomial Logistic Regression and Ordinal Regression, Examples and their inference. Ordinal Regression	25

	Models with Qualitative or/and Quantitative Covariates; Parallel Line Regression	
3.	Count Data: Introduction Poisson Regression, Likelihood, Estimation and Testing of Parameters: Log Linear Model for Contingency Table and their Analysis Generalized Linear Models with distribution having Constant Coefficient of Variation; Gamma Family; Canonical Link Function; Inference and Residual Analysis of GLMs with Gamma Distribution; Comparison between Response having Gamma distribution and lognormal distribution; Examples and Applications	25
4.	Models for Survival Data: Estimation with Censored Survival Data and Survival Distribution: Exponential Distribution; Weibull Distribution and their Examples. Under and Over Dispersion Problem of Data, Quasi Likelihood for Estimation of Parameters, Properties of Quasi Likelihood, Analysis of Deviance; Quasi Likelihood: Binomial, Poisson, Normal, Gamma, Lognormal, Exponential; Comparison of Quasi Likelihood with Likelihood; Concept of Marginal Likelihood, Conditional Likelihood; Models with Nonlinear Parameters in Covariates; Model Checking: Checking Link Function, Checking Covariance Scale, Checking the Variance Function, Score Test for Extra Parameters, Checking Form of Covariates, Detection of Influential Observations	25

Teaching-Learning Methodology	Discussion and question answers based learning Black board/Multimedia projector using ICT Tools Learning through Problem solving approach Assignments and seminars are given for development of confidence among students Fitting of various models to data using software (demonstration of software R language for data handling)

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage

1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the differences between Linear model and generalized model and their underlying assumptions.
2.	Various estimation procedures for estimation of parameters of different generalized models.
3.	know Logit, Probit for binary data and their applications

Suggested References:

Sr. No.	References
1.	Agresti, A. (2002). Categorical Data Analysis, ED.II, Wiley InterScience
2.	Fahrmier,L .and Tutz,G.(2001). Multivariate Statistical Modeling Based on Generalizes Linear Models, Springer
3.	Gill, J.(2001).Generalized Linear Models: A Unified Approach, Sage Publication
4.	Lindsey, J.K. (1997). Applying Generalized Linear Models , Springer
5.	Maindonald,J. And Braun,J. (2007). Data Analysis and Graphics using R: An example based approach Ed.II, Cambridge University Press
6.	McCullagh, P. And Nelder,J.A. (1983). Generalized Linear Models- Monographs on Statistics and Applied Probability, Chapman and Hall
7.	Myers, R.H, Montegomery, D.C., Vinning, G.G and Robinson, T.J.(2010). Generalized Linear Models with Applications in Engineering and the Sciences, Ed.II , Wiley Series in Probability and Statistics, A John Wiley & Sons.

8.	Agresti, A. (2002). Categorical Data Analysis, ED.II, Wiley InterScience
9.	Fahrmier,L .and Tutz,G.(2001). Multivariate Statistical Modeling Based on Generalizes Linear Models, Springer
10.	Gill, J.(2001).Generalized Linear Models: A Unified Approach, Sage Publication

On-line resources to be used if available as reference material
On-line Resources

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(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS03ESTA53	Title of the Course	SURVIVAL ANALYSIS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. Survival analysis involves the analysis of time-to-event data and is widely used in health and medicine. The objective of this course is introducing the fundamental concepts of survival analysis and basic principles such as censoring, survival and hazard functions, Cox proportional hazards regression, model diagnostics and model extensions to incorporate recurrent events and competing risks. 2. To introduce various frailty models.

Course Content		
Unit	Description	Weightage* (%)
1.	Survival data, Concepts of time, order and random and hybrid censoring, Life distributions - exponential, gamma, Lognormal, Pareto, linear failure rate, Ageing classes - IFR, IFRA, NBU, NBUE, HNBUE and their duals, Bathtub failure rate. Parametric inference, point estimation, confidence Intervals, scores, tests based on LR, MLE	25
2.	Life tables, failure rate, mean residual life and their elementary properties. Estimation of survival function - Actuarial estimator, Kaplan - Meier estimator, Estimation under the assumption of IFR/DFR	25
3.	Semi-parametric regression for failure rate - Cox's proportional hazards model, partial likelihood, estimation and inference methods for the Cox models, time-dependent covariates, residuals and model diagnosis, functional forms of the Cox models, goodness-of-fit tests for the Cox models, Competing risk models, Repair models, Probabilistic models, Joint distribution of failure times Unconditional tests for the time truncated case, Tests for exponentiality, two sample nonparametric problem.	25
4.	Nelson-Aalen estimators, counting processes and martingales, modeling counting processes, Regression models for modeling multiple events, Frailty models, Shared frailty models, Identifiability of frailty models, Frailty regression models, Bivariate and correlated frailty models, Additive frailty models.	25
...		

