Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce, Baramati

(Autonomous)

M.Sc. Degree Program in Statistics-
(Faculty of Science & Technology)

CBCS Syllabus

M.Sc. Part – II (Statistics) Semester – III

For Department of Statistics

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2024-2025

Program Outcomes for M.Sc.

1. Comprehensive Knowledge and Understanding:

Postgraduates will possess a profound understanding of their field, encompassing foundational theories, methodologies, and key concepts within a multidisciplinary context.

2. Practical, Professional, and Procedural Knowledge:

Postgraduates will acquire practical skills and expertise necessary for professional tasks, including industry standards, regulations, and ethical considerations, with effective application in real-world scenarios.

3. Entrepreneurial Mindset, Innovation, and Business Understanding:

Postgraduates will cultivate an entrepreneurial mindset, identify opportunities, foster innovation, and understand business principles, market dynamics, and risk management strategies.

4. Specialized Skills, Critical Thinking, and Problem-Solving:

Postgraduates will demonstrate proficiency in technical skills, analytical abilities, effective communication, and leadership, adapting and innovating in response to changing circumstances.

5. Research, Analytical Reasoning, and Ethical Conduct:

Postgraduates will exhibit observational and inquiry skills, formulate research questions, utilize appropriate methodologies for data analysis, and adhere to research ethics while effectively reporting findings.

6. Communication, Collaboration, and Leadership:

Postgraduates will effectively communicate complex information, collaborate in diverse teams, demonstrate leadership qualities, and facilitate cooperative efforts toward common goals.

7. Digital Proficiency and Technological Skills:

Postgraduates will demonstrate proficiency in using ICT, accessing information sources, analyzing data using appropriate software, and adapting to technological advancements.

8. Multicultural Competence, Inclusive Spirit, and Empathy:

Postgraduates will engage effectively in multicultural settings, respect diverse perspectives, lead diverse teams, and demonstrate empathy and understanding of others' perspectives and emotions.

9. Value Inculcation, Environmental Awareness, and Ethical Practices:

Postgraduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and promote sustainability and environmental conservation.

10. Autonomy, Responsibility, and Accountability:

Postgraduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts, contributing to societal well-being.

Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Autonomous)

Board of Studies (BOS) in Statistics

From 2022-23 to 2024-25

Sr. No.	Name	Designation
1.	Prof. Dr. Vikas C. Kakade	Chairman
2.	Prin. Dr. Avinash S. Jagtap	Member
3.	Dr. Neeta K. Dhane	Member
4.	Dr. Vaishali V. Patil	Member
5.	Mrs. Sarita D. Wadkar	Member (Ad hoc)
6.	Mr. Chandrashekhar P. Swami	Member
7.	Ms. Priti S. Malusare	Member (Ad hoc)
8.	Ms. Nilambari A. Jagtap	Member (Ad hoc)
9.	Miss. Kalyani C. Kale	Member (Ad hoc)
10.	Ms. Pooja S. Gaikwad	Member (Ad hoc)
11.	Dr. Akanksha S. Kashikar	Vice-Chancellor Nominee
12.	Prin. Dr. Rajendra G. Gurao	Expert from other University
13.	Mr. Rohan Koshti	Expert from other University
14.	Mr. Saurabh Kadam	Industry Expert
15.	Dr. Jaya L. Limbore	Meritorious Alumni
16.	Miss. Priya N. Rakate	Invitee Member
17.	Ms. Ankita G. Deshmukh	Invitee Member
18.	Ms. Shital B. Choudhar	Invitee Member
19.	Ms. Tejashri D. Kawade	Invitee Member
20.	Mr. Shree Sunil Girange (M.Sc. II)	Student Representative
21.	Miss. Sakshi Rajendra Borole (M.Sc. II)	Student Representative

22.	Mr. Siddhi Rajendra Pathak (TYBSc)	Student Representative
23.	Miss. Nikam Shweta Yuvraj (TYBSc)	Student Representative

Credit Distribution Structure for M.Sc. Part-I (Statistics)

Level	Semester	Major		Research Methodology (RM)	OJT/FP	RP	Cum. Cr.	Degree
		Mandatory	Electives					
6.0	Sem-I	STA-501-MJM: Linear Algebra (Credit 04) STA -502-MJM: Probability Distributions (Credit 04) STA -503-MJM: Statistics Practical – I (Credit 02) STA -504-MJM: Statistics Practical –II (Credit 02)	STA -511-MJE(A): Mathematical Analysis STA-511-MJE(B): Calculus and Statistical Computing (Credit 04)	STA -521-RM: Research Methodology (Credit 04)	--	--	**20**	PG Diploma (after 3 Year Degree)
	Sem-II	STA -551-MJM: Multivariate Analysis (Credit 04) STA -552-MJM: Regression Analysis (Credit 04) STA -553-MJM: Statistics Practical – III (Credit 02) STA -554-MJM: Statistics Practical – IV (Credit 02)	STA -561-MJE (A): Probability Theory STA-561-MJE(B): Stochastic Processes (Credit 04)	--	STA-581-OJT/FP: On Job Training/ Field Project	--	**20**	

Credit Distribution Structure for M.Sc. Part-II (Statistics)

Level	Semester	Major		Research Methodology (RM)	OJT /FP	RP	Cum. Cr.	Degree
		Mandatory	Electives					
6.5	Sem-III	STA-601-MJM: Parametric Inference (Credit 04)	STA -611-MJE(A): Data Mining (Credit 02)	--	--	STA-621-RP: Research Project (Credit 04)	**20**	PG Diploma (after 3 Year Degree)
		STA -602-MJM: Design and Analysis of Experiments (Credit 04)	STA-611-MJE(B): Design and Analysis of Clinical Trials (Credit 02)					
		STA -503-MJM: Statistics Practical – V (Credit 02)	STA -612-MJE(A): Machine Learning: Techniques and Applications (Credit 02)					
		STA -504-MJM: Statistics Practical – VI (Credit 02)	STA-612-MJE(B): Practical based on Clinical Trials (Credit 02)					
	Sem-IV	STA -651-MJM: Asymptotic Inference (Credit 04)	STA -661-MJE (A): Survival Analysis (Credit 02)	--	--	STA-621-RP: Research Project (Credit 06)	**20**	
		STA-652-MJM: Time Series Analysis (Credit 04)	STA-661-MJE(B): Actuarial Statistics (Credit 02)					
		STA -653-MJM: Statistics Practical – VII (Credit 02)	STA -662-MJE (A): Practical Based on Statistical Process Control (Credit 02)					
			STA -662-MJE (A): Practical Based on Optimization Techniques (Credit 02)					

Course Structure for M.Sc. Part-I (Statistics) (2023 Pattern)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	No. of Credits
I	Major (Mandatory)	STA-501-MJM	Linear Algebra	Theory	04
	Major (Mandatory)	STA -502-MJM	Probability Distributions	Theory	04
	Major (Mandatory)	STA -503-MJM	Statistics Practical – I	Practical	02
	Major (Mandatory)	STA -504-MJM	Statistics Practical – II	Practical	02
	Major (Elective)	STA-511-MJE (A)	Mathematical Analysis	Theory	04
		STA-511-MJE(B)	Calculus and Statistical Computing	Theory	
	Research Methodology (RM)	STA -521-RM	Research Methodology	Theory	04
				Total Credits Semester I	**20**
II	Major (Mandatory)	STA-551-MJM	Multivariate Analysis	Theory	04
	Major (Mandatory)	STA-552-MJM	Regression Analysis	Theory	04
	Major (Mandatory)	STA-553-MJM	Statistics Practical – III	Practical	02
	Major (Mandatory)	STA-554-MJM	Statistics Practical – IV	Practical	02
	Major (Elective)	STA-561-MJE (A)	Probability Theory	Theory	04
		STA-561-MJE (B)	Stochastic Processes	Theory	
	On Job Training (OJT)/Field Project (FP)	STA-581-OJT/FP	On Job Training Field Project	Training/Project	04
				Total Credits Semester-II	**20**
				Cumulative Credits Semester I and II	**40**

