Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)

Course Structure for M.Sc. - II Semester- III (STATISTICS)
(2019 Pattern)

Semester	Paper Code	Title of the Paper	No. of Credits
III	STAT-5301	Asymptotic Inference	4
	STAT-5302	Design and Analysis of Experiments	4
	STAT-5303	Time Series Analysis	4
	STAT-5304 (A) STAT-5304 (B) STAT-5304 (C)	Data Mining Or Design and Analysis of Clinical Trials Or Optimization Techniques	4
	STAT-5305	Practical-V	4
	STAT-5306	Practical-VI	4

Program Outcomes (POs) for M.Sc. Programme

PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that forms a part of a postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise way and help reach conclusions in group settings.

PO4	**Research-related skills and Scientific temper :** Infer scientific literature, build a sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge:** Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Perform independently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-III STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5301
Paper : I Title of Paper : Asymptotic Inference
Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. The main objective of this course is to learn and understand asymptotic behavior of the estimators.
2. Students should be able to find and verify the consistent estimator and consistency and asymptotic normality (CAN) estimator.
3. To learn various methods of finding consistent estimator, CAN estimator, large sample test and asymptotic confidence interval.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. understand concept of Consistent estimator, CAN estimator.

CO2. obtain consistent estimator and their asymptotic distributions.

CO3. choose the ARE estimator among given various consistent estimators.

CO4. obtain asymptotic distributions of moment estimators, percentile estimators.

CO5. determine maximum likelihood estimator and its asymptotic distributions

CO6. derive Likelihood Ratio Test (LRT), large sample test Wald's test, and Score test,

CO7. compute asymptotic confidence interval.

TOPICS/CONTENTS:

Unit-1

Consistency: real and vector parameters, invariance of consistency under continuous transformation, Consistent estimators by method of moments and method of percentiles, choosing between consistent estimators, Minimum sample sizes required to attain given level of accuracy, consistency and asymptotic normality (CAN): real and vector parameters, invariance of CAN under differentiable transformations (delta method), generation of CAN estimators using central limit theorem, CAN property of estimators obtained by moments and percentiles,

examples of consistent but not asymptotically normal estimators, Best asymptotically normal (BAN) estimator, asymptotic relative efficiency (ARE) of consistent estimator. **(18 L)**

Unit- 2

Maximum likelihood estimation, MLE in exponential family, Cramèr family, Cramèr-Huzurbazar theorem, asymptotic properties of maximum likelihood estimators, Solution of likelihood equations, Method of scoring, Newton-Raphson and other iterative procedures, MLE in case of restricted parameter space and its asymptotic distribution, super-efficient estimators, extension to vector–valued parameters, inconsistent MLE, special cases such as exponential class of densities and multinomial distribution, Multinomial with cell probabilities depending on a parameter. **(18 L)**

Unit- 3

The Likelihood Ratio Test (LRT), asymptotic distribution of log likelihood ratio, Bartlett Correction, Wald Test, Rao's score test, Barlett's Test for homogeneity of variances, Likelihood Ratio Test for Multinomials, variance stabilizing transformation and large sample tests, comparison of tests: asymptotic relative efficiency of a test, Consistency of Large Sample test.

(15 L)

Unit- 4

Asymptotic confidence intervals: construction and examples, applications to categorical data analysis. **(9 L)**

References:

1) Kale B. K. and Muralidharan K. (2015) Parametric Inference: An Introduction, Alpha Science International Ltd.
2) Gupta Anirban Das (2008), Asymptotic Theory of Statistics and Probability, Springer, New York.
3) Dudewicz E. J. and Mishra S. N. (1988) Modern Mathematical Statistics, John Wiley and Sons.
4) Casella G. and Berger R. L. (2001). Statistical Inference, 2nd edition, Duxbury press.
5) Lehmann, E.L. (1986). Testing Statistical Hypotheses (Student Edition).

6) Rohatgi V.K. and Ehsanes Saleh A. K. MD. (2003). An Introduction to Probability and Statistics, (Wiley Eastern, 2nd Ed.).
7) Fergusson T.S. (1996), A course in Large Sample Theory, Chapman and Hall.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3								3
CO2	3			3					3
CO3	2				2				3
CO4		3							3
CO5		3							3
CO6		3					1		3
CO7			3			1		1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Understand the concept of Consistent estimator, CAN estimator. (Weightage: 3 - Strongly Related)

Justification: This directly aligns with building a foundational understanding of statistical estimation, specifically focusing on consistency and the concept of CAN estimator.

CO2. Obtain consistent estimator and their asymptotic distributions. (Weightage: 3 - Strongly Related)

Justification: This builds on the foundational knowledge from PO1, emphasizing the application of consistent estimators and understanding their asymptotic behavior.

CO3. Choose the ARE estimator among given various consistent estimators. (Weightage: 2 - Moderately Related)

Justification: While related, the emphasis is more on understanding and applying consistent estimators rather than comparing their efficiency (ARE).

PO2. Critical Thinking and Problem Solving

CO4. Obtain asymptotic distributions of moment estimators, percentile estimators. (Weightage: 3 - Strongly Related)

Justification: This involves critical thinking in determining the asymptotic distributions for different types of estimators, requiring a deeper understanding of statistical concepts.

CO5. Determine maximum likelihood estimator and its asymptotic distributions. (Weightage: 3 - Strongly Related)

Justification: The process of determining maximum likelihood estimators involves critical thinking, and understanding their asymptotic distributions further enhances problem-solving skills.

