Re-Accredited 'B++' 2.86 CGPA by NAAC
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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-:પરિપત્ર:-

યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ અને યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓને જણાવવાનું કે, NEP-2020 અંતર્ગત શૈક્ષણિક વર્ષ ૨૦૨૬-૨૭ થી અમલમાં આવનાર B.Sc. Statistics Sem.-7 & 8 Honours (with OJT / without OJT) અને Honours with Research નો આંકડાશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૧૮/૦૯/૨૦૨૫ ની સભાના ઠરાવ ક્રમાંકઃ૦૪ થી નિમણૂંક કરેલ પેટાસમિતિ દ્વારા તૈયાર કરવામાં આવેલ અભ્યાસક્રમ આંકડાશાસ્ત્ર વિષય ની અભ્યાસ સમિતિના ચેરમેનશ્રીએ અભ્યાસ સમિતિવતી મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાની તા.૦૪/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંકઃ૩૮ થી મંજૂર કરવા એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૧૮/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંકઃ૨૬ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

(બિડાણઃઉપર મુજબ)

ક્રમાંકઃઓથો./પરિપત્ર/૧૩૬૫૫/૨૦૨૬
તા.૧૯/૦૬/૨૦૨૬

કુલસચિવ(ઇ.ચા.)

પ્રતિ,
(૧) યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ.
(૨) યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓ.
... આપશ્રીના વિભાગ/કોલેજના સંબંધિત શિક્ષકો/વિદ્યાર્થીઓને જાણ કરી અમલ કરવા સારૂ.
(૩) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
(૪) પરીક્ષા નિયામકશ્રી,પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.
.....તરફ જાણ તેમજ અમલ સારૂ.

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
SULLABUS OF
UNDER GRADUATE PROGRAMME IN STATISTICS
4 (YEARS HONOURS)
B.Sc. SEM-VII and VIII STATISTICS
As per NEP 2020
To be implemented from 2026-27

Name of Program	Bachelor of Science (Statistics) –Semester – VII and VIII
Program Abbreviation	(Statistics) – Sem – VII and VIII
Duration	4 -Years (Honours)
Eligibility Criteria	Students must have completed the first three years of their undergraduate degree.
Pre-requisite	Sem I–II: Descriptive Statistics, Data Presentation, Basics of Probability Sem III–IV: Correlation & Regression, Sampling Techniques Sem V–VI: Applied Statistics, Statistical Computing using Excel, Introductory Multivariate Concepts
Medium of Instruction	ENGLISH/GUJARATI
Objective of Program	Objective of programme is to equip students with a strong theoretical foundation in probability and statistical inference, combined with practical skills in data analysis, computation, and modelling to solve real-world problems.
Program Outcome (PO)	**PO-01: Scientific Knowledge & Conceptual Understanding**: Develop a strong foundation in scientific principles, theories and concepts across disciplines, fostering interdisciplinary learning, advance knowledge and problem-solving abilities. **PO-02: Analytical & Critical Thinking**: Apply critical thinking and analytical reasoning to evaluate scientific data, hypothesis and real-world problems, leading to evidence-based conclusions. **PO-03: Research & Inquiry-based Learning**: Develop investigative skills through experimentation, data analysis and scientific inquiry to contribute to research and innovation. **PO-04: Laboratory & Technical Skills**: Gain hands-on experience with laboratory techniques, instrumentation and computational tools relevant to scientific research and industry applications. **PO-05: Digital & Computational Literacy**: Utilize digital tools, computational techniques and emerging technologies such as AI, bioinformatics and statistical modelling to enhance scientific learning and problem-solving.

	PO-06: Environmental & Societal Responsibility: Understand the role of science in addressing environmental, health and societal challenges, promoting sustainability and ethical responsibility. **PO-07: Effective Communication & Collaboration**: Develop proficiency in scientific communication, both written and oral, for effective dissemination of knowledge while collaborating in multidisciplinary teams. **PO-08: Innovation & Entrepreneurship**: Foster an entrepreneurial mind-set by applying scientific knowledge for innovation, technology development, and industry-oriented applications. Develop sustainable solutions to address real-world challenges in research and environmental management. **PO-09: Lifelong Learning & Professional Growth**: Cultivate curiosity and adaptability for continuous learning, equipping students for higher education, research, and professional careers. **PO-10: Ethical Leadership & Value-based Education**: Develop leadership qualities, ethical values, and a sense of responsibility in applying science for societal progress, aligning with Indian knowledge systems and global perspectives
Program Specific Outcomes (PSO)	**PSO1: Understanding Statistical Principles** Graduate should comprehend the importance and value of statistical principles and be able to convert problem description into testable research hypothesis. **PSO2: Professional and Entrepreneurial Skills Development** The program enhances student's professional skills and entrepreneurial capabilities, fostering independent logical and analytical thinking. It also emphasizes teamwork and leadership, preparing students for diverse environments by providing skill enhancement Certificate courses. **PSO3: Real-World Problem Solving** Students are trained to investigate, design, and develop practical solutions for real world challenges, ensuring they can apply theoretical knowledge to practical situations through Experiential Learning and by providing platform for extracurricular activities. **PSO4: Self-Learning and Problem-Solving Skills** Students gain hands-on experience with advanced statistical tools and software, enhancing their ability to tackle real-world problems efficiently. **PSO5: Performing data Analysis** Graduate should be able to apply analytical and statistical methods to analyze data, interpret results, and provide solutions in various settings. **PSO6: Develop Communication Skills** Effectively Communicate Statistical results through clear & informative data

visualizations.

PSO7: Commitment to Lifelong Learning and Research

The program focuses not only on imparting core education but also to developing interest in research.

PSO8: Provide Employability

Identify & explore career opportunities in statistics, including roles in industry, government & academia.

Mapping between Pos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
PO1	✔		✔		✔			
PO2	✔	✔	✔	✔	✔			
PO3	✔		✔				✔	
PO4			✔	✔	✔		✔	
PO5	✔		✔	✔	✔			
PO6	✔		✔		✔			✔
PO7		✔	✔			✔		
PO8	✔	✔						✔
PO9			✔	✔	✔		✔	✔
PO10		✔	✔			✔		

Structure of Credit Frame Work as per NEP 2020 for Fourth Year B.Sc. Statistics (Semester -7) Single Major - without OJT/Research Project - total credits = 22 credits

Course Category	Course Code	Course Title	Marksheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total Makrs	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR	ST-MJ-701	Real Analysis	Real Analysis	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-701	Practical in Real Analysis	Practical in Real Analysis	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-702	Probability Theory	Probability Theory	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-702	Practical in Probability Theory	Practical in Probability Theory	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-703	Linear Algebra	Linear Algebra	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-703	Practical in Linear Algebra	Practical in Linear Algebra	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-704-1	Data Analytics	Data Analytics	400-499	04	-	02	-	04	-	50	-	50	-	100	-
MAJOR	ST-MJ-704-2	Decision Theory	Decision Theory	400-499	04	-	02	-	04	-	50	-	50	-	100	-
MAJOR	ST-MJ-704-3	Biostatistics and Survival Analysis	Biostatistics and Survival Analysis	400-499	04	-	02	-	04	-	50	-	50	-	100	-
MAJOR	ST-MJ-704-4	Nonparametric Inference	Nonparametric Inference	400-499	04	-	02	-	04	-	50	-	50	-	100	-
MAJOR	MJ-705	Research Methodology I	Research Methodology I	400-499	02	-	01	-	02	-	50	-	50	-	100	-
MINOR ELECTIVE	ME-701	Fundamentals of Cyber Security	Fundamentals of Cyber Security	400-499	04	-	02	-	04	-	50	-	50	-	100	-

*Research Methodology syllabus will be prepared by Adhoc Board of Research Methodology of VNSGU, SURAT.