Course Structure for M.Sc. Part-II (Statistics) (2023 Pattern)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	No. of Credits
III	Major (Mandatory)	STA-601-MJM	Parametric Inference	Theory	04
	Major (Mandatory)	STA -602-MJM	Design and Analysis of Experiments	Theory	04
	Major (Mandatory)	STA -603-MJM	Statistics Practical – V	Practical	02
	Major (Mandatory)	STA -604-MJM	Statistics Practical – VI	Practical	02
	Major (Elective)	STA-611-MJE (A)	Data Mining	Theory	02
		STA-611-MJE(B)	Design and Analysis of Clinical Trials	Theory	
		STA-612-MJE (A)	Machine Learning: Techniques and Applications	Practical	02
		STA-612-MJE(B)	Practical Based on Clinical Trials	Practical	
	RP	STA -621-RP	Research Project	Project	04
	Total Credits Semester III				**20**
IV	Major (Mandatory)	STA-651-MJM	Asymptotic Inference	Theory	04
	Major (Mandatory)	STA-652-MJM	Time Series Analysis	Theory	04
	Major (Mandatory)	STA-653-MJM	Statistics Practical – VII	Practical	02
	Major (Elective)	STA-661-MJE (A)	Survival Analysis	Theory	02
		STA-661-MJE (B)	Actuarial Statistics	Theory	
		STA-662-MJE (A)	Practical Based on Statistical Process Control	Practical	02
		STA-662-MJE (B)	Practical Based on Optimization Techniques	Practical	
	RP	STA-681-RP	Research Project	Project	06
	Total Credits Semester-IV				**20**
	Cumulative Credits Semester III and IV				**40**

Course Structure for M.Sc. Part-II (Statistics)
(2023 Pattern)

Name of the Programme	: M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – II
Semester	**:** III
Course Type	**:** Major Mandatory Theory
Course Name	**:** Parametric Inference
Course Code	**:** STA-601-MJM
No. of Credits	**:** 4 credits
No. of Teaching Hours	**:** 60

Course Objectives:

1. To understand the theoretical foundations of parametric inference.
2. To learn about various parametric models commonly used in statistical inference.
3. Students will be introduced to methods for estimating unknown parameters in parametric models.
4. To cover principles and procedures for hypothesis testing in parametric inference.
5. To understand the fundamental principles of Bayesian inference.
6. To understand the fundamental concepts of hypothesis testing.
7. To understand the concepts of statistical power and sample size calculations in hypothesis testing.

Course Outcomes:

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

CO1 demonstrate a comprehensive understanding of the theoretical foundations of parametric inference.

CO2 construct confidence intervals for unknown parameters in parametric models and interpret their meaning in the context of statistical inference.

CO3 develop proficiency in estimating unknown parameters in parametric models data reduction and different family of distributions.

CO4 apply the factorization theorem to determine sufficient statistics and construct minimal sufficient statistics for given probability distributions.

CO5 understand UMP tests for one-sided alternatives within the Exponential class of densities and extensions to distributions having Monotone Likelihood Ratio property.

CO6 estimation and testing procedures to deal with real life problems.

CO7 data reduction and different family of distributions.

Topics and Learning Points

Unit 1: **(15L)**

Sufficiency, Fisher's concept of sufficiency, Sufficient statistic, Factorization theorem, Joint Sufficiency, Likelihood Equivalence, Minimal Sufficiency, construction of Minimal Sufficient Statistic, Completeness, Exponential family and Pitman family admitting Minimal Sufficient Statistic.

Unit 2: **(15L)**

Fisher information and information matrix, Estimable function, Best Linear Unbiased Estimator, Gauss-Markov theorem, Cramer Rao inequality and its application, Rao-Blackwell theorem, Lehman-Scheffee theoremand its application, necessary sufficient condition of MVUE, necessary and sufficient condition for MVBUE and their applications, Ancillary statistic.

Unit 3: **(15L)**

Critical region and test function, Neyman Pearson lemma and most powerful test, Uniformly Most Powerful (UMP) test for one sided alternative for one parameter exponential family and Pitman family, Monotone Likelihood Ratio property, statement of UMPU test, nonexistence of UMP tests.

Unit 4: **(15L)**

Confidence Interval (C.I.), Shortest Expected Length C.I. Uniformly Most Accurate C.I., introduction to Bayesian estimation: Prior and Posterior distribution, Loss function, Bayes estimation under squared error and absolute error loss functions, Conjugate family of Prior distribution and its example, Principal of Minimum Expected Posterior Loss.

References:

1. Casella G. and Beregar R.L. (2002) Statistical Inference, 2nd Edition (Duxbury Advanced Series)
2. Dudewitz E.J. & Mishra S.N.(1988) Modern Mathematical Statistics (John Wiley)
3. Kale B.K. (1999) A First course on Parametric Inference (Narosa)

4. Lehman E.L (1988) Theory of point estimation (John Wiley)
5. Lehman E.L(1986) Testing of Statistical hypotheses (John Wiley)
6. Rohatagi V.K. (1976) Introduction to theory of probability & mathematical statistics(John Wiley & sons)
7. Dasgupta A. (2008), Asymptotic Theory of Statistics and Probability, Spinger-Verlag,New York.
8. Ulhas Jayram Dixit (2016) ISBN 978-981-10-0888-7 Examples in Parametric Inference with R.

COs POs Mapping

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	2	-	-	-	-
CO3	3	-	-	-	2	-	-	-	-	2
CO4	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	3	-	-	-	-	2	-
CO6	-	3	-	-	-	-	-	2	-	-
CO7	-	-	-	-	-	-	-	-	-	-

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

PO1. Comprehensive Knowledge and Understanding:

CO1: Demonstrate a comprehensive understanding of the theoretical foundations of parametric inference, including probability distributions, likelihood functions, estimation, and hypothesis testing.

Weightage: 3 (Strongly Related)

Justification: This CO directly aligns with the goal of acquiring comprehensive knowledge and understanding of theoretical foundations in parametric inference, covering various aspects such as probability distributions, likelihood functions, estimation, and hypothesis testing.

CO4: Apply the factorization theorem to determine sufficient statistics and construct minimal sufficient statistics for given probability distributions, especially within the exponential family and Pitman family.

Weightage: 3 (Strongly Related)

Justification: Understanding and applying the factorization theorem and constructing sufficient

statistics are fundamental components of parametric inference. This directly contributes to a comprehensive understanding of the subject matter.

PO2. Practical, Professional, and Procedural Knowledge:

CO2: Construct confidence intervals for unknown parameters in parametric models and interpret their meaning in the context of statistical inference. Develop proficiency in estimating unknown parameters in parametric models.

Weightage: 3 (Strongly Related)

Justification: This CO emphasizes practical skills related to constructing confidence intervals and estimating unknown parameters, which are essential for applying statistical inference techniques in professional settings.

CO6: Estimation and testing procedures to deal with real-life problems.

Weightage: 3 (Strongly Related)

Justification: Dealing with real-life problems requires practical knowledge and procedural skills in estimation and testing procedures, directly aligning with the practical, professional, and procedural knowledge objectives.

PO3. Entrepreneurial Mindset, Innovation, and Business Understanding:

No direct alignment identified.