CO6. Derive Likelihood Ratio Test (LRT), large sample test Wald's test, and Score test. (Weightage: 3 - Strongly Related)

Justification: These statistical tests involve critical thinking and problem-solving skills in choosing and applying the appropriate test for a given scenario.

PO3. Social Competence

CO7. Compute asymptotic confidence interval. (Weightage: 1 - Partially Related)

Justification: While this involves statistical inference, it has less direct relevance to social competence. The focus is more on the technical aspects of estimation and confidence intervals.

PO4. Research-related Skills and Scientific Temper

CO2. Obtain consistent estimator and their asymptotic distributions. (Weightage: 3 - Strongly Related)

Justification: This aligns with research-related skills, as obtaining and understanding consistent estimators and their asymptotic distributions is fundamental to statistical research.

PO5. Trans-disciplinary Knowledge

CO3. Choose the ARE estimator among given various consistent estimators. (Weightage: 2 - Moderately Related)

Justification: While not directly trans-disciplinary, the ability to choose the most efficient estimator is a skill that can be applied across various disciplines.

PO6. Personal and Professional Competence

CO7. Compute asymptotic confidence interval. (Weightage: 1 - Partially Related)

Justification: The focus here is more on technical competence rather than personal and professional aspects.

PO7. Effective Citizenship and Ethics

CO6. Derive Likelihood Ratio Test (LRT), large sample test Wald's test, and Score test. (Weightage: 1 - Partially Related)

Justification: The derivation of statistical tests is not directly related to citizenship and ethics, but an understanding of these tests is crucial for ethical and responsible statistical practice.

PO8. Environment and Sustainability

CO7. Compute asymptotic confidence interval. (Weightage: 1 - Partially Related)

Justification: The content of this outcome is more focused on statistical methods rather than environmental or sustainability issues.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: The entire set of outcomes is closely tied to the ability to engage in self-directed learning. Mastering statistical estimation and related concepts requires ongoing learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-III STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5302
Paper : II Title of Paper : Design and Analysis of Experiments
Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. The main objective of this course is to learn and understand various designs of experiments.
2. Students should be able to design and carryout various experiments and analyze the data.
3. Students should be able to apply appropriate design in real life situation.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. understand basic principles and various terms of Design of Experiments.

CO2. apply factorial design in real life problems.

CO3. apply fractional factorial design in real life problems.

CO4. implicating total confounding and partial confounding in real life problems.

CO5. apply appropriate design in real life situation

CO6. analyze the data of various experimental design.

CO7. understand the concept of Taguchi methods.

TOPICS/CONTENTS:

Unit-1

Estimability of linear parametric function, necessary and sufficient condition for estimability, Best Linear Unbiased Estimator (BLUE), Gauss-Markov set up, Least square

estimation, Normal equations, Consistency of system of normal equations and their solution, Gauss-Markov theorem, Variances and covariances of BLUE's, Estimation space, Error space, their ranks, Orthogonality of estimation space and error space, Simultaneous estimates of linear parametric function, Estimation of error variance, Estimation with correlated observations, Least square estimates with restriction on parameters, Method of generalized least squares. **(15L)**

Unit-2

Review of 2^k full factorial experiments, concepts of main effects, interaction effect, their graphical representation, analysis of single replicate and more than one replicates of 2^k design using ANOVA total and partial confounding of 2^k design in 2^p blocks p = 2, 3. Two level fractional factorial experiments, resolution of a design (III, IV and V), aberration of a design, aliases, generators of the design, complete defining relation. **(12L)**

Unit-3

3^k design: contrasts for linear and quadratic effects, statistical analysis of 3^k design, confounding and fractional experiments in 3^k design, Response Surface Methodology (RSM): linear and quadratic model, stationary point, central composite designs (CCD), ridge systems, rotatability, multiple responses, blocking in RSM, Box-Behnken design. **(18L)**

Unit-4

Taguchi methods: Concept of noise and control factors, inner and outer arrays, concept of loss function, S/N ratio, orthogonal arrays, linear graphs, interaction tables, ANOVA, random effect models and mixed models, Nested design. **(15L)**

References:

1) Dean, A. and Voss, D. (1999). *Design and Analysis of Experiments*, Springer.
2) George E. P. Box, Draper N.R. (1987). *Empirical Model-Building and Response Surfaces*, Wiley.
3) Kshirsagar A.M. (1983). *Linear Models*, Marcel Dekker.
4) Montgomery, D.C. (2001). *Design and Analysis of Experiments*, Wiley.
5) Phadke, M.S. (1989). Quality Engineering using Robust Design, Prentice Hall, Englewood Cliffs, New Jersey.

6) Wu, C.F. Jeff and Hamada M. (2000). Experiments: Planning, Analysis and Parameter Design Optimization, John Wiley and Sons.
7) Bapat, R. B. (2012). Linear algebra and linear models. Springer Science & Business Media.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3	1	3		1	1	1	3
CO2	3	3	1	3		1	1	1	3
CO3	3	3	1	3		1	1	1	3
CO4	3	3	1	3		1	1	1	3
CO5	3	3	1	3		1	1	1	3
CO6	3	3	1	3		1	1	1	3
CO7	2	3	1	3	2	1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Understand basic principles and various terms of Design of Experiments. (Weightage: 3 - Strongly Related)

Justification: This directly aligns with building foundational knowledge in the field of experimental design, emphasizing the understanding of principles and terms.

CO2. Apply factorial design in real-life problems. (Weightage: 3 - Strongly Related)

Justification: This extends disciplinary knowledge into practical application, requiring the application of factorial design principles in solving real-life problems.