*Fundamentals of Cyber Security syllabus will be prepared by Computer Faculty of VNSGU, SURAT.

Structure of Credit Frame Work as per NEP 2020 for Fourth Year B.Sc. Statistics (Semester -7) Single Major - with OJT/Research Project – Total Credits = 22 credits

Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration		Credit		Internal Marks		External Marks		Total Makrs	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR	ST-MJ-701	Real Analysis	Real Analysis	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-701	Practical in Real Analysis	Practical in Real Analysis	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-702	Probability Theory	Probability Theory	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-702	Practical in Probability Theory	Practical in Probability Theory	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-703	Linear Algebra	Linear Algebra	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-703	Practical in Linear Algebra	Practical in Linear Algebra	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MINOR ELECTIVE	ME-701	Fundamentals of Cyber Security	Fundamentals of Cyber Security	400-499	04	-	02	-	04	-	50	-	50	-	100	-
OJT/Research Project	ST-RP/OJT - 701	RESEARCH PROJECT/ ON JOB TRAINING	RESEARCH PROJECT/ ON JOB TRAINING	400-499	12	--	--	-	06		75		75		150	

*Fundamentals of Cyber Security syllabus will be prepared by Computer Faculty of VNSGU, SURAT.

[Subject code for Theory-2603000507011101]

[Subject code for Practical-2603000507011102]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc.- SEM-VII STATISTICS (PAPER-ST-MJ-701)
Real Analysis (Major)
(2 Credits Theory+2 credits Practical)
To be implemented from the Academic year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	7					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Skill Development					
Subject Type	Discipline Specific					
Course Code	ST-MJ-701					
Course Level	400–499					
Course Title	Real Analysis					
Credit	Theory	2	Practical	2	Total	4
Effective From	Academic Year: 2026–27					
Course Outcomes	**CO1** – Demonstrate in-depth understanding of the real number system including Archimedean property, countable and uncountable sets, supremum and infimum, as foundational knowledge for advanced statistical theory. **CO2** – Develop rigorous understanding of metric spaces, sequences, series, Cauchy convergence, compactness, completeness, and connectedness required for advanced statistical inference and probability. **CO3** – Apply concepts of classes of sets, sigma-fields, Borel sets, measurable spaces, and measurable functions to formalize probability spaces and statistical models. **CO4** – Construct rigorous mathematical proofs and analytical arguments involving measure theory, Caratheodory extension, and Lebesgue-Stieltjes measures, ensuring readiness for GSET and UGC NET Statistics. **CO5** – Apply Lebesgue integration, dominated convergence, monotone convergence, and Fatou's lemma to evaluate integrals arising in probability distributions and statistical inference. **CO6** – Analyze absolute continuity, singularity of measures, Radon–Nikodym theorem, and Lebesgue decomposition, and relate these to likelihood-based inference and change-of-variable techniques. **CO7** – Communicate mathematical reasoning and analytical findings effectively in written and oral form, and engage in collaborative learning activities to prepare for research and competitive examinations. **CO8** – Cultivate a lifelong learning orientation toward mathematical foundations of statistics, integrating ethical and value-based scientific practices in academic and research endeavors.					
Course Content	**Unit – 1: Foundations of Real Analysis and Measurable Spaces** • Real number system as a complete ordered field; Archimedean property, denseness of rationals and irrationals. • Countable and uncountable sets, cardinality; supremum, infimum, and the completeness axiom.					

	• Sequences and series of real numbers: convergence, divergence, subsequences, and limit superior/inferior. • Cauchy sequences, Cauchy criterion for convergence; monotone convergence theorem for sequences. • Functions of a real variable: limits, continuity, uniform continuity, and differentiability. • Metric spaces: definition, open and closed sets, interior, closure and boundary; compactness (Heine-Borel theorem), completeness, and connectedness. • Classes of sets: semi-rings, rings, fields (algebras), σ-rings, σ-fields (σ-algebras), and monotone classes. • Generated σ-fields; Borel σ-fields on R and R^{ϵ} and their properties. • Measurable spaces and measurable functions; simple functions and their properties. • Borel measurable functions; pointwise limits and measurability. • Modes of convergence: almost everywhere (a.e.), in measure, in mean; inter-relationships and counterexamples. **Unit – 2: Measure Theory and Integration** • Finitely additive and σ-additive set functions; signed measures and total variation. • Measures and their properties: monotonicity, continuity from above and below, subadditivity. • Outer measures and the Caratheodory Extension theorem (statement and construction). • Construction of Lebesgue measure on R; Lebesgue measurable sets and non-measurable sets (existence). • Lebesgue–Stieltjes measure through distribution functions; product measures and Fubini's theorem (statement). • Integration of non-negative measurable functions and simple functions with respect to a measure. • Properties of Lebesgue integrals: linearity, monotonicity, and absolute continuity of integral. • Monotone Convergence theorem, Fatou's Lemma, and Dominated Convergence theorem with statistical applications. • Absolute continuity and singularity of measures; Lebesgue Decomposition theorem. • Radon–Nikodym theorem: statement, proof sketch, and applications to probability densities and likelihood functions. • L^p spaces: definitions, completeness (Riesz-Fischer theorem), Hölder's and Minkowski's inequalities (statements).
Course Code	STP-MJ-701
Course Title	Practical in Real Analysis
Course Practical Content	P-01: Exploring the Real Number System P-02: Convergence and Divergence of Sequences P-03: Cauchy Sequences and Convergence Criterion P-04: Limit Superior, Limit Inferior, and Subsequences P-05: Continuity and Uniform Continuity P-06: Classes of Sets and Sigma-Fields P-07: Measurable Functions and its applications P-08: Modes of Convergence and its applications

	P-09: Lebesgue Measure of Intervals and Step Sets P-10: Numerical Lebesgue Integration using Simple Functions P-11: Verification of Convergence Theorems – Monotone Convergence and Dominated Convergence P-12: Absolute Continuity and the Radon–Nikodym Derivative P-13: Lebesgue–Stieltjes Integration and Computation of Expectations P-14: L^p Norms and Inequalities
Mapping between COs and PSOs	

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓							
CO2	✓	✓						
CO3	✓	✓	✓					
CO4	✓						✓	✓
CO5	✓							
CO6	✓	✓	✓	✓				
CO7	✓	✓	✓	✓	✓		✓	✓
CO8		✓		✓		✓	✓	✓