PO4. Specialized Skills, Critical Thinking, and Problem-Solving:

CO5: Understand UMP tests for one-sided alternatives within the Exponential class of densities and extensions to distributions having Monotone Likelihood Ratio property.

Weightage: 3 (Strongly Related)

Justification: Understanding UMP tests and extensions for different distributions demonstrates specialized skills, critical thinking, and problem-solving abilities, which are crucial for addressing complex statistical problems.

PO5. Research, Analytical Reasoning, and Ethical Conduct:

CO3: Continuously engage in lifelong learning and professional development in the field of parametric inference, staying updated on recent advancements and applying new methodologies to address emerging challenges in data analysis and statistical inference.

Weightage: 2 (Moderately Related)

Justification: Engaging in lifelong learning and professional development reflects a commitment to ethical conduct and research integrity, essential aspects of PO5.

PO6. Communication, Collaboration, and Leadership:

CO2: Construct confidence intervals for unknown parameters in parametric models and interpret their meaning in the context of statistical inference. Develop proficiency in estimating unknown parameters in parametric models.

Weightage: 2 (Moderately Related)

Justification: While not directly related to communication, collaboration, or leadership, this CO involves interpreting and communicating statistical results effectively, which is a form of communication skill. Additionally, collaborating with peers or supervisors in the process of constructing confidence intervals can foster teamwork and collaboration.

PO7. Digital Proficiency and Technological Skills:

No direct alignment identified.

PO8. Multicultural Competence, Inclusive Spirit, and Empathy:

CO6: Estimation and testing procedures to deal with real-life problems.

Weightage: 2 (Moderately Related)

Justification: Employing estimation and testing procedures in various contexts requires sensitivity to different cultural backgrounds and perspectives, indirectly contributing to multicultural competence and fostering an inclusive spirit.

PO9. Value Inculcation, Environmental Awareness, and Ethical Practices:

CO5: Understand UMP tests for one-sided alternatives within the Exponential class of densities and extensions to distributions having Monotone Likelihood Ratio property.

Weightage: 2 (Moderately Related)

Justification: Ethical practices are often implicit in statistical analysis, such as ensuring fairness and transparency in testing procedures. Understanding these tests and their applications contributes to upholding ethical standards in statistical practice.

PO10. Autonomy, Responsibility, and Accountability:

CO3: Continuously engage in lifelong learning and professional development in the field of parametric inference, staying updated on recent advancements and applying new methodologies to address emerging challenges in data analysis and statistical inference.

Weightage: 2 (Moderately Related)

Justification: While not directly addressing autonomy, responsibility, and accountability, this CO promotes a sense of professional responsibility and autonomy in staying updated with advancements in the field and applying them effectively, albeit to a moderate extent.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Statistics (2023 Pattern)

Name of the Programme : M.Sc. Statistics

Program Code : PSST

Class : M.Sc. Part – II

Semester : III

Course Type : Major Mandatory Theory

Course Name : Design and Analysis of Experiments

Course Code : STA-602-MJM

No. of Credits : 04

No. of Teaching Hours : 60

Course Objectives:

1. To understand the concept of GLM.
2. To use various design properly to various purpose.
3. To carry out Experimental techniques and methods efficiently and effectively.
4. To make interpretations by using design of experiments.
5. To learn and understand various designs of experiments.
6. To design and carryout various experiments and analyze the data.
7. To apply appropriate design in real life situation.

Course Outcomes:

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

CO1 learn and understand concept of general linear mode;

CO2 understand the properties of general linear model.

CO3 learn and understand various designs of experiments.

CO4 design and carryout various experiments and analyze the data.

CO5 apply appropriate design in real life situation.

CO6 apply Factorial design, fractional factorial design, confounding in real life problems

CO7 Apply advanced techniques of Design of experiments like Taguchi method, etc.

Topics and Learning Points

Unit 1: **(15L)**

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.

Unit 2: **(12L)**

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 2k design in 2p 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.

Unit 3: **(18L)**

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.

Unit 4:

(15L)

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.

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:

	Programme Outcomes(POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10
CO1	3	2	2	3	2	2	3	1	1	1
CO2	2	3	1	3	2	2	3	1	1	1
CO3	2	2	2	3	2	2	3	1	1	1
CO4	2	3	2	3	2	2	3	1	1	1
CO5	2	3	2	3	2	2	3	1	1	1
CO6	2	3	2	3	2	2	2	1	1	1
CO7	2	3	2	3	2	2	3	1	1	1

PO1. Comprehensive Knowledge and Understanding:

CO1: Strongly Related (Weightage: 3)

CO2: Moderately Related (Weightage: 2)

CO3: Moderately Related (Weightage: 2)

CO4: Moderately Related (Weightage: 2)

CO5: Moderately Related (Weightage: 2)

CO6: Moderately Related (Weightage: 2)

CO7: Moderately Related (Weightage: 2)

Justification: PO1 focuses on acquiring a broad and deep understanding of various concepts. CO1 is strongly related as it directly addresses understanding the general linear model. CO2 to CO7 are moderately related as they contribute to understanding experimental designs, data analysis techniques, and applying statistical methods, all of which enrich the comprehensive knowledge and understanding in the field.

PO2. Practical, Professional, and Procedural Knowledge:

CO1: Moderately Related (Weightage: 2)

CO2: Strongly Related (Weightage: 3)

CO3: Moderately Related (Weightage: 2)

CO4: Strongly Related (Weightage: 3)

CO5: Strongly Related (Weightage: 3)

CO6: Strongly Related (Weightage: 3)

CO7: Strongly Related (Weightage: 3)

Justification: PO2 involves acquiring practical, professional, and procedural knowledge. All the objectives (CO1 to CO7) are strongly related as they contribute directly to practical skills, understanding procedures, and professional competence in experimental design, data analysis, and statistical modeling.

PO3. Entrepreneurial Mindset, Innovation, and Business Understanding:

CO1: Moderately Related (Weightage: 2)

CO2: Partially Related (Weightage: 1)

CO3: Moderately Related (Weightage: 2)

CO4: Moderately Related (Weightage: 2)

CO5: Moderately Related (Weightage: 2)

CO6: Moderately Related (Weightage: 2)

CO7: Moderately Related (Weightage: 2)

Justification: While aspects of innovation and business understanding may not be directly addressed by these objectives, understanding experimental designs and data analysis techniques (CO3 to CO7) can contribute indirectly to fostering an entrepreneurial mindset by enabling the identification of opportunities and problem-solving skills.

PO4. Specialized Skills, Critical Thinking, and Problem-Solving:

CO1: Strongly Related (Weightage: 3)

CO2: Strongly Related (Weightage: 3)

CO3: Strongly Related (Weightage: 3)

CO4: Strongly Related (Weightage: 3)

CO5: Strongly Related (Weightage: 3)

CO6: Strongly Related (Weightage: 3)

CO7: Strongly Related (Weightage: 3)

Justification: PO4 focuses on specialized skills, critical thinking, and problem-solving abilities. All objectives (CO1 to CO7) are strongly related as they directly contribute to developing these skills through understanding statistical models, experimental designs, and applying advanced techniques in data analysis.

PO5. Research, Analytical Reasoning, and Ethical Conduct:

CO1: Moderately Related (Weightage: 2)

CO2: Moderately Related (Weightage: 2)

CO3: Moderately Related (Weightage: 2)

CO4: Moderately Related (Weightage: 2)

CO5: Moderately Related (Weightage: 2)

CO6: Moderately Related (Weightage: 2)

CO7: Moderately Related (Weightage: 2)

Justification: PO5 encompasses research skills, analytical reasoning, and ethical conduct. While CO1 to CO7 contribute to analytical reasoning and research skills, they are only moderately related to ethical conduct, as ethical considerations are not explicitly addressed within these objectives.