CO3. Apply fractional factorial design in real-life problems. (Weightage: 3 - Strongly Related)

Justification: Similar to CO2, this involves the application of fractional factorial design, deepening the understanding and application of experimental design concepts.

CO4. Implicate total confounding and partial confounding in real-life problems. (Weightage: 3 - Strongly Related)

Justification: Understanding and implicating confounding factors are integral to disciplinary knowledge in experimental design.

CO5. Apply appropriate design in real-life situations. (Weightage: 3 - Strongly Related)

Justification: This is a direct application of disciplinary knowledge, requiring the selection and application of the appropriate experimental design in various situations.

CO6. Analyze the data of various experimental designs. (Weightage: 3 - Strongly Related)

Justification: Analyzing data from different experimental designs is a critical aspect of disciplinary knowledge, enhancing the ability to draw meaningful conclusions.

CO7. Understand the concept of Taguchi methods. (Weightage: 2 - Moderately Related)

Justification: While Taguchi methods are related, they represent a specific aspect of experimental design that may not be as fundamental to basic principles. Hence, the moderately related weightage.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: The entire set of outcomes involves critical thinking and problem-solving skills, from understanding principles to applying designs and analyzing data.

PO3. Social Competence

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and focused on statistical methodologies, with less direct relevance to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: Experimental design is a fundamental aspect of research, and the outcomes align closely with research-related skills and the development of a scientific temper.

PO5. Trans-disciplinary Knowledge

CO7. Understand the concept of Taguchi methods. (Weightage: 2 - Moderately Related)

Justification: Taguchi methods have applications beyond traditional experimental design, making this outcome moderately related to trans-disciplinary knowledge.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: While the outcomes contribute to technical competence, the direct connection to personal and professional aspects is limited.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The focus here is more on statistical methodologies and less on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Experimental design is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-III STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5303
Paper : III Title of Paper : Time Series Analysis
Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. The main objective of this course is that students should understand various time series models, estimation of its parameters and be able to make predictions.
2. To learn the concepts like Auto-covariance, auto-correlation function and vector auto regression.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. fit the model on time series data like ARMA, ARIMA, SARIMA, ARCH and GARCH properties.

CO2. apply and understand the techniques for estimating parameters of time series models also the role of maximum likelihood estimation in time series modeling.

CO3. perform diagnostic checks on time series models to assess model adequacy.

CO4. identify and address issues such as autocorrelation and heteroscedasticity.

CO5. analyses time series data and use multivariate time series models such as vector auto regression (VAR).

CO6. Gain proficiency in using ITSM, R and Python to fit an appropriate time series model and infer the results.

CO7. effectively interpret the results of time series analyses, both in written reports and oral presentations.

TOPICS/CONTENTS:

Unit-1

Exploratory time Series analysis, Time Series as a discrete parameter stochastic process, tests for trend and seasonality, moving average smoothing, exponential smoothing, double (Holt exponential smoothing), Triple (Holt -Winters exponential smoothing), adaptive smoothing definition and its application. **(15 L)**

Unit 2

Stationary process: General linear process, stationary process and strict stationary process, moving average (MA), Auto regressive (AR) and autoregressive moving average (ARMA) auto covariance and auto correlation functions and its properties stationary and invertibility. Introduction to spectral analysis of weakly stationary process. Periodogram and correlogram analysis. **(15L)**

Unit 3

Non-stationary: Unit root, non-stationary unit root test, Integrated ARMA (ARIMA) model, seasonal ARIMA (SARIMA) models, Yule-Walker estimation. Estimation of ARIMA models parameters, Maximum likelihood method for estimation, residual analysis and diagnostic checking. Filter and transfer function. Durbin-Levison algorithm, innovation algorithm, Box-Jenkins model (Without proof). **(15L)**

Unit 4

Graphical method for choosing AR and MA lags, FPE, AIC, BIC, residual analysis, conditional hetroschedastic models, volatility models, ARCH and GARCH properties, examples, estimation and forecasting. Multivariate Time series model, VAR models, vector ARMA models. Conintegration models, use of statistical software for time series analysis. **(15L)**

References:

1. Brockwell, P.J. and Davis, R. A. *Introduction to Time Series Analysis*, Springer.
2. Chatfield, C. (2001). *Time Series Forecasting*, Chapmann & hall, London.
3. Fuller, W. A. (1996). *Introduction to Statistical Time Series*, 2nd Ed. John Wiley.
4. Hamilton N. Y. (1994). *Time Series Analysis*. Princeton University press. Princeton.
5. Kendall, Sir Maurice and Ord, J. K. (1990). Time Series (Third Edition), Edward Arnold.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3		3		1	1	1	3
CO2	3	3		3		1	1	1	3
CO3	3	3		3		1	1	1	3
CO4	3	3		3		1	1	1	3
CO5	3	3		3	2	1	1	1	3
CO6	3	3		3		1	1	1	3
CO7	3	3	1	3		1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Fit the model on time series data like ARMA, ARIMA, SARIMA, ARCH, and GARCH properties. (Weightage: 3 - Strongly Related)

Justification: This directly aligns with building disciplinary knowledge in time series modeling, covering various models and their properties.

CO2. Apply and understand the techniques for estimating parameters of time series models, also the role of maximum likelihood estimation in time series modeling. (Weightage: 3 - Strongly Related)

Justification: Understanding and applying estimation techniques in time series models contribute directly to disciplinary knowledge in this field.

CO3. Perform diagnostic checks on time series models to assess model adequacy. (Weightage: 3 - Strongly Related)

Justification: Diagnostic checks are an essential part of assessing the validity of time series models, enhancing disciplinary knowledge.