Reference Books

1. Athreya, K. B., & Lahiri, S. N. (2006). *Measure Theory and Probability Theory*. New York: Springer. ISBN: 978-0387329031.
2. Billingsley, P. (2012). *Probability and Measure* (4th ed.). Hoboken, NJ: John Wiley & Sons. ISBN: 978-1118122372.
3. Casella, G., & Berger, R. L. (2002). *Statistical Inference* (2nd ed.). Pacific Grove, CA: Duxbury Press. ISBN: 978-0534243128.
4. Chung, K. L. (2001). *A Course in Probability Theory* (3rd ed.). San Diego, CA: Academic Press. ISBN: 978-0121741518.
7. Durrett, R. (2019). *Probability: Theory and Examples* (5th ed.). Cambridge: Cambridge University Press. ISBN: 978-1108473682.
5. Feller, W. (1968). *An Introduction to Probability Theory and Its Applications* (Vols. I & II, 3rd ed.). New York: John Wiley & Sons. ISBN: 978-8126518050.
8. Gut, A. (2013). *Probability: A Graduate Course* (2nd ed.). New York: Springer. ISBN: 978-1461447061.
9. Hogg, R. V., McKean, J. W., & Craig, A. T. (2018). *Introduction to Mathematical Statistics* (8th ed.). Boston: Pearson Education. ISBN: 978-0134686998.
10. Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). *Introduction to the Theory of Statistics* (3rd ed.). New York: McGraw-Hill. ISBN: 978-0070431744.
11. Resnick, S. I. (2014). *A Probability Path*. New York: Birkhäuser. ISBN: 978-0817639242.
6. Rohatgi, V. K., & Saleh, A. K. M. E. (2015). *An Introduction to Probability and Statistics* (3rd ed.). Hoboken, NJ: John Wiley & Sons. ISBN: 978-1118799680.
12. Ross, S. M. (2014). *A First Course in Probability* (9th ed.). Boston: Pearson Education. ISBN: 978-0321794772.
13. Shiryaev, A. N. (2016). *Probability* (2nd ed.). New York: Springer. ISBN: 978-1493932386.

NPTEL / Online Resources

14. NPTEL Course: Real Analysis (IIT level) – available at nptel.ac.in
15. SWAYAM MOOCs on Mathematical Analysis and Probability – available at

	swayam.gov.in
Teaching Methodology	Classwork, Discussion, Self – Study through SWAYAM, Seminar and/or Assignments
Evaluation Method	Internal Assessment : 25 Marks Theory + 25 marks Practical External Assessment : 25 Marks Theory + 25 marks Practical

[Subject code for Theory-2603000507021101]

[Subject code for Practical-2603000507021102]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT **Fourth Year B.Sc.- SEM-VII STATISTICS (PAPER-ST-MJ-702)** **Probability Theory (Major)** **(2 Credits Theory+2 credits Practical)** **To be implemented from the Academic year 2026-27**						
Program Name	B.Sc. (Statistics)					
Semester	7					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Skill Development					
Subject Type	Discipline Specific					
Course Code	ST-MJ-702					
Course Level	400–499					
Course Title	Probability Theory					
Credit	Theory	2	Practical	2	Total	4
Effective From	Academic Year: 2026–27					
Course Outcomes	**CO1–**Demonstrate comprehensive understanding of probability spaces, sigma-fields, random variables, distribution functions, and their Lebesgue decomposition as mathematical foundations for advanced statistical theory. **CO2**–Apply classical probability inequalities — Markov, Chebyshev (one-sided and two-sided), Jensen, Cauchy–Schwarz, Hölder, and Minkowski — to derive statistical bounds and solve GSET/UGC NET problems. **CO3**–Analyse characteristic functions, MGFs, inversion theorem, uniqueness theorem, and continuity theorem; apply these to identify distributions and establish limit theorems. **CO4**–Develop rigorous understanding of modes of convergence (a.s., in probability, in distribution, in rth mean), Borel–Cantelli lemma, Kolmogorov zero–one law, LLN, and CLT for asymptotic statistical theory. **CO5**–Implement Excel and JAMOVI to simulate, visualise, and numerically verify probability theorems, inequalities, convergence behaviour, and limiting distributions. **CO6**–Apply probability theory in interdisciplinary contexts—actuarial science, Bayesian inference, survey sampling, data science, and environmental modelling—promoting innovation in statistics-based industries. **CO7** – Construct mathematical proofs involving characteristic functions, independence, tail sigma-fields, Kolmogorov inequality, and CLT, ensuring readiness for GSET and UGC NET Statistics. **CO8** – Cultivate ethical scientific practice, effective communication, and lifelong learning through seminars, SWAYAM/NPTEL engagement, collaborative projects, and competitive examination preparation.					
Course Content	**Unit – 1: Foundations of Probability and Distribution Theory** • Probability spaces (Ω, $\mathcal{F}$, P): sample space, events, sigma-fields, probability measure; properties — monotonicity, sub-additivity, continuity from above and below, inclusion-exclusion. • Random variables and random vectors: measurability, Borel measurability, and induced probability measures. • Distribution functions and joint distribution functions: properties, marginals, and correspondence with probability measures. • Types: discrete (PMF), absolutely continuous (PDF), and singular distributions; Lebesgue decomposition of distribution functions.					

	• Mathematical expectation: definition via Lebesgue integration; moments, central moments, skewness, kurtosis; MGF and cumulant generating functions. • Characteristic functions: definition, properties (continuity, positive-definiteness, boundedness, uniqueness), and examples for Binomial, Poisson, Normal, Exponential, and Uniform distributions. • Inversion theorem, uniqueness theorem, and continuity theorem (Lévy) — statements, interpretations, and statistical implications. • Classical inequalities with applications: Markov, Chebyshev (both forms), Jensen (convex functions), Cauchy–Schwarz, Hölder, and Minkowski inequalities. • Stochastic independence: independent events, independent classes, independent random variables; multiplication theorem. • Borel–Cantelli lemma (first and second parts) and Borel zero–one law with applications. • Conditional probability and conditional expectation: existence (Radon–Nikodym), Tower property, law of total variance. • Weak convergence of distribution functions: Helly's theorem, Helly–Bray theorem, tightness, and weak compactness. **Unit – 2: Convergence Concepts and Limit Theorems** • Sequences of random variables: definitions and basic properties. • Tail sigma-field and Kolmogorov zero–one law — statement, proof sketch, and examples. • Modes of convergence: almost sure (a.s.), in probability, in distribution (weak), and in rth mean (Lr). • Interrelationships: implications diagram, Slutsky's theorem, and counterexamples for non-implications. • Weak Law of Large Numbers: Chebyshev's version and Khintchine's version; conditions and applications. • Kolmogorov's inequality and Strong Law of Large Numbers (Kolmogorov's SLLN for i.i.d.; Marcinkiewicz–Zygmund statement). • Central Limit Theorem: Lindeberg–Lévy CLT — statement, proof via characteristic functions, and statistical applications. • Liapunov's theorem: Liapunov condition and CLT for independent non-identically distributed sequences. • Lindeberg–Feller theorem: Lindeberg condition, statement, and necessity (Feller's theorem). • Applications: consistency and asymptotic normality of sample mean; Delta method and its applications in inference.
Course Code	STP-MJ-702
Course Title	Practical in Probability Theory
Course practical content	P-01: Verifying Probability Axioms and Rules P-02: Simulation and Analysis of Discrete Distributions P-03: Simulation and Analysis of Continuous Distributions P-04: Numerical Verification of Probability Inequalities P-05: Characteristic Functions P-06: Decomposition of Distribution Functions P-07: Stochastic Independence and Borel–Cantelli Lemma P-08: Conditional Expectation and Tower Property P-09: Modes of Convergence P-10: Weak Law of Large Numbers P-11: Strong Law of Large Numbers

	P-12: Central Limit Theorem P-13: Liapunov Condition and CLT for Non-Identical Variables
Mapping between COs and PSOs	