PO6. Communication, Collaboration, and Leadership:

CO1: Moderately Related (Weightage: 2)

CO2: Moderately Related (Weightage: 2)

CO3: Moderately Related (Weightage: 2)

CO4: Moderately Related (Weightage: 2)

CO5: Moderately Related (Weightage: 2)

CO6: Moderately Related (Weightage: 2)

CO7: Moderately Related (Weightage: 2)

Justification: While these objectives mainly focus on technical skills, understanding experimental designs and data analysis techniques (CO1 to CO7) can indirectly contribute to communication, collaboration, and leadership skills by facilitating effective problem-solving and decision-making processes.

PO7. Digital Proficiency and Technological Skills:

CO1: Moderately Related (Weightage: 2)

CO2: Moderately Related (Weightage: 2)

CO3: Moderately Related (Weightage: 2)

CO4: Moderately Related (Weightage: 2)

CO5: Moderately Related (Weightage: 2)

CO6: Moderately Related (Weightage: 2)

CO7: Strongly Related (Weightage: 3)

Justification: PO7 focuses on digital proficiency and technological skills. While all objectives (CO1 to CO7) involve the application of statistical methods using software tools like R, CO7 is particularly strong in this aspect as it involves applying advanced techniques of experimental design using technology

PO8. Multicultural Competence, Inclusive Spirit, and Empathy:

All COs: Partially Related (Weightage: 1)

Justification: None of the objectives directly relate to multicultural competence, inclusive spirit, or empathy. These aspects are not explicitly addressed within the context of statistical modeling and experimental design.

PO9. Value Inculcation, Environmental Awareness, and Ethical Practices:

- All COs: Partially Related (Weightage: 1)

Justification: While ethical practices are indirectly involved in conducting experiments and data analysis, none of the objectives explicitly address environmental awareness or value inculcation.

PO10. Autonomy, Responsibility, and Accountability:

All COs: Partially Related (Weightage: 1)

Justification: While the objectives involve developing skills and knowledge, they do not directly address autonomy, responsibility, or accountability. These aspects are more related to personal and professional development, which may be indirectly fostered through achieving the objectives.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Statistics (2023 Pattern)

Name of the Programme	**:** M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – II
Semester	**:** III
Course Type	**:** Major Mandatory Practical
Course Name	**:** Statistics Practical – V
Course Code	**:** STA-603-MJM
Credit	**:** 2 credits
No. of lectures	**:** 60

Course Objectives:

1. To understand the basic principles of programming.
2. To learn Python syntax and data structures.
3. To develop problem-solving skills using Python.
4. To gain practical experience in writing and debugging Python programs.
5. To explore commonly used Python libraries and packages such as NumPy and Pandas.
6. To introduce students to basic algorithms and their implementation in Python.
7. To provide hands-on experience through small Python programming.

Course Outcomes:

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

CO 1. demonstrate fundamental programming concepts such as variables, data types, control structures, and functions..

CO 2. write Python code, understand its syntax, semantics, and basic operations.

CO 3. effectively utilize built-in data structures in Python.

CO 4. understand the concept of modular programming.

CO 5. demonstrate proficiency in handling exceptions and errors gracefully in Python programs.

CO 6. implement basic algorithms such as searching and sorting algorithms in Python.

CO 7. demonstrate proficiency in testing and debugging Python programs to ensure correctness and reliability.

Topics and Learning Points

Sr. No.	Title of Experiments	No. of Practicals
1.	**Basics of Python** • Variables and data types • Basic input and output • Operators and expressions • Comments and style conventions	01
2.	**Data Structures** • List, tuple, and dictionary, set • Basic operations on data structures • Indexing and slicing • List comprehensions	02
3.	**Control Structures** • Conditional statements (if, elif, else) • Loops (for and while) • Break and continue statements • Indentation and code blocks	03
4.	**Functions** • Defining and calling functions • Parameters and arguments • Return statement and function output	03
5.	**Introduction to numpy**	02
6.	**Introduction to pandas**	02
7.	Data visualization on using matplotlib and seaborn libraries • Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot	02

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Statistics (2023 Pattern)

Name of the Programme	**:** M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – II
Semester	**:** III
Course Type	**:** Major Mandatory Practical
Course Name	**:** Statistics Practical – VI
Course Code	**:** STA-604-MJM
No. of Credits	**:** 02
No. of Teaching Hours	**:** 60

Course Objectives:

1. To understand the principles and concepts underlying the general linear model and its application in statistical analysis.
2. To learn the application of Balance Incomplete Block Design (BIBD) with a focus on intra-block analysis.
3. To learn the techniques and interpretation involved in Analysis of 3^k factorial experiments, including identification and management of total and partial confounding.
4. To understand the concept of total confounding in 3^k factorial experiments and learn methods to address it effectively.
5. To develop proficiency in analyzing one-half and quarter fractional factorial experiments, including identifying significant factors and interactions.
6. To learn the principles and applications of Response Surface Methodology (RSM) using Central Composite Design (CCD) for optimizing response variables.
7. To understand the random effect model with one factor and estimation of variance to account for variability due to random factors.

Course Outcomes:

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

CO1. understand the theoretical foundation and practical applications of the general linear model in statistical analysis.

CO2. demonstrate proficiency in designing and analyzing experiments using the Balance

Incomplete Block Design, including intra-block analysis techniques.

CO3. apply analysis of covariance (ANCOVA) in both one-way and two-way models to appropriately account for covariate effects in experimental designs.

CO4. interpret and analyze results from 2^k factorial experiments, including main effects, interactions, and optimization of experimental factors.

CO5. apply statistical techniques to analyze and interpret results from 3^k factorial experiments, considering total and partial confounding effects.

CO6. recognize and address total confounding in 3^k factorial experiments to ensure accurate interpretation of experimental results.

CO7. identify and address partial confounding in 3^k factorial experiments to mitigate potential biases in statistical analysis.

Topics and Learning Points

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 2^k factorial experiments
5.	Analysis of 3^k factorial experiments
6.	Total Confounding in 3^k factorial experiment
7.	Partial Confounding in 3^k factorial experiment
8.	Analysis of one-half fractional factorial experiment
9.	Analysis of quarter fractional factorial experiment
10.	Response Surface Methodology I (Central Composite Design)
11.	Response Surface Methodology II (Box-Behnken Design)
12.	Random effect model with one factor, estimation of variance.
13.	Analysis of Split lot Design
14.	Analysis of Placket Berman design
15.	Taguchi methods: S/N ratio, orthogonal arrays, triangular tables, linear graphs, inner and outer arrays.

Programme Outcomes and Course Outcomes Mapping:

Course	Programme Outcomes(POs)									
Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**
CO1	**3**	**2**	**1**	**3**	**2**	**1**	**2**	**1**	**1**	**1**
CO2	**2**	**3**	**1**	**3**	**2**	**1**	**2**	**1**	**1**	**1**
CO3	**2**	**3**	**1**	**3**	**2**	**1**	**2**	**1**	**1**	**1**
CO4	**2**	**3**	**1**	**3**	**2**	**1**	**2**	**1**	**1**	**1**
CO5	**2**	**3**	**1**	**3**	**2**	**1**	**2**	**1**	**1**	**1**
CO6	**2**	**3**	**1**	**3**	**2**	**1**	**2**	**1**	**1**	**1**
CO7	**2**	**3**	**1**	**3**	**2**	**1**	**2**	**1**	**1**	**1**

Justification:

PO1. Comprehensive Knowledge and Understanding:

CO1: Strongly Related (Weightage: 3)

CO2: Moderately Related (Weightage: 2)

CO3: Moderately Related (Weightage: 2)

CO4: Moderately Related (Weightage: 2)

CO5: Moderately Related (Weightage: 2)

CO6: Moderately Related (Weightage: 2)

CO7: Moderately Related (Weightage: 2)

CO8: Moderately Related (Weightage: 2)

Justification: PO1 emphasizes comprehensive understanding, particularly in statistical analysis. CO1 directly aligns with this by focusing on the theoretical foundation and practical applications of the general linear model. CO2 to CO8 provide additional depth to this understanding by covering various experimental designs and statistical techniques, albeit not as directly as CO1.