CO4. Identify and address issues such as autocorrelation and heteroscedasticity. (Weightage: 3 - Strongly Related)

Justification: Dealing with issues like autocorrelation and heteroscedasticity is crucial in time series modeling, contributing directly to disciplinary knowledge.

CO5. Analyze time series data and use multivariate time series models such as vector auto-regression (VAR). (Weightage: 3 - Strongly Related)

Justification: Analyzing time series data and using multivariate models extends disciplinary knowledge to a broader and more advanced level.

CO6. Gain proficiency in using ITSM, R, and Python to fit an appropriate time series model and infer the results. (Weightage: 3 - Strongly Related)

Justification: Proficiency in using specific tools and programming languages is integral to disciplinary knowledge in the modern context of time series analysis.

CO7. Effectively interpret the results of time series analyses, both in written reports and oral presentations. (Weightage: 3 - Strongly Related)

Justification: The ability to interpret and communicate results is a critical aspect of disciplinary knowledge, especially in the context of time series analysis.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: Time series analysis requires critical thinking and problem-solving skills at every stage, from model fitting to interpretation of results.

PO3. Social Competence

CO7. Effectively interpret the results of time series analyses, both in written reports and oral presentations. (Weightage: 1 - Partially Related)

Justification: While interpretation skills are essential, the direct social relevance is limited in this technical context.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: Time series analysis is a research-oriented field, and the outcomes align closely with research-related skills and scientific temper.

PO5. Trans-disciplinary Knowledge

CO5. Analyze time series data and use multivariate time series models such as vector auto-regression (VAR). (Weightage: 2 - Moderately Related)

Justification: The use of multivariate models extends the knowledge to a more trans-disciplinary context, although not fully.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence, with limited direct

connection to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The focus here is more on statistical methodologies and less on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Time series analysis is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-III STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5304 (A)
Paper : IV Title of Paper : Data Mining
Credit : 4 credits No. of lectures: 60

A) Course objectives:

1. Students should understand Big Data, Data Warehouse, Data Mining Principles.
2. Students should be able to identify appropriate data mining techniques to analyze big data.
3. Evaluating efficiency of different data mining techniques like classification prediction, clustering and association rule mining

B) Course outcomes:

By the end of the course, students will be able to:

CO1. understand the basic concepts, goals, and challenges of data mining.

CO2. explore the role of data mining in extracting meaningful patterns and knowledge from large datasets.

CO3. Study and apply a variety of data mining techniques, like CART, SVM, PCA, KNN, etc.

CO4. understand and implement supervised learning algorithms for classification and regression tasks, and explore unsupervised learning techniques, including clustering algorithms.

CO5. Explore ethical issues related to data mining, including privacy concerns and bias in algorithms.

CO6. apply data mining techniques to real-world datasets, and interpret the results and draw actionable insights from the analysis.

CO7. gain practical experience by working with data mining tools and software like, R, Python.

TOPICS/CONTENTS:

Unit- 1

Introduction to big data, supervised and unsupervised learning, review of linear discriminant analysis, logistic regression, clustering procedure- k means, hierarchical, principal component analysis. **(10 L)**

Unite -2

Bayes classifier, nearest neighbour classifier, Classification and Regression tree (CART): information gain, gain ratio, Gini index, artificial neural network, convoluted neural network (CNN), Support Vector Machine (SVM) for linearly separable data and linearly in separable data. **(15 L)**

Unit- 3

Model evaluation and selection methods: Metrics for evaluating classifier performance (confusion matrix), holdout method and random sampling, cross validation, bootstrap, ROC curves, AIC, BIC, CIC, DIC (information criterion), bias variance tradeoff.

Techniques to improve classification accuracy: Bagging, boosting, Ada boosting, Random forest, gradiant boosting. **(20 L)**

Unit -4

Self Organizing Map (SOM), EM algorithm, market basket analysis, text mining: sentiment analysis, word frequency analysis, N-grams and correlation, topic modeling. **(15 L)**

References:

1. Breiman, L., Friedman, J.H., Olshen, R.A. and Stone, C.J. (1984). Classification and Regression Trees. (Wadsworth and Brooks/Cole).
2. Daniel T.Larose, (2006). Data Mining Methods and Models, Wile-Interscience.
3. Galit Shmueli, Nitin Patel, Peter Bruce, (2010). Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner, Wiley
4. Hastie T., Tibshirani R. and Friedman J. H., (2003). The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer.
5. Mitchell Tom, (1997). Machine Learning. McGraw-Hill.
6. Ripley, B.D. (1996). Pattern Recognition and Neural Networks. (Cambridge University Press).

7. Gareth M. James, Trevor Hastie, Daniela Witten, Robert Tibshirani, Introduction to Statistical Learning using R, Springer.
8. Julia Silge and David Robinson, (2017) Text Mining with R, a Tidy Approach, O'Reilly Publication.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3		3		1	2	1	3
CO2	3	3		3		1	2	1	3
CO3	3	3		3		1	2	1	3
CO4	3	3		3		1	2	1	3
CO5	2	3	2	3	2	1	2	1	3
CO6	3	3		3		1	2	1	3
CO7	3	3		3		1	2	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Understand the basic concepts, goals, and challenges of data mining. (Weightage: 3 - Strongly Related)

Justification: This directly aligns with building foundational knowledge in the field of data mining, covering its concepts, goals, and challenges.

CO2. Explore the role of data mining in extracting meaningful patterns and knowledge from large datasets. (Weightage: 3 - Strongly Related)

Justification: Exploring the role of data mining in extracting meaningful patterns contributes to disciplinary knowledge by delving into the practical applications of the field.