COs / PSOs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓			✓	✓		✓	
CO2	✓	✓	✓	✓	✓			✓
CO3	✓	✓	✓	✓	✓		✓	✓
CO4	✓		✓	✓	✓		✓	✓
CO5		✓	✓	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓	✓
CO7	✓	✓		✓	✓	✓	✓	✓
CO8		✓	✓	✓		✓	✓	✓

Reference Books

1. Athreya, K. B., & Lahiri, S. N. (2006). *Measure Theory and Probability Theory*. New York: Springer. ISBN: 978-0387329031.
2. Billingsley, P. (2012). *Probability and Measure* (4th ed.). Hoboken, NJ: John Wiley & Sons. ISBN: 978-0470521939.
3. Chung, K. L. (2001). *A Course in Probability Theory* (3rd ed.). San Diego: Academic Press. ISBN: 978-0121741518.
4. Feller, W. (1968). *An Introduction to Probability Theory and Its Applications* (Vols. 1 & 2, 3rd ed.). New York: John Wiley & Sons. ISBN: 978-8126518050.
5. Rohatgi, V. K., & Saleh, A. K. M. E. (2015). *An Introduction to Probability and Statistics* (3rd ed.). Hoboken, NJ: John Wiley & Sons. ISBN: 978-1118799680.
6. Casella, G., & Berger, R. L. (2002). *Statistical Inference* (2nd ed.). Pacific Grove, California: Duxbury Press. ISBN: 978-0534243128.
7. Durrett, R. (2019). *Probability: Theory and Examples* (5th ed.). Cambridge: Cambridge University Press. ISBN: 978-1108473682.
8. Gut, A. (2013). *Probability: A Graduate Course* (2nd ed.). New York: Springer. ISBN: 978-1461447061.
9. Resnick, S. I. (2014). *A Probability Path*. Boston: Birkhäuser. ISBN: 978-0817639242.
10. Ross, S. M. (2014). *A First Course in Probability* (9th ed.). Boston: Pearson Education. ISBN: 978-0321794772.
11. Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). *Introduction to the Theory of Statistics* (3rd ed.). New York: McGraw-Hill. ISBN: 978-0070431744.
12. Hogg, R. V., McKean, J. W., & Craig, A. T. (2018). *Introduction to Mathematical Statistics* (8th ed.). Boston: Pearson Education. ISBN: 978-0134686998.
13. Shiryaev, A. N. (2016). *Probability* (2nd ed.). New York: Springer. ISBN: 978-1493932386.

Online Resources

- NPTEL: Probability Theory and Applications (IIT level) — nptel.ac.in.
- SWAYAM MOOCs: Probability and Statistics — swayam.gov.in
- MIT Open Course Ware — Probability and Random Variables 18.440 — ocw.mit.edu
- JAMOVI Official Learning Resources — jamovi.or
- Microsoft Excel Statistical Functions Documentation - support.microsoft.com

	• Coursera / edX Probability Courses by top universities JAMOVI Official Learning Resources (jamovi.org)
Teaching Methodology	Classwork, discussion, self-study through SWAYAM/NPTEL, Excel and JAMOVI lab sessions, seminars, assignments, and research-oriented exercises.
Evaluation Method	Internal Assessment: 25 (Theory) + 25 (Practical) External Assessment: 25 (Theory) + 25 (Practical)

[Subject code for Theory-2603000507031101]

[Subject code for Practical-2603000507031102]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc.- SEM-VII STATISTICS (PAPER-ST-MJ-703)
Linear Algebra (Major)
(2 Credits Theory+2 credits Practical)
To be implemented from the Academic year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	7					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Skill Development & Employability					
Subject Type	Discipline Specific					
Course Code	ST-MJ-703					
Course Level	400-499					
Course Title	Linear Algebra					
Credit	Theory:	2	Practical:	2	Total:	4
Effective From	Academic Year: 2026-27					

Course Outcomes	**CO-01:**	Understand the concepts of vector spaces, subspaces, basis, dimension and linear transformations.
	CO-02:	Apply the concepts of linear dependence, independence and orthogonalization in solving mathematical and statistical problems.
	CO-03:	Analyze different classes of matrices and their algebraic properties.
	CO-04:	Compute rank, generalized inverse and Moore-Penrose inverse of matrices and apply them in statistical computations.
	CO-05:	Reduce and classify quadratic forms and determine their index and signature.
	CO-06:	Determine eigenvalues, eigenvectors and multiplicities of matrices and interpret their properties.
	CO-07:	Apply matrix algebra and eigenvalue techniques in multivariate statistics, linear models and data analysis.
	CO-08:	Utilize computational tools for matrix operations and numerical solutions of statistical problems.
	CO-09:	Develop analytical and problem-solving skills required for advanced statistical theory and research.
Course Content	**Unit-1**	**Vector Spaces and Matrix Algebra** • Fields and Vector Spaces • Subspaces • Linear Dependence and Independence • Basis and Dimension of a Vector Space • Finite Dimensional Vector Spaces • Completion Theorem • Inner Product Spaces • Gram-Schmidt Orthogonalization Process • Orthogonal Basis and Orthonormal Basis • Symmetric, Skew-Symmetric, Hermitian and Skew-Hermitian Matrices

<table>
<tr><td></td><td></td><td>• Orthogonal, Unitary and Normal Matrices
• Laplace Expansion Method
• Matrix Polynomials
• Rank of a Matrix and Properties of Rank
• Idempotent Matrices
• Generalized Inverse and Moore-Penrose Generalized Inverse</td></tr>
<tr><td></td><td>Unit-2</td><td>Quadratic Forms and Characteristic Roots
• Real Quadratic Forms
• Reduction and Classification of Quadratic Forms
• Index and Signature of Quadratic Forms
• Properties and Applications of Quadratic Forms
• Characteristic Roots (Eigenvalues) and Characteristic Vectors (Eigenvectors)
• Algebraic and Geometric Multiplicity
• Properties of Characteristic Roots and Vectors of:
• Symmetric Matrices
• Hermitian Matrices
• Skew-Hermitian Matrices
• Orthogonal Matrices
• Unitary Matrices
• Normal Matrices
• Diagonalization of Matrices
• Applications of Eigenvalues and Eigenvectors in Statistics</td></tr>
<tr><td>Course Code</td><td colspan="2">STP-MJ-703</td></tr>
<tr><td>Course Title</td><td colspan="2">Practical in Linear Algebra</td></tr>
<tr><td>Course practical content</td><td colspan="2"><table>
<tr><td>1.</td><td>Verification of Linear Dependence and Independence of Vectors</td></tr>
<tr><td>2.</td><td>Determination of Basis and Dimension of a Vector Space</td></tr>
<tr><td>3.</td><td>Computation of Inner Products and Norms of Vectors</td></tr>
<tr><td>4.</td><td>Gram-Schmidt Orthogonalization Process.</td></tr>
<tr><td>5.</td><td>Construction of Orthogonal and Orthonormal Bases</td></tr>
<tr><td>6.</td><td>Identification and Verification of Symmetric and Skew-Symmetric Matrices.</td></tr>
<tr><td>7.</td><td>Determination of Rank of a Matrix</td></tr>
<tr><td>8.</td><td>Verification of Properties of Rank</td></tr>
<tr><td>9.</td><td>Computation of Determinants using Laplace Expansion</td></tr>
<tr><td>10.</td><td>Matrix Polynomial Calculations</td></tr>
<tr><td>11.</td><td>Identification and Verification of Idempotent Matrices</td></tr>
<tr><td>12.</td><td>Computation of Generalized Inverse of a Matrix</td></tr>
<tr><td>13.</td><td>Computation of Moore-Penrose Generalized Inverse</td></tr>
<tr><td>14.</td><td>Reduction of Quadratic Forms to Canonical Form</td></tr>
<tr><td>15.</td><td>Determination of Index and Signature of Quadratic Forms</td></tr>
<tr><td>16.</td><td>Computation of Eigenvalues and Eigenvectors</td></tr>
<tr><td>17.</td><td>Verification of Algebraic and Geometric Multiplicity</td></tr>
<tr><td>18.</td><td>Diagonalization of Matrices using Eigenvalues and Eigenvectors</td></tr>
</table></td></tr>
<tr><td>Mapping</td><td colspan="2"><table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td><td>PSO8</td></tr>
</table></td></tr>
</table>