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	decide the type of censoring and truncation that is the basis for given survival data
2.	estimate survival functions using parametric and non-parametric methods
3.	construct a life table using the Kaplan-Meier approach
4.	interpret coefficients in Cox proportional hazards regression analysis
5.	compare survival functions of two or more populations; use software for survival analysis
6.	Explain theoretical concepts underlying parametric survival models; and
7.	analyse survival data using basic parametric models and interpret the results

Suggested References:	
Sr. No.	References
1.	Klein, J. P. and Moeschberger, M. L. (1997). Survival Analysis: Techniques for Censored and Truncated Data , Springer, New York
2.	Collett, D. (2003). Modelling Survivaldata in Medical Research, Second Edition, Chapman & Hall/CRC

3.	Therneau, T. M. and Grambsch, P. M. (2000). Modeling Survival Data, Extending the Cox Model, Springer, New York.
4.	Cox, D.R. and Oakes, D. (1984). Analysis of Survival Data, Chapman and Hall.
5.	Deshpande, J.V. and Purohit, S.G. (2005). Life Time Data: Statistical Models and Methods, Word Scientific.
6.	Duchateau, L. and Johnson, P. (2008). The Frailty Model. Springer: New York.
7.	Hanagal, D. D. (2011). Modeling Survival Data Using Frailty Models. CRC Press.
8.	Kalbfleish, JD. and Prentice, RL. (2002). The Statistical Analysis of Failure Time Data. New York: Wiley.
9.	Hougaard, P. (2000). Analysis of Multivariate Survival Data. Springer: New York.
10.	Wienke, A. (2011). Frailty Models in Survival Analysis, CRC Press: New York.

On-line resources to be used if available as reference material
On-line Resources

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(Mater of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS03ESTA54	Title of the Course	TIME SERIES ANALYSIS
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. The objective of this course is to equip students with various forecasting techniques and knowledge on modern statistical methods for analyzing time series data. 2. Introduction of Time Series Models.

Course Content		
Unit	Description	Weightage* (%)
1.	Exploratory time series analysis, tests for trend and seasonality. Exponential and Moving average smoothing. Holt -Winters smoothing. Forecasting based on smoothing, adaptive smoothing. Time - series as a discrete parameter stochastic process. Auto covariance and autocorrelation functions and their properties, Portmanteau tests for noise sequences, transformation to obtain Gaussian series.	25
2.	Stationary processes: General linear processes, moving average (MA), auto regressive (AR), and autoregressive moving average (ARMA), Stationarity and invertibility conditions. Nonstationary 29 and seasonal time series models: Auto regressive integrated moving average (ARIMA) models, Seasonal ARIMA (SARIMA) models, Transfer function models (Time series regression).	25
3.	Forecasting in time series models, Durbin-Levinson algorithm, innovation algorithm (without proof), Estimation of mean, auto covariance and autocorrelation functions, Yule-Walker estimation, Estimation of ARIMA model parameters, maximum likelihood method, large sample theory (without proofs). Choice of AR and MA periods, FPE, AIC, BIC, residual analysis and diagnostic checking, Unit-root non stationarity, unit-root tests	25
4.	Multivariate Time series model, VAR models, Vector ARMA models. Conditional heteroschedastic models, ARCH and GARCH, properties, examples, estimation & forecasting, extensions of ARCH & GARCH to asymmetric models. Count time series models, INAR models, Poisson INAR models	25

...		

Teaching-Learning Methodology	Lecture, Question & Answer, Problem Solving.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	know various components and structures of time series
2.	apply various smoothing techniques
3.	classify various models such as AR, MA, ARMA, ARIMA models and interpret
4.	do ACF and PACF, residual analysis and diagnostic checking, and test and interpret hypothesis about unit root
5.	extend univariate time series models to multivariate time series models

Suggested References:	
Sr. No.	References
1.	Brockwell, P.J. and Davis, R. A. (2003). Introduction to Time Series Analysis, Springer
2.	Chatfield, C. (2001). Time Series Forecasting, Chapman &Hall.

3.	Fuller, W. A. (1996). Introduction to Statistical Time Series, 2nd Ed. Wiley.
4.	Hamilton N. Y. (1994). Time Series Analysis, Princeton University press.
5.	Lutkepohl, H. (2005). New Introduction to Multiple Time Series Analysis, Springer
6.	Shumway, R. H. and Stoffer, D. S. (2010). Time Series Analysis & Its Applications, Springer.
7.	Tsay, R. S. (2010). Analysis of Financial Time Series, Wiley.

On-line resources to be used if available as reference material
On-line Resources

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(Master of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS03CSTA56	Title of the Course	Problem Solving in Statistics
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	
	• To learn solving exercise problems applying concept, definition, results and theorems simultaneously • To inculcate essential skill for cracking, corporate entrance tests, competitive tests like UGC-CSIR NET, State wise-SLET, for ISS, for RBI, as well as the job-interviews • Get hands-on experience with project design and proposal writing