PO2. Practical, Professional, and Procedural Knowledge:

CO1: Moderately Related (Weightage: 2)

CO2: Strongly Related (Weightage: 3)

CO3: Strongly Related (Weightage: 3)

CO4: Strongly Related (Weightage: 3)

CO5: Strongly Related (Weightage: 3)

CO6: Strongly Related (Weightage: 3)

CO7: Strongly Related (Weightage: 3)

CO8: Strongly Related (Weightage: 3)

Justification: PO2 revolves around practical knowledge and procedural skills, essential for statistical analysis. All the COs (CO1 to CO8) are strongly related as they directly contribute to developing proficiency in experimental design and statistical analysis techniques, which are crucial for practical applications in various fields.

PO3. Entrepreneurial Mindset, Innovation, and Business Understanding:

CO1: Partially Related (Weightage: 1)

CO2: Partially Related (Weightage: 1)

CO3: Partially Related (Weightage: 1)

CO4: Partially Related (Weightage: 1)

CO5: Partially Related (Weightage: 1)

CO6: Partially Related (Weightage: 1)

CO7: Partially Related (Weightage: 1)

CO8: Partially Related (Weightage: 1)

Justification: While statistical analysis skills are valuable in business contexts, the objectives (CO1 to CO8) do not directly address entrepreneurial mindset or business understanding. They mainly focus on technical skills relevant to statistical analysis.

PO4. Specialized Skills, Critical Thinking, and Problem-Solving:

CO1: Strongly Related (Weightage: 3)

CO2: Strongly Related (Weightage: 3)

CO3: Strongly Related (Weightage: 3)

CO4: Strongly Related (Weightage: 3)

CO5: Strongly Related (Weightage: 3)

CO6: Strongly Related (Weightage: 3)

CO7: Strongly Related (Weightage: 3)

CO8: Strongly Related (Weightage: 3)

Justification: PO4 emphasizes specialized skills, critical thinking, and problem-solving abilities, all of which are directly addressed by the objectives (CO1 to CO8). These objectives focus on developing proficiency in experimental design, statistical analysis, and interpretation, contributing significantly to specialized skills and critical thinking.

PO5. Research, Analytical Reasoning, and Ethical Conduct:

CO1: Moderately Related (Weightage: 2)

CO2: Moderately Related (Weightage: 2)

CO3: Moderately Related (Weightage: 2)

CO4: Moderately Related (Weightage: 2)

CO5: Moderately Related (Weightage: 2)

CO6: Moderately Related (Weightage: 2)

CO7: Moderately Related (Weightage: 2)

CO8: Moderately Related (Weightage: 2)

Justification*: While statistical analysis skills are relevant to research and analytical reasoning, the objectives (CO1 to CO8) do not directly address ethical conduct. However, they contribute to analytical reasoning and research skills, which are essential for conducting ethical research.

PO6. Communication, Collaboration, and Leadership:

All COs: Partially Related (Weightage: 1)

Justification: Statistical analysis skills can indirectly contribute to communication and collaboration in research contexts, but the objectives (CO1 to CO8) do not directly address communication, collaboration, or leadership skills.

PO7. Digital Proficiency and Technological Skills:

CO1: Moderately Related (Weightage: 2)

CO2: Moderately Related (Weightage: 2)

CO3: Moderately Related (Weightage: 2)

CO4: Moderately Related (Weightage: 2)

CO5: Moderately Related (Weightage: 2)

CO6: Moderately Related (Weightage: 2)

CO7: Moderately Related (Weightage: 2)

CO8: Moderately Related (Weightage: 2)

Justification: Statistical analysis often requires the use of digital tools and technology. While the objectives (CO1 to CO8) involve statistical analysis, they do not specifically focus on developing digital proficiency or technological skills.

PO8. Multicultural Competence, Inclusive Spirit, and Empathy:

All COs: Partially Related (Weightage: 1)

Justification: The objectives (CO1 to CO8) mainly focus on technical skills related to statistical analysis and do not directly address multicultural competence, inclusive spirit, or empathy.

PO9. Value Inculcation, Environmental Awareness, and Ethical Practices:

All COs: Partially Related (Weightage: 1)

Justification: While ethical considerations are important in research, the objectives (CO1 to CO8) do not directly address value inculcation, environmental awareness, or ethical practices.

PO10. Autonomy, Responsibility, and Accountability:

All COs: Partially Related (Weightage: 1)

Justification: While statistical analysis skills require autonomy, responsibility, and accountability, the objectives (CO1 to CO8) do not explicitly address these aspects.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Statistics (2023 Pattern)

Name of the Programme	**:** M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – II
Semester	**:** III
Course Type	**:** Major Mandatory Elective
Course Name	**:** Data Mining
Course Code	**:** STA-611-MJE(A)
No. of Credits	**:** 02
No. of Teaching Hours	**:** 30

Course Objectives:

1. To Students should understand Big Data, Data Warehouse, Data Mining Principles.
2. To explore various data mining techniques, algorithms, and methodologies used for extracting meaningful patterns and insights from large datasets.
3. To provide practical, hands-on experience with popular data mining tools to apply theoretical knowledge to real-world datasets.
4. To introduce methods for evaluating and validating the results obtained through data mining, including cross-validation, testing, and performance metrics.
5. Understand and implement ensemble methods to enhance predictive modeling.
6. To encourage students to identify and apply data mining techniques in statistical research scenarios, promoting a seamless integration of both fields.
7. To discuss ethical considerations and challenges associated with data mining, including issues related to privacy, bias, and responsible use of data.

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, 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 and Learning Points

Unit – 1 **(6L)**

Introduction to big data, Data preparation for knowledge discovery: Data understanding and data cleaning tools, Data transformation, Data Discretization, Data Visualization, Imbalanced data, supervised and unsupervised learning.

Unit – 2 **(10L)**

Bayes classifier, nearest neighbor classifier, Classification and Regression tree (CART): information gain, gain ratio, Gini index, artificial neural network, Support Vector Machine (SVM) for linearly separable data and linearly inseparable data.

Unit – 3 **(7L)**

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

Techniques to improve classification accuracy: Bagging, boosting, Ada boosting, Random forest.

Unit – 4 **(7L)**

Self-Organizing Map (SOM), EM algorithm, market basket analysis, text mining: sentiment analysis, word frequency analysis.

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.

Course Outcomes	Programme Outcomes (POs)									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3									
CO2			2							
CO3				3						
CO4										
CO5					3				3	
CO6		3				2				2
CO7							3			

PO1. Comprehensive Knowledge and Understanding

CO1: Strongly Related (3)

Justification: Understanding the basic concepts, goals, and challenges of data mining contributes to comprehensive knowledge and understanding in the field of data science and analytics.

PO2. Practical, Professional, and Procedural Knowledge

CO6: Strongly Related (3)

Justification: Applying data mining techniques to real-world datasets requires practical knowledge and procedural skills, enhancing practical, professional, and procedural knowledge in data mining.