between Cos and PSOs	CO1	✓			✓	✓		✓	✓
	CO2	✓	✓	✓	✓	✓		✓	✓
	CO3	✓	✓	✓	✓	✓		✓	✓
	CO4	✓	✓	✓	✓	✓		✓	✓
	CO5	✓	✓	✓	✓	✓		✓	✓
	CO6	✓	✓	✓	✓	✓		✓	✓
	CO7	✓	✓	✓	✓	✓	✓	✓	✓
	CO8		✓	✓	✓	✓	✓	✓	✓
	CO9	✓	✓	✓	✓	✓	✓	✓	✓

Reference Books

1. Graybill, F. A. (1983): Matrices with Applications in Statistics, Wadsworth International Group, ISBN: 9780534980382.
2. Khuri, A. I. & Searle, S. R. (2017): Matrix Algebra Useful for Statistics, Wiley, ISBN: 9781118935163.
3. Ramachandra Rao, A. & Bhimasankaram, P. (2000): Linear Algebra, Hindustan Book Agency, ISBN: 9789386279019.
4. Bellman, R. (1997): Introduction to Matrix Analysis, Society for Industrial and Applied Mathematics (SIAM), ISBN: 9780898713992.
5. Biswas, S. (2012): Textbook of Matrix Algebra, PHI Learning, ISBN: 9788120346239.
6. Lipschutz, S. (1997): Schaum's Outline of Theory and Problems of Beginning Linear Algebra, McGraw-Hill, ISBN: 9780070380370.
7. Halmos, P. R. (2017): Finite-Dimensional Vector Spaces, Dover Publications, ISBN: 9780486822266.
8. Hoffman, K. & Kunze, R. (1971): Linear Algebra, 2nd Edition, Prentice Hall, ISBN: 9780135367971.
9. Shafarevich, I. R. & Remizov, A. O. (2012): Linear Algebra and Geometry, Springer, ISBN: 9783642309946.
10. Mitra, S. K. & Rao, C. R. (1971): Generalized Inverse of Matrices and Its Applications, Wiley, ISBN: 9780471708216.
11. Rao, C. R. (2009): Linear Statistical Inference and Its Applications, Wiley, ISBN: 9780470402726.
12. Gentle, J. E. (2017): Matrix Algebra: Theory, Computations and Applications in Statistics, Springer, ISBN: 9783319648897.
13. Abadir, K. M. & Magnus, J. R. (2005): Matrix Algebra, Cambridge University Press, ISBN: 9780521828925.
14. Harville, D. A. (2008): Matrix Algebra From a Statistician's Perspective, Springer, ISBN: 9780387784267.
15. Petersen, K. B. & Pedersen, M. S. (2012): The Matrix Cookbook, Technical University of Denmark.

Teaching Methodology	Classwork, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments
Evaluation Method	Internal Assessment: 25 (Theory) + 25 (Practical) External Assessment: 25 (Theory) + 25 (Practical)

[Subject code-2603000507051101]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT **Fourth Year B.Sc. Sem – VII STATISTICS PAPER ST-MJ-704-1** **Data Analytics (Major)** **(4 Credits Theory)** **To be implemented from Academic Year 2026-27**						
Program Name	B. Sc. (Statistics)					
Semester	7					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Employability and Skill Development					
Subject Type	Discipline Specific Course					
Course Code	ST-MJ-704-1					
Course Level	400 - 499					
Course Title	Data Analytics					
Credit	Theory:	4	Practical:	0	Total:	4
Effective Form	Academic Year: 2026-27					
Course Outcomes	**CO1:** Explain the fundamental concepts of Data Analytics, including types and sources of data, the data analytics lifecycle, and various categories of analytics used in data-driven decision-making. **CO2:** Analyze data using exploratory analytical techniques and interpret relationships, patterns, trends, and anomalies through concepts of correlation, regression, classification, and clustering. **CO3:** Examine the role of feature engineering, data visualization, and communication strategies in transforming analytical findings into meaningful insights for decision-making. **CO4:** Evaluate the applications of data analytics techniques across diverse domains, including business, governance, healthcare, education, and social sciences, and explain the principles of recommendation systems and social network analysis. **CO5:** Assess ethical, legal, and societal issues associated with data analytics, including privacy, fairness, transparency, accountability, and the responsible use of data and analytical models.					
Course Content	**Unit–I: Introduction to Data Analytics and Data Understanding** • Data Analytics – An Overview : Definition, meaning and scope of Data Analytics , Evolution and importance of Data Analytics, Role of Data Analytics in decision-making, Data-driven organizations and analytical thinking, • Types and Sources of Data: Structured, semi-structured and unstructured data, Quantitative and qualitative data, Cross-sectional, time-series and panel data, Sources of data: transactional, administrative, social and sensor data • Data Analytics Process: Data collection and data acquisition, Data cleaning and preprocessing (conceptual overview), Data transformation and data preparation, Data modelling and interpretation , Data visualization and					

	communication of results • Types of Analytics: Descriptive Analytics, Diagnostic Analytics, Predictive Analytics(introductory concepts), Prescriptive Analytics (conceptual overview) **Unit–II: Core Analytical Techniques and Pattern Discovery** • Exploratory Data Analysis: Purpose and significance of exploratory analysis, Data summarization and pattern identification , Detection of trends, variations and anomalies • Relationship Analysis: Concept of association and dependence, Correlation and its interpretation, Regression as an analytical and predictive tool, Applications and limitations of regression analysis • Classification Techniques (Conceptual Framework): Meaning and objectives of classification , Types of classification problems, Conceptual understanding of classification models, Applications of classification in real-world scenarios • Clustering Techniques (Conceptual Framework): Meaning and objectives of clustering, Similarity and dissimilarity concepts, Types of clustering approaches, Applications of clustering in data analytics **Unit–III: Feature Engineering, Visualization and Communication of Results** • Feature Engineering Concepts: Meaning and importance of features, Feature generation and feature extraction (conceptual), Feature selection and dimensionality reduction (introductory concepts), Role of features in analytical modelling • Data Visualization: Principles of effective data visualization, Bar charts and pie charts, Histograms and frequency distributions, Box plots and distribution analysis, Heat maps and pattern visualization , Trend curves and learning curves • Interpretation and Communication: Interpretation of analytical outputs, Presentation of analytical findings, Data storytelling and communication strategies, Reporting analytical results for decision-making **Unit–IV: Applications, Social Analytics and Responsible Data Analytics** • Applications of Data Analytics: Applications of regression, classification and clustering, Analytics in business and industry, Analytics in governance and public policy, Analytics in healthcare and biomedical sciences, Analytics in education and social sciences • Recommendation Systems (Conceptual Overview): Introduction and significance, Content-based and collaborative approaches (conceptual), Applications and challenges • Social Network Analysis: Introduction to network data, Nodes, edges and network structures, Degree centrality, Closeness centrality, Betweenness centrality, Applications of social network analysis • Ethics and Responsible Analytics: Data privacy and confidentiality, Data quality and reliability, Bias and fairness in analytics, Transparency and accountability, Responsible use of data and analytics