CO3. Study and apply a variety of data mining techniques, like CART, SVM, PCA, KNN, etc. (Weightage: 3 - Strongly Related)

Justification: Studying and applying various data mining techniques directly enhances disciplinary knowledge by covering a range of methods used in the field.

CO4. Understand and implement supervised learning algorithms for classification and regression tasks, and explore unsupervised learning techniques, including clustering algorithms. (Weightage: 3 - Strongly Related)

Justification: Understanding and implementing both supervised and unsupervised learning algorithms contributes significantly to disciplinary knowledge in data mining.

CO5. Explore ethical issues related to data mining, including privacy concerns and bias in algorithms. (Weightage: 2 - Moderately Related)

Justification: While not the primary focus, ethical considerations are moderately related to disciplinary knowledge, as they influence the responsible application of data mining techniques.

CO6. Apply data mining techniques to real-world datasets, and interpret the results and draw actionable insights from the analysis. (Weightage: 3 - Strongly Related)

Justification: Applying data mining techniques to real-world datasets and drawing actionable insights directly contributes to disciplinary knowledge in a practical context.

CO7. Gain practical experience by working with data mining tools and software like R, Python. (Weightage: 3 - Strongly Related)

Justification: Gaining practical experience with tools like R and Python is essential for disciplinary knowledge in data mining, emphasizing hands-on skills.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: Data mining involves critical thinking at every stage, from understanding concepts to applying techniques and interpreting results.

PO3. Social Competence

CO5. Explore ethical issues related to data mining, including privacy concerns and bias in algorithms. (Weightage: 2 - Moderately Related)

Justification: Ethical considerations in data mining have a social impact, making this outcome moderately related to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of data mining.

PO5. Trans-disciplinary Knowledge

CO5. Explore ethical issues related to data mining, including privacy concerns and bias in algorithms. (Weightage: 2 - Moderately Related)

Justification: Ethical considerations in data mining can have trans-disciplinary implications beyond the core technical aspects.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: While technical skills are emphasized, the outcomes have limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

CO5. Explore ethical issues related to data mining, including privacy concerns and bias in algorithms. (Weightage: 2 - Moderately Related)

Justification: Ethical issues related to data mining have direct implications for effective citizenship and ethical considerations.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on data mining methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Data mining is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-III STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5304(B)

Paper : IV Title of Paper : Design and Analysis of Clinical Trials

Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. Students will be able to understand the basic principles of probability and how they are related to biostatistics.
2. Establishing an objective framework for conducting an investigation for clinical trials.
3. To provide an unbiased evaluation of the merits of using one or more treatment options for a given disease or condition of interest.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. understand the principles of Good Clinical Practice.

CO2. demonstrate an understanding of the essential principles of modern bio-statistical methods and statistical software and how to apply them.

CO3. learn methods for determining the appropriate sample size for a clinical trial.

CO4. understand the purpose and importance of clinical trials in medical research.

CO5. explore the phases of clinical trials and their objectives.

CO6. learn about ethical guidelines and regulatory requirements governing clinical trials.

CO7. develop and implement statistical analysis plans for clinical trials, and understand the principles of intention-to-treat analysis.

TOPICS/CONTENTS:

Unit-1

Introduction to Clinical Trials (CTs): epidemiology, need and ethics of CTs, History of clinical trials, New Drug Application, overview of phase I-IV trials, clinical trial protocol, Bias and Random error, Objective and points of CTs. **(15L)**

Unit 2

Design of clinical trials: Basic design consideration, introduction, patent selection, selection control parallel and cross-over designs, cross-sectional and longitudinal designs, balanced incomplete block and designs, Titration designs, Enrichment Designs. Randomization models, Randomization methods, Implementation of Randomization, Generalization of controlled Randomized trials blinding. **(15L)**

Unit 3

Bio availability and Bio equivalence studies: History Bioavailability studies, Formulation and Routes of administration, Pharmacokinetic parameter, Clinically importance differences, Assessment of Bioequivalence Statistical inference for standard 2 x 2 crossover designs: The carry-over effect, The direct drug effect, The period effect Analysis of Variance (ANOVA), Assessment of inter and intra subject variability. **(15L)**

Unit 4

Multicenter trials, nonparametric test, outlier detection in clinical trials, power and sample size determination, drug interaction study, dose proportionality study, steady state analysis, Meta analysis. **(15L)**

References:

1) Chow S. C. and Liu J. P. (2009) Design and Analysis of Bioavailability and bioequivalence, 3rd Edn. CRC Press.
2) Chow S. C. and Liu J.P. (2004) Design and Analysis of Clinical Trials, 2nd Edn. Marcel Dekkar.
3) Fleiss J. L. (1989) The Design and Analysis of Clinical Experiments, Wiley.
4) Friedman L. M., Furburg C., Demets D. L. (1998). Fundamentals of Clinical Trials, Springer.
5) Jennison. C. and Turnbull B. W. (1999) Group Sequential Methods with Applications to Clinical Trials, CRC Press.
6) Marubeni .E. and Valsecchi M. G. (1994) Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3	2	3		1		1	3
CO2	3	3	2	3		1		1	3
CO3	3	3	2	3		1		1	3
CO4	3	3	2	3		1		1	3
CO5	3	3	2	3		1		1	3
CO6	3	3	2	3	2	1	2	1	3
CO7	3	3	2	3		1		1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Understand the principles of Good Clinical Practice. (Weightage: 3 - Strongly Related)

Justification: This directly aligns with building disciplinary knowledge in the field of clinical research, emphasizing the principles of ethical and quality research practices.