PO3. Entrepreneurial Mindset, Innovation, and Business Understanding

CO2: Moderately Related (2)

Justification: Exploring the role of data mining in extracting meaningful patterns and knowledge from large datasets can foster innovation and contribute to an entrepreneurial mindset, though the direct connection to business understanding might be somewhat indirect.

PO4. Specialized Skills, Critical Thinking, and Problem-Solving

CO3: Strongly Related (3)

Justification: Studying and applying a variety of data mining techniques involve specialized skills, critical thinking, and problem-solving abilities, which are essential components of this program outcome.

PO5. Research, Analytical Reasoning, and Ethical Conduct

CO5: Strongly Related (3)

Justification: Exploring ethical issues related to data mining, such as privacy concerns and bias in algorithms, promotes ethical conduct alongside research and analytical reasoning skills.

PO6. Communication, Collaboration, and Leadership

CO6: Moderately Related (2)

Justification: While applying data mining techniques to real-world datasets may involve communication and collaboration to some extent, the direct connection to leadership might be less significant in this context.

PO7. Digital Proficiency and Technological Skills

CO7: Strongly Related (3)

Justification: Gaining practical experience with data mining tools and software like R and Python directly enhances digital proficiency and technological skills.

PO8. Multicultural Competence, Inclusive Spirit, and Empathy

N/A

Justification: Data mining primarily focuses on technical skills and knowledge and does not inherently address multicultural competence, inclusive spirit, or empathy.

PO9. Value Inculcation, Environmental Awareness, and Ethical Practices

CO5: Strongly Related (3)

Justification: Exploring ethical issues related to data mining, including privacy concerns and bias in algorithms, aligns with the promotion of ethical practices and values.

PO10. Autonomy, Responsibility, and Accountability

CO6: Moderately Related (2)

Justification: Applying data mining techniques to real-world datasets may require autonomy, responsibility, and accountability in interpreting results and drawing actionable insights, although the direct connection might not be as strong as in other outcomes.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Statistics (2023 Pattern)

Name of the Programme	**:** M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – II
Semester	**:** III
Course Type	**:** Major Elective Theory
Course Name	**:** Design and Analysis of Clinical Trials
Course Code	**:** STA-611-MJE(B)
No. of Credits	**:** 2 credits
No. of Teaching Hours	**:** 30

Course Objectives:

1. To understand the principles and significance of clinical trials
2. To understand the concept of bias and random error in clinical trials
3. To familiarize with the clinical guidelines and standards such as STDM (Standard Data Tabulation Model), ADAM (Analysis Data Model), SAP (Statistical Analysis Plan), and mock shells.
4. To understand their role in ensuring consistency and quality in clinical trial data analysis.
5. To explore the fundamental principles and considerations in the design of clinical trials.
6. To understand the concept of randomization in clinical trials, including different randomization models and methods, importance of blinding.
7. To explore multicenter trials, nonparametric tests, outlier detection, power and sample size determination, drug interaction studies, mixed model analysis, and data imputation techniques.

Course Outcomes:

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

CO1. understand the fundamental concepts and principles of clinical trials.

CO2. gain proficiency in drafting clinical trial protocols and identifying potential sources of bias and random error in study design and execution.

CO3. acquire knowledge of clinical guidelines such as STDM, ADaM, SAP, and mock shells.

CO4. develop expertise in designing clinical trials, including considerations for patient selection, control group allocation, and the selection of appropriate trial designs.

CO5. gain competency in randomization models and methods, as well as the

implementation of blinding techniques.

CO6. acquire advanced skills in conducting multicenter trials, performing nonparametric tests, detecting outliers, determining power and sample sizes.

CO7. develop proficiency in conducting meta-analyses, mixed-model analyses, and data imputation techniques, facilitating the synthesis of evidence across multiple studies and the accurate interpretation of complex clinical trial data.

Topics and Learning Points

Unit 1: **(8L)**

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. Introduction of clinical guidelines for STDM, ADAM, SAP and mock shells.

Unit 2: **(12L)**

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.

Unit 3: **(10L)**

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, mixed model analysis, Data imputation technique.

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.

Course Outcomes	Programme Outcomes (POs)									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3									
CO2		3								
CO3					3					
CO4				3						
CO5									3	
CO6						2				
CO7										

PO1. Comprehensive Knowledge and Understanding
CO1: Strongly Related (3)
Justification: Understanding the fundamental concepts and principles of clinical trials contributes significantly to comprehensive knowledge and understanding in the field of clinical research and healthcare.
PO2. Practical, Professional, and Procedural Knowledge
CO2: Strongly Related (3)
Justification: Gaining proficiency in drafting clinical trial protocols and identifying potential sources of bias and random error in study design and execution enhances practical, professional, and procedural knowledge in conducting clinical trials.
PO3. Entrepreneurial Mindset, Innovation, and Business Understanding
N/A
Justification: Clinical trials primarily focus on research methodology and healthcare practices rather than entrepreneurial mindset, innovation, or business understanding.
PO4. Specialized Skills, Critical Thinking, and Problem-Solving
CO4: Strongly Related (3)
Justification: Developing expertise in designing clinical trials involves specialized skills, critical thinking, and problem-solving abilities, which are essential components of this program outcome.
PO5. Research, Analytical Reasoning, and Ethical Conduct
CO3: Strongly Related (3)
Justification: Acquiring knowledge of clinical guidelines and understanding concepts such as STDM, ADaM, SAP, and mock shells promotes research, analytical reasoning, and ethical conduct in the context of clinical trials.
PO6. Communication, Collaboration, and Leadership

CO6: Moderately Related (2)
Justification: Acquiring advanced skills in conducting multicenter trials involves some level of communication and collaboration, although the direct connection to leadership might be less pronounced in this context.
PO7. Digital Proficiency and Technological Skills
N/A
Justification: While technology may play a role in clinical trials, the focus of COs listed is more on research methodology and data analysis rather than digital proficiency and technological skills.
PO8. Multicultural Competence, Inclusive Spirit, and Empathy
N/A
Justification: Clinical trials primarily deal with research methodology and healthcare practices and do not inherently address multicultural competence, inclusive spirit, or empathy.
PO9. Value Inculcation, Environmental Awareness, and Ethical Practices
CO5: Strongly Related (3)
Justification: Gaining competency in randomization models, implementation of blinding techniques, and understanding ethical considerations aligns with the promotion of ethical practices and values in clinical research.
PO10. Autonomy, Responsibility, and Accountability
CO7: Strongly Related (3)
Justification: Developing proficiency in conducting meta-analyses, mixed-model analyses, and data imputation techniques requires autonomy, responsibility, and accountability in accurately interpreting complex clinical trial data.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Statistics (2023 Pattern)

Name of the Programme : M.Sc.
Statistics**Program Code** : PSST
Class : M.Sc. Part – II
Semester : III
Course Type : Major Elective Practical
Course Name : Machine Learning: Techniques and Applications
Course Code : STA-612-MJE(A)
No. of Credits : 2 credits
No. of Teaching Hours : 60

Course Objectives:

1. To understand the principles and applications of Self-Organizing Maps (SOM) and Expectation-Maximization (EM) algorithm
2. To enable students to visualize data effectively.
3. To provide an overview of classification and regression algorithms.
4. To provide practical experience in applying data mining techniques to solve complex data analysis problems.
5. To introduce sentiment analysis and word frequency analysis techniques.
6. To introduce students to basic algorithms and their implementation.
7. To provide hands-on experience through various data sets.

Course Outcomes:

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

CO 1. understand the basic syntax and semantics of the Python programming language.

CO 2. use matplotlib and seaborn for creating various types of data visualizations, including plots, charts, and graphs.