<table>
<tr><td>Mapping between Cos and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td>✔</td><td>✔</td><td></td><td></td><td>✔</td><td></td><td>✔</td><td>✔</td></tr>
<tr><td>CO2</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td><td>✔</td></tr>
<tr><td>CO3</td><td></td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td></tr>
<tr><td>CO4</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td><td>✔</td></tr>
<tr><td>CO5</td><td></td><td>✔</td><td>✔</td><td></td><td>✔</td><td>✔</td><td>✔</td><td>✔</td></tr>
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<tr><td>Reference Books</td><td>

Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer
Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2018). Analyzing social networks (2nd ed.). Sage Publications.
Bouveyron, C. et al. (2019). Model-Based Clustering and Classification for Data Science. Cambridge University Press.
Bruce, P., Bruce, A., & Gedeck, P. (2020). Practical statistics for data scientists: 50+ essential concepts using R and Python (2nd ed.). O'Reilly Media.
Easley, D., & Kleinberg, J. (2010). Networks, crowds, and markets: Reasoning about a highly connected world. Cambridge University Press.
Han, J., Kamber, M., & Pei, J. (2012). Data mining: Concepts and techniques (3rd ed.). Morgan Kaufmann.
Heumann, C., Schomaker, M., & Shalabh. (2016). Introduction to Statistics and Data Analysis. Springer
James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). An introduction to statistical learning: With applications in R (2nd ed.). Springer.
Khan, B. H. et al. (2019). Responsible Analytics and Data Mining. Routledge.
Knaflic, C. N. (2015). Storytelling with data: A data visualization guide for business professionals. Wiley.
Loukides, M., Mason, H., & Patil, D. J. (2018). Ethics and data science. O'Reilly Media.
Provost, F., & Fawcett, T. (2013). Data science for business: What you need to know about data mining and data-analytic thinking. O'Reilly Media.
Rajput, A., & Bhatt, D. (2025). Visual Analytics Using Tableau. BPB Publications.
Ricci, F., Rokach, L., & Shapira, B. (Eds.). (2022). Recommender systems handbook (3rd ed.). Springer.
Shankarmani, R., & Vijayalakshmi, M. (2023). Data Analytics. Wiley India.
Tan, P.-N., Steinbach, M., Karpatne, A., & Kumar, V. (2019). Introduction to data mining (2nd ed.). Pearson.
Wilke, C. O. (2019). Fundamentals of data visualization: A primer on making informative and compelling figures. O'Reilly Media.
Zheng, A., & Casari, A. (2018). Feature engineering for machine learning: Principles and techniques for data scientists. O'Reilly Media

</td></tr>
<tr><td>Teaching Methodology</td><td>Lecture based teaching, Assignments and group discussions, Case-study based learning, Practical sessions, Self-learning through SWAYAM / open data portals</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 50 Marks theory
External Assessment: 50 Marks theory</td></tr>
</table>

[Subject code-2603000507051102]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc. Sem – VII STATISTICS PAPER ST-MJ-704-2
Decision Theory (Major)
(4 Credits Theory)
To be implemented from Academic Year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	7					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Employability and Skill Development					
Subject Type	Discipline Specific					
Course Code	ST-MJ-704-2					
Course Level	400-499					
Course Title	Decision Theory					
Credit	Theory:	4	Practical:	0	Total:	4
Effective From	Academic Year : 2026-27					

Course Outcomes

CO-01:	Demonstrate conceptual understanding of decision-theoretic principles.
CO-02:	Apply decision rules under uncertainty and risk.
CO-03:	Analyze and evaluate alternative decision strategies.
CO-04:	Use quantitative techniques for decision making.
CO-05:	Develop computational and problem-solving skills.

Course Content

Unit-1	Introduction to Decision Theory -Meaning -Components of decision theory -Types of Decision Making -Payoff Table -Loss function & Utility function -Applications of decision theory
Unit-2	Decision Making Under Uncertainty -Introduction -Min-Min Criterion -Max_-Max criterion -Max-min criterion -Min-Max Criterion -LaplaceCriterion -Hurwicz Criterion

<table>
<tr><td></td><td>
<table>
<tr><td>Unit-3</td><td>Decision Making Under Risk
-Introduction
-Expected Monetary Value
-Expected Opportunity Loss
-Expected value of Perfect Information
-Decision Tree Analysis</td></tr>
<tr><td>Unit-4</td><td>Statistical Decision Theory
-Statistical decision functions: definitions and terminology
- Loss function and risk function
- Admissible decision functions
-Complete class and minimal complete class
- Minimax solution of a decision problem
•-Bayesian solution of statistical decision problems</td></tr>
</table>
</td></tr>
<tr><td>Mapping between Cos and PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td><td>PSO8</td></tr>
<tr><td>CO1</td><td>✔</td><td></td><td></td><td></td><td>✔</td><td></td><td>✔</td><td></td></tr>
<tr><td>CO2</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td><td></td><td></td><td>✔</td></tr>
<tr><td>CO3</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td><td>✔</td></tr>
<tr><td>CO4</td><td>✔</td><td></td><td>✔</td><td>✔</td><td>✔</td><td></td><td></td><td>✔</td></tr>
<tr><td>CO5</td><td></td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td></tr>
</table>
</td></tr>
<tr><td>Reference Books</td><td>

Ferguson, T. S. (1967). Mathematical Statistics: A Decision Theoretic Approach. New York: Academic Press.
Raiffa, H., & Schlaifer, R. (1961). Applied Statistical Decision Theory. Boston, MA: Harvard University Press / MIT Press.
Goon, A. M., Gupta, M. K., & Das Gupta, B. (1977). Fundamentals of Statistics (Vols. I & II). Calcutta: World Press Private Limited.
Taha, H. A. (2017). Operations Research: An Introduction (10th ed.). New York: McGraw-Hill Education
Gauss, S. I. (2010). Linear Programming: Methods and Applications (5th ed.). New York: McGraw-Hill.