CO2. Demonstrate an understanding of the essential principles of modern bio-statistical methods and statistical software and how to apply them. (Weightage: 3 - Strongly Related)

Justification: The understanding and application of bio-statistical methods contribute significantly to disciplinary knowledge in the context of clinical trials.

CO3. Learn methods for determining the appropriate sample size for a clinical trial. (Weightage: 3 - Strongly Related)

Justification: Determining the appropriate sample size is a critical aspect of designing clinical trials, directly contributing to disciplinary knowledge.

CO4. Understand the purpose and importance of clinical trials in medical research. (Weightage: 3 - Strongly Related)

Justification: Understanding the purpose and importance of clinical trials is fundamental to disciplinary knowledge in medical research.

CO5. Explore the phases of clinical trials and their objectives. (Weightage: 3 - Strongly Related)

Justification: Exploring the phases of clinical trials directly contributes to disciplinary knowledge, providing insights into the systematic process of medical research.

CO6. Learn about ethical guidelines and regulatory requirements governing clinical trials. (Weightage: 3 - Strongly Related)

Justification: Understanding ethical guidelines and regulatory requirements is crucial for maintaining disciplinary knowledge and ensuring the integrity of clinical research.

CO7. Develop and implement statistical analysis plans for clinical trials, and understand the principles of intention-to-treat analysis. (Weightage: 3 - Strongly Related)

Justification: Developing and implementing statistical analysis plans for clinical trials, including the intention-to-treat analysis, is a key component of disciplinary knowledge in this field.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: Clinical trials involve critical thinking and problem-solving skills at every stage, from study design to statistical analysis.

PO3. Social Competence

CO6. Learn about ethical guidelines and regulatory requirements governing clinical trials. (Weightage: 2 - Moderately Related)

Justification: The understanding of ethical guidelines and regulatory requirements contributes to social competence, as it involves ethical considerations in conducting research involving human subjects.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of clinical research.

PO5. Trans-disciplinary Knowledge

CO6. Learn about ethical guidelines and regulatory requirements governing clinical trials. (Weightage: 2 - Moderately Related)

Justification: Ethical guidelines and regulatory requirements can have trans-disciplinary implications, as they may extend beyond the strictly clinical or medical domain.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in the context of clinical research, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

CO6. Learn about ethical guidelines and regulatory requirements governing clinical trials. (Weightage: 2 - Moderately Related)

Justification: The understanding of ethical guidelines and regulatory requirements contributes to effective citizenship and ethical considerations in the context of clinical research.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The focus here is more on clinical and research methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Clinical research is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-III STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5304(C)

Paper : IV Title of Paper : Optimization Techniques

Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. The main objective is to understand the mathematical tools that are needed to solve optimization problems.
2. Students should be able to understand discrete event simulation and decision analysis with inclusion of modeling based on random events involving uncertainties.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. understand the fundamental concepts of optimization, and differentiate between constrained and unconstrained optimization problems.

CO2. explore optimization problems with integer constraints, and understand methods for solving integer and mixed-integer programming problems.

CO3. apply optimization techniques to solve problems in operations research, such as network optimization, transportation problems, and scheduling.

CO4. apply optimization techniques to real-world problems, demonstrating the ability to formulate and solve practical optimization challenges.

CO5. study optimization problems with nonlinear objective functions or constraints.

CO6. effectively communicate the results of optimization analyses, both in written reports and oral presentations.

CO7. gain proficiency in using programming languages like R and Python for solving optimization problems also apply optimization libraries and tools available in these languages.

TOPICS/CONTENTS:

Unit-1

Linear Programming Problem: Review of simplex algorithm and simplex method, Existence of unbounded solution, optimality conditions, for other related theorems (statement only), artificial variable technique: Two phase and Big-M method, Revised simplex method.

(12L)

Unit 2

Duality in LPP: Concept of duality, duality theorems, dual simplex method, duality theory of testing optimality of solution in and transshipment problem. Sensitivity analysis: Bellman's optimality principle, changes affecting feasibility and optimality. **(12L)**

Unit 3

Integer linear programming problem (ILPP): The concept of cutting plane, Gomory's method of cutting plane for all ILPP and mixed ILPP, Branch and Bound method, Nonlinear programming: Kuhn-Tucker conditions of optimality, Quadratic programming, Wolfes, Beales methods, applications of ILPP. **(18L)**

Unit 4

Dynamic programming: Nature of dynamic programming, deterministic processes, Non-sequential discrete optimization allocation problems, sequential discrete optimization long-term planning problem, multi-stage production processes. Inventory model: Inventory model building, single items inventory control models without shortages, EOQ model with constant rate of demand, with different rate of demand and economic production quantity model when supply is gradual. **(18L)**

References:

1) Bertsekas, D. (1999). Nonlinear Programming, 2nd Edn. Athena Scientific.
2) Chong, E. K. P. and Zak, S. (2004). An Introduction to Optimization, Wiley.
3) Fletcher, R. (2000). Practical Methods of Optimization, Wiley.
4) Hadley, G. (1987). Linear Programming. Addison-Wesley.
5) Kambo, N.S. (1991). Mathematical Programming Techniques. Affiliated East-West press.
6) Panneerselvam, R. (2012). Operations Research, 2nd Edn. Prentice Hall of India.
7) Taha, H.A. (1992). Operations Research, 5th ed. Macmillan.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3	1	3		1	1	1	3
CO2	3	3	1	3		1	1	1	3
CO3	3	3	1	3	2	1	1	1	3
CO4	3	3	1	3		1	1	1	3
CO5	3	3	1	3		1	1	1	3
CO6	3	3	1	3		1	1	1	3
CO7	3	3	1	3		1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Understand the fundamental concepts of optimization and differentiate between constrained and unconstrained optimization problems. (Weightage: 3 - Strongly Related)

Justification: Understanding the fundamental concepts of optimization is foundational to disciplinary knowledge in this field.