CO 3. identify and handle missing values, outliers, and inconsistencies in the data.

CO 4. implement LDA and logistic regression algorithms for classification.

CO 5. understand the concepts of dimensionality reduction using PCA and factor analysis.

CO 6. construct decision trees for both classification and regression tasks.

CO 7. understand the principles and applications of Self-Organizing Maps (SOM) and Expectation-Maximization (EM) algorithm.

Topics and Learning Points

Sr. No.	Title of Experiments	No. of Practical
1.	Data Understanding and Cleaning and Data Visualization Using Tableau	02
2.	Data Understanding and Cleaning and Data Visualization Using Power BI	02
3.	Unsupervised Techniques • Clustering • Principal Component Analysis • Factor Analysis • Self-Organizing Maps (SOM)	02
4.	Supervised Techniques • Linear Discriminant Analysis • Logistic Regression • Bayes Classifier • k-Nearest Neighbors • Classification and Regression tree (CART) • Artificial Neural Network (ANN) • Support Vector Machines (SVM)	04
5.	Model Enhancement Techniques to Improve Classification Accuracy	02
6.	Market Basket Analysis Using Association Rule Mining Techniques	01
7.	Sentiment Analysis and Word Frequency Analysis on Text Data Using Natural Language Processing (NLP)	02

Programme Outcomes and Course Outcomes Mapping:

	Programme Outcomes(POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10
CO1	3						3			
CO2		2				2				
CO3										
CO4										
CO5										
CO6										
CO7										

PO1. Knowledge and Critical Thinking:

CO1. Understand sampling techniques. (Weightage: 3 - Strongly Related)
Justification: Knowledge and critical thinking involve the ability to understand how data is collected and sampled, making it crucial for students to comprehend sampling techniques to analyze and interpret data critically.

PO2. Communication Skill:
CO2. Visual representation of data. (Weightage: 2 - Moderately Related)
Justification: Effective communication often relies on visual representations of data to convey information clearly. Students with strong communication skills should be able to understand and utilize visual data representations effectively, hence the moderate relation.

PO6. Communication, Collaboration, and Leadership:

CO2. Visual representation of data. (Weightage: 2 - Moderately Related)
Justification: Effective communication and collaboration often involve the use of visual representations of data to convey information and facilitate understanding among team members. Thus, there's a moderate relation.

PO7. Digital Proficiency and Technological Skills:

CO1. Understand the basic syntax and semantics of the Python programming language. (Weightage: 3 - Strongly Related)
Justification: Digital proficiency and technological skills require understanding programming languages like Python. Since Python is a fundamental tool for data analysis and visualization, there is a strong relation between the two.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Statistics (2023 Pattern)

Name of the Programme	**:** M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – II
Semester	**:** III
Course Type	**:** Major Elective Practical
Course Name	**:** Practical Based on Clinical Trials
Course Code	**:** STA-612-MJE(B)
No. of Credits	**:** 2 credits
No. of Teaching Hours	**:** 60

Course Objectives:

1. To demonstrate the application of p-value, type I, and type II errors to assess the significance of observed differences in clinical trial data.
2. To explore the relationship between sample size and the power of the test, Randomization Techniques.
3. To examine randomization methods and their role in minimizing bias.
4. To understand and apply appropriate statistical techniques for the analysis of data from parallel design clinical trials.
5. To explore the statistical methods and considerations involved in the analysis of data from standard 2x2 crossover designs.
6. To learn the principles and methods for analyzing data from longitudinal and cross-sectional clinical trial designs.
7. To learn analysis of continuous data with repeated measures.

Course Outcomes:

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

CO1. interpret results and comprehend the role of hypothesis testing in clinical research.

CO2. gain knowledge about the relationship between sample size and the power of statistical tests.

CO3. acquire practical skills in implementing randomization methods, ensuring a hands-on understanding of the random assignment process and its significance in minimizing bias in clinical trials.

CO4. proficient in conducting statistical analyses for parallel design clinical trials.

CO5. gain expertise in the statistical analysis of standard 2x2 crossover designs.

CO6. proficient in applying nonparametric tests and demonstrating an understanding of when and how to use these methods in clinical trial data analysis.

CO7. apply data imputation techniques to handle missing data in clinical trials, ensuring a thorough understanding of the methods and their impact on the validity of study results.

Topics and Learning Points

Sr. No.	Title of Experiments
1.	Demonstration of p-value, type I and type-II errors using Z-test, t-test, two sample t-test, paired t-test and its interpretation and role in testing of hypothesis in CTs.
2.	Relation between sample size and power of the test.
3.	Randomization Methods.
4.	Statistical Analysis for Parallel Designs.
5.	Statistical Analysis for Standard 2x2 Crossover Designs.
6.	Analysis of Longitudinal and Cross-Sectional Design.
7.	Analysis of continuous data based on repeated measures under CTs.
8.	Nonparametric methods- I (Krushkal Wallis, Tukey's test, Duncan's Test)
9.	Nonparametric methods- II (Bartle's test, Mc Nemar, and Friedman test)
10.	Analysis of Categorical Data.
11.	Outlier Detection in CTs.
12.	Estimation of Pharmacokinetic parameters.
13.	Mixed model analysis in CTs
14.	Data imputation technique in CTs
15.	Case study.

Course Outcomes	Programme Outcomes (POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3				3		1			
CO2	2									
CO3	3									
CO4		3								
CO5		2								
CO6				3						
CO7				3					2	

PO1. Comprehensive Knowledge and Understanding

CO1. Students will be able to interpret results and comprehend the role of hypothesis testing in clinical research.

Weightage: 3 (Strongly Related)

Justification: This CO directly relates to the acquisition of comprehensive knowledge and understanding in clinical research methods, particularly in interpreting results and understanding hypothesis testing, which are fundamental aspects of research.

CO2. Students will gain knowledge about the relationship between sample size and the power of statistical tests.

Weightage: 2 (Moderately Related)

Justification: While understanding the relationship between sample size and statistical power contributes to comprehensive knowledge, it's more focused on statistical methodology rather than the broader understanding of clinical research as encompassed in PO1.

CO3. Students will acquire practical skills in implementing randomization methods, ensuring a hands-on understanding of the random assignment process and its significance in minimizing bias in clinical trials.

Weightage: 3 (Strongly Related)

Justification: Practical skills in implementing randomization methods directly contribute to understanding the methodology of clinical trials, which is crucial for comprehensive knowledge and understanding in clinical research.

PO2. Practical, Professional, and Procedural Knowledge

CO4. Students will be proficient in conducting statistical analyses for parallel design clinical trials.

Weightage: 3 (Strongly Related)

Justification: Proficiency in conducting statistical analyses for parallel design clinical trials indicates practical and procedural knowledge in the field, aligning well with the practical aspect of PO2.

CO5. Students will gain expertise in the statistical analysis of standard 2x2 crossover designs.

Weightage: 2 (Moderately Related)

Justification: While expertise in statistical analysis is practical knowledge, the focus on a specific design (2x2 crossover) makes it slightly less generalizable to overall practical, professional, and procedural knowledge.

PO4. Specialized Skills, Critical Thinking, and Problem-Solving

CO6. Students will be proficient in applying nonparametric tests and demonstrating an understanding of when and how to use these methods in clinical trial data analysis.

Weightage: 3 (Strongly Related)

Justification: Proficiency in applying nonparametric tests requires specialized skills and critical thinking, which are essential components of PO4.

CO7. Students will be able to apply data imputation techniques to handle missing data in clinical trials, ensuring a thorough understanding of the methods and their impact on the validity of study results.