</td></tr>
<tr><td>Teaching Methodology</td><td>Class work, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments Lectures, Problem-solving sessions.</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 50 Marks theory
External Assessment: 50 Marks theory</td></tr>
</table>

[Subject code-2603000507051103]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT **Fourth Year B.Sc. Sem – VII STATISTICS PAPER ST-MJ-704-3** **Biostatistics and Survival Analysis (Major)** **(4 Credits Theory)** **To be implemented from Academic Year 2026-27**						
Program Name	B. Sc. (Statistics)					
Semester	7					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Employability and Skill Development					
Subject Type	Discipline Specific Course					
Course Code	ST-MJ-704-3					
Course Level	400-499					
Course Title	Biostatistics and Survival Analysis					
Credit	Theory:	4	Practical:	0	Total:	4
Effective Form	Academic Year: 2026-27					
Course Outcomes	**CO1**: Explain the fundamental concepts of biostatistics, medical uncertainties, clinical trials, ethical considerations, data management practices, and their applications in health and biomedical sciences. **CO2**: Design and evaluate different types of clinical trials, including Phase I–IV studies, crossover and parallel designs, factorial experiments, bioequivalence studies, and sequential monitoring procedures. **CO3**: Apply appropriate statistical methods for the analysis and reporting of clinical trial data, including categorical outcomes, survival outcomes, interim analyses, and intent-to-treat principles. **CO4**: Analyse time-to-event data using survival analysis techniques, including lifetime distributions, censoring mechanisms, actuarial life tables, Kaplan–Meier estimation, and Cox proportional hazards regression models. **CO5**: Interpret results obtained from clinical trial and survival data analyses to support evidence-based decision-making in medical, biological, and public health research.					
Course Content	**UNIT I: Introduction to Biostatistics** Introduction to Bio-statistics, Sources of medical uncertainties, managing medical uncertainties. Applications of Bio-statistics. Clinical trials: the need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I-IV trials, multi-center trials, Data management: data definitions, data collection systems for good clinical practice, protocol definition. **UNIT II: Experimental Designs in Clinical Trials** Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitude					

designs, review of factorial designs, objectives and endpoints of clinical trials, design of Phase I trials, design of single-stage and multi-stage Phase II trials, design and monitoring of Phase III trials with sequential stopping, design of bioequivalence trials.

UNIT III: Analysis and Interpretation of Clinical Trial Data

Reporting and analysis: analysis of categorical outcomes from Phase I-III trials, analysis of survival data from clinical trials. Interim analysis method, motivating intent-to-treat analysis.

UNIT IV: Survival Analysis – Concept, Distributions and Estimation

Concept of survival time and time-to-event data; survival function, hazard function and death density; lifetime distributions – exponential, Weibull, gamma and lognormal distributions; concept of bathtub-shaped hazard (conceptual); censoring schemes – Type-I, Type-II and progressive censoring; estimation of mean survival time; actuarial life table method; Kaplan–Meier estimator and interpretation, Cox Regression.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✔		✔	✔	✔		✔	✔
CO2	✔	✔	✔	✔	✔		✔	✔
CO3	✔	✔	✔	✔	✔	✔	✔	✔
CO4	✔	✔	✔	✔	✔	✔	✔	✔
CO5	✔	✔	✔	✔	✔	✔	✔	✔

Reference Books

1. Daniel, W. W., & Cross, C. L. (2013). Biostatistics: A foundation for analysis in the health sciences (10th ed.). John Wiley & Sons.
2. Finney, D. J. (1971). *Probit analysis* (3rd ed.). Cambridge University Press.
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7. Indrayan, A., & Satyanarayana, L. (2006). *Biostatistics for medical, nursing and pharmacy students*. Prentice Hall India.
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11. Kleinbaum, D. G. (1996). *Survival analysis*. Springer.
12. Lawless, J. F. (2003). Statistical models and methods for lifetime data. Wiley.
13. Lee, E. T., & Wang, J. W. (2003). *Statistical methods for survival data analysis*

	(3rd ed.). Wiley. 14. Mahajan, B. K. (1997). *Methods in biostatistics for medical students and research workers* (6th ed.). Jaypee Brothers Medical Publishers. 15. Miller, R. G. (2011). *Survival analysis*. Wiley. 16. Narayan, P., Bhatia, & Malhotra. (1979). *Handbook of statistical genetics*. Indian Agricultural Statistics Research Institute, ICAR. 17. Piantadosi, S. (1977). Clinical trials: A methodologic perspective (3rd ed.). Wiley. 18. Wetherill, G. B. (1966). Sequential methods in statistics. Methuen.
Teaching Methodology	Lecture based teaching, Assignments and group discussions, Case-study based learning, Practical sessions, Self-learning through SWAYAM / open data portals
Evaluation Method	Internal Assessment: 50 Marks theory External Assessment: 50 Marks theory

[Subject code-2603000507051104]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc. Sem – VII STATISTICS PAPER ST-MJ-704-4
Non-Parametric Inference (Major)
(4 Credits Theory)
To be implemented from Academic Year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	7					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Nil					
Subject Type	Discipline Specific					
Course Code	ST-MJ-704-4					
Course Level	400-499					
Course Title	Non-Parametric Inference					
Credit	Theory:	4	Practical:	0	Total:	4
Effective From	Academic Year : 2026-27					

Course Outcomes

CO-01:	Understand the need for non-parametric methods and their advantages over parametric methods.
CO-02:	Learn to Apply appropriate non-parametric tests for one-sample and two-sample problems.
CO-03:	Select suitable non-parametric tests based on scale of measurement and data structure.
CO-04:	Interpret results of non-parametric tests in real-life data situations.
CO-05:	Implement non-parametric methods using statistical software.

Course Content

Unit-1 Introduction of Nonparametric Inference.

- Nature and scope of non-parametric methods.
- Introduction of Non-Parametric test, Assumptions and its Applications.
- Difference between Parametric tests and Non-Parametric tests.
- Scale of Measurements and choice of Non-parametric tests.

Unit-2 One-Sample Non-parametric tests.

- Binomial Test
- Sign Test
- Wilcoxon Signed Rank Test
- Kolmogorov-Smirnov Test
- Runs Test for randomness

Unit-3 Two-Samples (related) and two-Sample (independent) Non-parametric tests.

- **Two-Samples (related) Non-parametric tests:**
  - McNemar Test
  - Sign Test
  - Wilcoxon Test

<table>
<tr><td></td><td>
– Walsh Test
• Two-Sample (independent) Non-parametric tests.
– Median Test (Chi-square based)
– Mann–Whitney U Test
– Wald–Wolfowitz Runs Test
– Kolmogorov-Smirnov Test
Unit-4K-Samples (related) and K-Sample (independent) Non-parametric tests.
• K-Samples (related) Non-parametric tests:
– Cochran’s Q Test
– Friendman Test
– Kendall’s W Test
• K-Sample (independent) Non-parametric tests:
– Kruskal-Wallis Test
– Kendall’s W Test
– Extension of Median Test
</td></tr>
<tr><td>Mapping between Cos and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
</table>
</td></tr>
<tr><td>Reference Books</td><td>

1. Gibbons, J. D. (1992). Nonparametric Statistical Inference (4th ed.). Marcel Dekker
2. Siegel, S., & Castellan, N. J. (1988). Nonparametric Statistics for the Behavioral Sciences (2nd ed.). McGraw-Hill
3. Conover, W. J. (1999). Practical Nonparametric Statistics (3rd ed.). Wiley
4. Daniel, W. W. (1990). Applied Nonparametric Statistics (2nd ed.). PWS-Kent
5. Hollander, M., Wolfe, D. A., & Chicken, E. (2014). Nonparametric Statistical Methods (3rd ed.). Wiley
6. Fraser, D. A. S. (1956). Nonparametric methods in statistics. John Wiley & Sons
7. Lehmann, E. L. (2006). Non-parametrics: Statistical methods based on ranks (Rev. ed.). Springer. (Original work published 1975)
8. Randles, R. H., & Wolfe, D. A. (1979). Introduction to the theory of nonparametric statistics. John Wiley & Sons.
9. Hettmansperger, T. P. (1984). Statistical inference based on ranks. John Wiley & Sons
10. Wasserman, L. (2006). All of nonparametric statistics. Springer.