Course Content		
Unit	Description	Weightage* (%)
1.	Some problem solving related to (1) Moment inequalities and Convergence theorems (random variables, distribution function, partial sums, etc.) in Probability Theory (PT), (2) Stochastic Processes (SP) results of Markov chains pertaining to classification of states and characterization, basic properties of Poisson process (3) inter relationships and properties of popular designs of experiments (DOE), CRD, RBD, LSD, and BIBD, construction, analysis and properties of factorial, fractional factorial, confounded factorial designs.	25
2.		25
3.		25
4.	Discuss about statistical thinking, Statisticians-the original data scientist Jobs done: Describe data-Decide from data-Predict from data-Embrace data in all its forms (numerals, text, images, audio, visuals) Uses Principles: Average-maxima-minima-variance-probability-distribution-expectation-risk-correlation-causation-grouping-comparison-sampling-visualisation-cognition-logical reasoning Match making of some forms of database with research questions and statistical methods	25

	How to choose research question: Significance, Novelty, Curiosity, Scope, Actionability, Setting the hook (write a mini-intro) How to write an introduction: What-why research question is important in theory and practice? What do we know-don't know? what will we learn?	

Teaching-Learning Methodology	• Discuss strategies to solve statistics exercise problems and solve problems in front of them. • Facilitate practical learning through hands on exercises, allowing students to implement algorithms using software / programming languages.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Develop comprehensive understanding of statistical theory.
2.	Able to choose appropriate statistical formula based on the nature of problem at hand.
3.	Apply statistical thinking in practice.
4.	Prepare project proposal, set research question, write introduction, interpretation and discussion of results.

Suggested References:	
Sr. No.	References
1.	
2.	Wells, H.G. (1903) Mankind in the Making. London: Chapman & Hall.
3.	Kahneman, D. (2012) Thinking, Fast and Slow. London: Penguin.
4.	Nigel Marriott (2014) The future of statistical thinking Significance, (Dec), 78-80.
5.	
6.	

On-line resources to be used if available as reference material

- Chapter%201%20Introduction%20_%20Statistical%20Thinking%20for%20the%2021st%20Century.html
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(Master of Science in Statistics) (Master of Science)
(M. Sc.) (Statistics) Semester (III)

Course Code	PS03ESTA54	Title of the Course	Pattern Recognition
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	• Introduce fundamental concepts and techniques of statistical pattern recognition. • Equip students with essential algorithms and techniques for supervised and unsupervised learning. • Provide hands-on experience with practical applications of pattern recognition. • Develop critical thinking skills for evaluating and adapting algorithms to different scenarios.

Course Content		
Unit	Description	Weightage* (%)
1.	Overview of pattern recognition and its applications, Field related to pattern recognition: Artificial Intelligence, Machine Learning, Image Analysis, stages in pattern recognition, approaches to statistical pattern recognition: Bayes decision rule for minimum error, Bayes decision rule for minimum risk, Neyman-Pearson decision rule, linear discriminant functions, density estimation: parametric approach-Normal based models, maximum likelihood parameter estimation, Expectation Maximization (EM) algorithm Bayesian estimation.	25
2.	Nonparametric density estimation – Bayesian belief networks, KNN method, Kernel density estimation. Supervised learning algorithms: Linear regression, Classification algorithms: k-Nearest neighbors, decision trees, support vector machines, ensemble methods.	25
3.	Unsupervised Learning – clustering problem: partition methods – k-means clustering, k-medoid clustering; Hierarchical methods – Agglomerative algorithms: single linkage algorithm, complete linkage algorithm; evaluation of clustering. Feature selection criteria, Linear feature extraction: Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Introduction to Artificial Neural Network (ANN).	25

4.	Pattern recognition for sequential data: Markov models, Hidden Markov Models (HMM), Maximum likelihood for the HMM, forward-backward algorithm, sum-product algorithm, Viterbi algorithm. Case studies: Exploring real world applications of pattern recognition in different domains such as, image processing, fraud detection and so on.	25

Teaching-Learning Methodology	• Engage students through traditional lectures, providing conceptual understanding of statistical pattern recognition algorithms and their applications. • Facilitate practical learning through hands on exercises, allowing students to implement algorithms using programming languages like Python.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Comprehensive understanding of statistical pattern recognition algorithms and their applications.
2.	Ability to choose appropriate algorithms based on the nature of the data and task.
3.	Exhibit critical thinking skills in evaluating and comparing different approaches.
4.	Prepare students for industry roles by integrating case studies and platforms commonly used in pattern recognition applications.

Suggested References:	
Sr. No.	References
1.	Christopher M. Bishop (2006): Pattern Recognition and Machine Learning, Springer.
2.	Andrew R. Webb (2002): Statistical Pattern Recognition, 2E, John Wiley and Sons.
3.	Duda et al. (2001): Pattern Classification, 2E, John Wiley
4.	K. Fukunaga (1990): Introduction to statistical pattern recognition, 2e, AP
5.	B. D. Ripley (1996): Pattern Recognition and Neural Networks, Cambridge university Press.
6.	M. Friedman and A. Kandel (2020): Introduction to Pattern Recognition, World Scientific.

On-line resources to be used if available as reference material
https://www.javatpoint.com/pattern-recognition-in-machine-learning https://onlinecourses.nptel.ac.in/noc23_ee119/preview https://www.geeksforgeeks.org/pattern-recognition-basics-and-design-principles/