Weightage: 3 (Strongly Related)

Justification: The ability to apply data imputation techniques involves problem-solving skills and critical thinking, directly aligning with the specialized skills aspect of PO4.

PO5. Research, Analytical Reasoning, and Ethical Conduct

CO1. Students will be able to interpret results and comprehend the role of hypothesis testing in clinical research.

Weightage: 3 (Strongly Related)

Justification: Interpretation of results and understanding hypothesis testing are key aspects of analytical reasoning in research, and understanding their role contributes to ethical conduct in research.

PO7. Digital Proficiency and Technological Skills

CO1. Students will be able to interpret results and comprehend the role of hypothesis testing in clinical research.

Weightage: 1 (Partially Related)

Justification: While interpretation of results may involve some digital proficiency, this CO is more focused on statistical and methodological understanding rather than digital skills.

PO9. Value Inculcation, Environmental Awareness, and Ethical Practices

CO7. Students will be able to apply data imputation techniques to handle missing data in clinical trials, ensuring a thorough understanding of the methods and their impact on the validity of study results.

Weightage: 2 (Moderately Related)

Justification: Understanding the impact of data imputation techniques on the validity of study results contributes to ethical practices in research, as it ensures transparency and integrity in handling missing data.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Statistics (2023 Pattern)

Name of the Programme	**:** M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – II
Semester	**:** III
Course Type	**:** Research Project
Course Name	**:** Project
Course Code	**:** STA-621-RP
No. of Credits	**:** 4 credits
No. of Teaching Hours	**:** 60

Course Objectives:

1. To develop proficiency in using statistical software packages like R, SPSS, Matlab or Python for data analysis and visualization.
2. To acquire skills in data collection, data cleaning, and data transformation.
3. To improve the ability to communicate statistical findings effectively through written reports and presentations.
4. To apply advanced statistical techniques to analyze the research data and draw meaningful conclusions.
5. To interpret the results of the analysis and discuss their implications in the context of the project questions/objectives.
6. To present the project findings in a clear and concise manner, both in written form and through oral presentations.
7. To develop the ability to critically evaluate existing statistical literature and research studies in the field.

Course Outcomes:

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

CO1. gain practical experience in data collection, data cleaning, and data imputation, which are essential skills in statistics, data analytics and data science.

CO2. gain expertise in statistical software packages like R, SAS, or Python and using these tools is valuable for future career opportunities in IT industry and many more filed.

CO3. do MSc project serves as a valuable stepping stone, demonstrating research capabilities.

CO4. carry out statistical analysis which may provide insights that can inform policy or decision-making in these areas in a specific social issue or problem, such as healthcare, education, or environmental sustainability.

CO5. identify actionable insights; consider providing recommendations or guidelines for addressing the social issue that were studied.

CO6. collaborate with experts from other fields (e.g., biology, economics, psychology, garniture, manufacturing industry) to apply statistical methods to interdisciplinary problems, potentially leading to innovative solutions and insights.

CO7. open doors to consulting opportunities where students can apply statistical methods to solve practical problems for businesses or organizations.

Topics and Learning Points

This part of the course consist summary of research articles, data analysis and report in dissertation form.

1. **Summary of Research Articles**

Students are expected to choose her/his own project topic and read some (not less than 5) articles (exact number of articles will be decided by the supervisor) on a selected topic or theme, summarize and write a comprehensive report and present the summary of the articles.

2. **Data Analysis**

Students are expected to analyze data pertaining to certain theme using a variety of statistical tools that they have studied so far.

Note:

1. Students have to prepare project report and have to submit one copy for the assessment.

2. Data analysis project can be done in a group (at the most 3 students).

Programme Outcomes and Course Outcomes Mapping:

	Programme Outcomes(POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10
CO1	3									
CO2		3				2	3			
CO3					3					
CO4				2						
CO5									1	
CO6			3			3				
CO7										2

PO1. Comprehensive Knowledge and Understanding:

CO1. Gain practical experience in data collection, data cleaning, and data imputation, which are essential skills in statistics, data analytics, and data science. (Weightage: 3 - Strongly Related)

Justification: The practical experience in data collection, cleaning, and imputation directly contributes to the comprehensive knowledge and understanding of statistical concepts and methodologies, fulfilling the objectives of PO1.

PO2. Practical, Professional, and Procedural Knowledge:

CO2. Gain expertise in statistical software packages like R, SAS, or Python, and using these tools is valuable for future career opportunities in the IT industry and many more fields. (Weightage: 3 - Strongly Related)

Justification: Acquiring expertise in statistical software is directly aligned with the practical, professional, and procedural knowledge required for professional tasks, as stated in PO2. It enhances the postgraduates' proficiency in practical skills necessary for real-world scenarios.

PO3. Entrepreneurial Mindset, Innovation, and Business Understanding:

CO6. Collaborate with experts from other fields (e.g., biology, economics, psychology, agriculture, manufacturing industry) to apply statistical methods to interdisciplinary problems, potentially leading to innovative solutions and insights. (Weightage: 3 - Strongly Related)

Justification: Collaboration with experts from diverse fields fosters innovation and entrepreneurial mindset by applying statistical methods to interdisciplinary problems, which

aligns with the objectives of PO3.

PO4. Specialized Skills, Critical Thinking, and Problem-Solving:

CO4. Carry out statistical analysis which may provide insights that can inform policy or decision-making in specific social issues or problems, such as healthcare, education, or environmental sustainability. (Weightage: 2 - Moderately Related)

Justification: Performing statistical analysis to inform policy or decision-making requires specialized skills, critical thinking, and problem-solving abilities, which are essential components of PO4, albeit to a moderate extent.

PO5. Research, Analytical Reasoning, and Ethical Conduct:

CO3. Do MSc project serves as a valuable stepping stone, demonstrating research capabilities. (Weightage: 3 - Strongly Related)

Justification: The MSc project serves as a practical application of research skills, analytical reasoning, and ethical conduct, thereby aligning closely with the objectives of PO5.

PO6. Communication, Collaboration, and Leadership:

CO6. Collaborate with experts from other fields (e.g., biology, economics, psychology, agriculture, manufacturing industry) to apply statistical methods to interdisciplinary problems, potentially leading to innovative solutions and insights. (Weightage: 3 - Strongly Related)

Justification: Collaboration with experts from diverse fields not only enhances communication and collaboration skills but also demonstrates leadership qualities by facilitating cooperative efforts toward common goals, fulfilling the objectives of PO6.

PO7. Digital Proficiency and Technological Skills:

CO2. Gain expertise in statistical software packages like R, SAS, or Python, and using these tools is valuable for future career opportunities in the IT industry and many more fields. (Weightage: 3 - Strongly Related)

Justification: Demonstrating proficiency in statistical software enhances digital proficiency and technological skills, which are essential for postgraduates to adapt to technological advancements, in alignment with PO7.

PO9. Value Inculcation, Environmental Awareness, and Ethical Practices:

CO5. Identify actionable insights; consider providing recommendations or guidelines for addressing the social issue that were studied. (Weightage: 1 - Partially Related)

Justification: Providing recommendations or guidelines for addressing social issues studied

requires considering ethical practices, environmental awareness, and value inculcation, aligning partially with the objectives of PO9.

PO10. Autonomy, Responsibility, and Accountability:

CO7. Open doors to consulting opportunities where students can apply statistical methods to solve practical problems for businesses or organizations. (Weightage: 2 - Moderately Related

Justification: Consulting opportunities allow students to apply statistical methods independently, demonstrating autonomy, responsibility, and accountability in solving practical problems for businesses or organizations. While not directly related, this aligns moderately with the objectives of PO10 as it involves applying knowledge and skills independently and managing projects effectively.