CO2. Explore optimization problems with integer constraints and understand methods for solving integer and mixed-integer programming problems. (Weightage: 3 - Strongly Related)

Justification: Exploring integer and mixed-integer programming problems contributes directly to disciplinary knowledge in optimization.

CO3. Apply optimization techniques to solve problems in operations research, such as network optimization, transportation problems, and scheduling. (Weightage: 3 - Strongly Related)

Justification: Applying optimization techniques to solve operations research problems directly aligns with disciplinary knowledge.

CO4. Apply optimization techniques to real-world problems, demonstrating the ability to formulate and solve practical optimization challenges. (Weightage: 3 - Strongly Related)

Justification: Applying optimization to real-world problems enhances disciplinary knowledge by demonstrating practical applications.

CO5. Study optimization problems with nonlinear objective functions or constraints. (Weightage: 3 - Strongly Related)

Justification: Studying optimization problems with nonlinear elements is an advanced aspect of disciplinary knowledge in optimization.

CO6. Effectively communicate the results of optimization analyses, both in written reports and oral presentations. (Weightage: 3 - Strongly Related)

Justification: Communication of optimization results is essential for disciplinary knowledge, ensuring that insights are conveyed effectively.

CO7. Gain proficiency in using programming languages like R and Python for solving optimization problems also apply optimization libraries and tools available in these languages. (Weightage: 3 - Strongly Related)

Justification: Proficiency in using programming languages for optimization aligns with disciplinary knowledge, emphasizing practical implementation.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: Optimization inherently involves critical thinking and problem-solving skills, from understanding concepts to solving real-world challenges.

PO3. Social Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more technical and focused on optimization methodologies, with less direct relevance to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of optimization.

PO5. Trans-disciplinary Knowledge

CO3. Apply optimization techniques to solve problems in operations research, such as network optimization, transportation problems, and scheduling. (Weightage: 2 - Moderately Related)

Justification: Optimization in operations research has some trans-disciplinary applications, making this outcome moderately related.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in optimization, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on optimization methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Optimization is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5305

Paper : V Title of Paper : Practical-V

Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. Students should be able to design and carryout various experiments and analyze the data.
2. Students should be able to apply appropriate design in real life situation.
3. Students should be able to find and verify the consistent estimator and consistency and asymptotic normality (CAN) estimator.
4. To learn various methods of finding consistent estimator, CAN estimator, large sample test and asymptotic confidence interval.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. apply factorial design in real life problems.

CO2. apply fractional factorial design in real life problems.

CO3. implicating total confounding and partial confounding in real life problems.

CO4. understand the concept of Taguchi methods.

CO5. obtain and verify consistent estimator and their asymptotic distributions.

CO6. derive Likelihood Ratio Test (LRT), large sample test Wald's test, and Score test.

CO7. plotting likelihood function and obtain the MLE by scoring method.

Sr. No.	Title of Experiments
1.	Analysis of general linear model
2.	Balance Incomplete Block Design (Intra block analysis)
3.	Analysis of Covariance in one way and two-way model
4.	Analysis of 3^k factorial experiments
5.	Total Confounding in 3^k factorial experiment
6.	Partial Confounding in 3^k factorial experiment
7.	Analysis of 3^k fractional factorial experiment
8.	Fitting first and second order response surface model, central composite design contour, surface plots, canonical analysis of stationery points, Blocking in RSM
9.	Random effect model with one factor, estimation of variance
10.	Taguchi methods: S/N ratio, orthogonal arrays, triangular tables, linear graphs, inner and outer arrays
11.	Verification of consistency and asymptotic normality of the estimators
12.	Comparing Consistent estimator, MSE and sample size considerations
13.	Asymptotic Confidence Intervals
14.	Power functions of large sample test (LR, Wald, Rao)
15.	Analysis of three-dimensional contingency tables
16.	Plotting Likelihood function, MLE by methods of scoring

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3	1	3		1	1	1	3
CO2	3	3	1	3		1	1	1	3
CO3	3	3	1	3		1	1	1	3
CO4	3	3	1	3	2	1	1	1	3
CO5	2	3	1	3		1	1	1	3
CO6	2	3	1	3		1	1	1	3
CO7	2	3	1	3		1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Apply factorial design in real-life problems. (Weightage: 3 - Strongly Related)

Justification: Applying factorial design directly contributes to building disciplinary knowledge in experimental design and statistical methodologies.

CO2. Apply fractional factorial design in real-life problems. (Weightage: 3 - Strongly Related)

Justification: Similar to CO1, applying fractional factorial design enhances disciplinary knowledge in experimental design and statistical techniques.

CO3. Implicate total confounding and partial confounding in real-life problems. (Weightage: 3 - Strongly Related)

Justification: Understanding and implicating confounding factors in real-life problems directly aligns with building disciplinary knowledge in statistical design.

CO4. Understand the concept of Taguchi methods. (Weightage: 3 - Strongly Related)

Justification: Understanding Taguchi methods contributes to disciplinary knowledge in the context of experimental design and optimization.

CO5. Obtain and verify consistent estimator and their asymptotic distributions. (Weightage: 2 - Moderately Related)

Justification: While related, the emphasis here is more on statistical estimation, making it moderately related to the broader discipline.

CO6. Derive Likelihood Ratio Test (LRT), large sample test Wald's test, and Score test. (Weightage: 2 - Moderately Related)

Justification: Deriving statistical tests is moderately related to disciplinary knowledge, focusing on the application of statistical methods.

CO7. Plotting likelihood function and obtain the MLE by scoring method. (Weightage: 2 - Moderately Related)

Justification: Similarly, plotting likelihood functions and obtaining Maximum Likelihood Estimators (MLE) is moderately related to disciplinary knowledge, emphasizing statistical inference.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills, from experimental design to statistical estimation and hypothesis testing.

PO3. Social Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more technical and focused on statistical methodologies, with less direct relevance to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of statistical research and experimentation.

PO5. Trans-disciplinary Knowledge

CO4. Understand the concept of Taguchi methods. (Weightage: 2 - Moderately Related)

Justification: Taguchi methods, while specific to certain fields, have some trans-disciplinary applications, making this outcome moderately related.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on statistical methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes require ongoing self-directed learning and adaptation, aligning with the goal of lifelong learning in statistical research and experimentation.

Top of Form

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5306

Paper : VI Title of Paper : Practical-VI

Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. The main objective of this course is that students should understand various time series models, estimation of its parameters and be able to make predictions.
2. To learn the concepts like Auto-covariance, auto-correlation function and vector auto regression.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. fit the model on time series data like ARMA, ARIMA, SARIMA, ARCH and GARCH properties.

CO2. apply and understand the techniques for estimating parameters of time series models also the role of maximum likelihood estimation in time series modeling.

CO3. perform diagnostic checks on time series models to assess model adequacy.

CO4. identify and address issues such as autocorrelation and heteroscedasticity.

CO5. develop skills in time series forecasting using appropriate models.

CO6. gain proficiency in using ITSM, R and Python to fit an appropriate time series model and infer the results.

CO7. effectively communicate the results of time series analyses, both in written reports and oral presentations.

Sr. No.	Title of Experiments
1.	Smoothing time series using various filters (exponential, MA), Box-Cox transformation, differencing, checking stationarity and normality after transformation.
2.	ACF/PACF of series and residual analysis.
3.	Stationarity, Causality and invertibility of ARMA model
4.	Order selection in time series: use of ACF/PACF and AIC, BIC, fitting of AR, MA models (conditional least squares or maximum likelihood).
5.	Fitting of ARMA, ARIMA and SARIMA models (conditional least squares or maximum likelihood).
6.	Forecasting using fitted linear models (recursively), Holt -Winters forecasts construction of forecast intervals.
7.	Fitting heteroscedastic models: checking for heteroscedecity from residuals, ARCH, GARCH modeling.
8.	Mini project based on time series analysis paper (2 Practicals)
9.	Case study based on optional paper (2 Practicals)
10.	Research Paper Review (4 Practicals)

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3	1	3		1	1	1	3
CO2	3	3	1	3		1	1	1	3
CO3	3	3	1	3		1	1	1	3
CO4	3	3	1	3	2	1	1	1	3
CO5	2	3	1	3		1	1	1	3
CO6	2	3	1	3		1	1	1	3
CO7	2	3	1	3		1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Fit the model on time series data like ARMA, ARIMA, SARIMA, ARCH, and GARCH properties. (Weightage: 3 - Strongly Related)

Justification: Fitting various time series models aligns directly with building disciplinary knowledge in time series analysis and forecasting.

CO2. Apply and understand the techniques for estimating parameters of time series models also the role of maximum likelihood estimation in time series modeling. (Weightage: 3 - Strongly Related)

Justification: Understanding and applying estimation techniques in time series models contributes significantly to disciplinary knowledge in time series analysis.

CO3. Perform diagnostic checks on time series models to assess model adequacy. (Weightage: 3 - Strongly Related)

Justification: Diagnostic checks are essential for assessing the adequacy of time series models, enhancing disciplinary knowledge in model evaluation.

CO4. Identify and address issues such as autocorrelation and heteroscedasticity. (Weightage: 3 - Strongly Related)

Justification: Addressing issues like autocorrelation and heteroscedasticity directly contributes to disciplinary knowledge in time series analysis.

CO5. Develop skills in time series forecasting using appropriate models. (Weightage: 3 - Strongly Related)

Justification: Developing forecasting skills with appropriate time series models is fundamental to disciplinary knowledge in this field.

CO6. Gain proficiency in using ITSM, R, and Python to fit an appropriate time series model and infer the results. (Weightage: 3 - Strongly Related)

Justification: Proficiency in using software tools to fit time series models and infer results is a practical aspect of disciplinary knowledge in time series analysis.

CO7. Effectively communicate the results of time series analyses, both in written reports and oral presentations. (Weightage: 3 - Strongly Related)

Justification: Communicating results effectively is an integral part of disciplinary knowledge, ensuring that insights are conveyed to stakeholders.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: Time series analysis requires critical thinking and problem-solving skills at every stage, from model fitting to communication of results.

PO3. Social Competence

CO7. Effectively communicate the results of time series analyses, both in written reports and oral presentations. (Weightage: 2 - Moderately Related)

Justification: Effective communication of results has a social dimension, making this outcome moderately related to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of time series analysis.

PO5. Trans-disciplinary Knowledge

CO6. Gain proficiency in using ITSM, R, and Python to fit an appropriate time series model and infer the results. (Weightage: 2 - Moderately Related)

Justification: Proficiency in using various software tools has trans-disciplinary applications, making this outcome moderately related.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 2 - Moderately Related)

Justification: Ethical considerations in communicating results and using software tools make this outcome moderately related to effective citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on time series analysis methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Time series analysis is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.