</td></tr>
<tr><td>Teaching Methodology</td><td>Class work, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments Lectures, Problem-solving sessions.</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 50 Marks theory
External Assessment: 50 Marks theory</td></tr>
</table>

Structure of Credit Frame Work as per NEP 2020 for Fourth Year B.Sc. Statistics (Semester -8) Single Major - without OJT/Research Project - total credits = 22 credits

Course Category	Course Code	Course Title	Marksheet Title in English	Level of Course	Teaching Hours/ Week		Exam Duration		Credit		Internal Marks		External Marks		Total Makrs	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR	ST-MJ-801	Univariate Distributions	Univariate Distributions	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-801	Practical in Univariate Distributions	Practical in Univariate Distributions	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-802	Estimation Theory	Estimation Theory	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-802	Practical in Estimation Theory	Practical in Estimation Theory	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-803	Multivarite Analysis	Multivarite Analysis	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-803	Practical in Multivarite Analysis	Practical in Multivarite Analysis	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-804 -1	Acturial Statistics	Acturial Statistics	400-499	04	-	02	-	04	-	50	-	50	-	100	-
MAJOR	ST-MJ-804 -2	Mathematical Statistics	Mathematical Statistics	400-499	04	-	02	-	04	-	50	-	50	-	100	-
MAJOR	ST-MJ-804 -3	Time Series Analysis	Time Series Analysis	400-499	04	-	02	-	04	-	50	-	50	-	100	-
MAJOR	ST-MJ-804 -4	Industrial Statistics	Industrial Statistics	400-499	04	-	02	-	04	-	50	-	50	-	100	-
MAJOR	MJ-805	Research Methodology II	Research Methodology II	400-499	02	-	01	-	02	-	50	-	50	-	100	-
MINOR ELECTIVE	ME-801	Entrepreneurship	Entrepreneurship	400-499	04	-	02	-	04	-	50	-	50	-	100	-

NOTE: (1) Research Methodology syllabus will be prepared by Adhoc Board of Research Methodology of VNSGU, SURAT.
(2) Entrepreneurship syllabus will be prepared by Commerce including B. A. Board of studies - VNSGU, SURAT.

Structure of Credit Frame Work as per NEP 2020 for Fourth Year B.Sc. Statistics (Semester -8) Single Major - with OJT/Research Project – Total Credits = 22 credits

Course Category	Course Code	Course Title	Marksheet Title in English	Level of Course	Teaching Hours/ Week		Exam Duration		Credit		Internal Marks		External Marks		Total Makrs	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR	ST-MJ-801	Univariate Distributions	Univariate Distributions	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-801	Practical in Univariate Distributions	Practical in Univariate Distributions	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-802	Estimation Theory	Estimation Theory	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-802	Practical in Estimation Theory	Practical in Estimation Theory	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MAJOR	ST-MJ-803	Multivarite Analysis	Multivarite Analysis	400-499	02	-	01	-	02	-	25	-	25	-	50	-
MAJOR	STP-MJ-803	Practical in Multivarite Analysis	Practical in Multivarite Analysis	400-499	-	04	-	04	-	02	-	25	-	25	-	50
MINOR ELECTIVE	ME-801	Entrepreneurship	Entrepreneurship	400-499	04	-	02	-	04	-	50	-	50	-	100	-
RP/OJT	ST – RP/OJT - 801	RESEARCH PROJECT/ ON JOB TRAINING	RESEARCH PROJECT/ ON JOB TRAINING	400-499	12	-	-	-	06	-	75		75		150	

*Entrepreneurship syllabus will be prepared by Computer Faculty of VNSGU, SURAT.

[Subject code for Theory-2703000508011101]

[Subject code for Practical-2703000508011102]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc. Sem – VIII STATISTICS PAPER ST-MJ-801
Univariate Distributions (Major)
(2 Credits Theory+2 credits Practical)
To be implemented from Academic Year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	8					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Skill Development & Employability					
Subject Type	Discipline Specific					
Course Code	ST-MJ-801					
Course Level	400-499					
Course Title	Univariate Distributions					
Credit	Theory:	2	Practical:	2	Total:	4
Effective From	Academic Year : 2026-27					

Course Outcomes

CO-01:	Understand the properties and applications of important continuous probability distributions such as Laplace, Lognormal, Cauchy, Weibull and Logistic distributions.
CO-02:	Apply truncated probability distributions in situations involving restricted or incomplete observations.
CO-03:	Analyse compound and contagious distributions used in modelling count and risk-related phenomena.
CO-04:	Understand and apply power series distributions and their statistical properties.
CO-05:	Interpret and apply non-central probability distributions in advanced statistical inference problems.
CO-06:	Analyse order statistics and range distributions arising from random samples.
CO-07:	Utilize computational tools to evaluate probabilities, distribution functions and statistical measures associated with univariate distributions.
CO-08:	Apply distribution theory to real-life problems in reliability, quality control, actuarial science and data analysis.

Course Content

Unit-1	**Continuous and Truncated Distributions** • Review of Laplace, Lognormal and Cauchy Distributions • Weibull Distribution: Properties and Applications • Logistic Distribution: Properties and Applications • Concept of Truncated Distributions • Truncated Binomial Distribution • Truncated Poisson Distribution • Truncated Normal Distribution

		• Applications of Truncated Distributions
	Unit-2	**Compound, Non-Central and Order Statistics** • Univariate Compound Distributions • Contagious Distributions: Neyman Type-A Distribution • Poisson-Binomial Distribution • Poisson-Negative Binomial Distribution • Univariate Power Series Distributions • Non-central t, F and Chi-square Distributions • Order Statistics: Distribution and Properties • Distribution and Properties of Range • Applications of Order Statistics in Statistical Inference

Course Code	STP-MJ-801
Course Title	Practical in Univariate Distributions

Course Practical Content

1.	Computation and graphical representation of Laplace, Lognormal and Cauchy Distribution.
2.	Estimation of probabilities and percentiles for Weibull Distribution.
3.	Estimation of probabilities and percentiles for Logistic Distribution.
4.	Construction and analysis of Truncated Binomial Distribution.
5.	Construction and analysis of Truncated Poisson Distribution.
6.	Construction and analysis of Truncated Normal Distribution.
7.	Computation of probabilities for Poisson-Binomial Distribution.
8.	Fitting of Neyman Type-A Distribution.
9.	Computation of probabilities and moments for Power Series Distributions.
10.	Evaluation of Non-central t, Non-central F Distribution and Non-central Chi-square Distribution probabilities
11.	Computation of Order Statistics from random samples.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓		✓		✓			✓
CO2	✓		✓	✓	✓			✓
CO	✓	✓	✓	✓	✓		✓	✓
CO4	✓		✓	✓	✓		✓	✓
CO5	✓		✓	✓	✓		✓	✓
CO6	✓	✓	✓	✓	✓		✓	✓
CO7		✓	✓	✓	✓	✓	✓	✓
CO8	✓	✓	✓	✓	✓	✓	✓	✓

Reference Books

1.	Johnson, N. L. & Kotz, S. (1970): Distributions in Stati tics, John Wiley & Sons, ISBN: 9780471715812.
2.	Rohatgi, V. K. (1984): Statistical Inference, John Wiley & Sons, ISBN: 9780471360914.
3.	Rohatgi, V. K. (1976): An Introduction to Probability Theory and Mathematical Statistics, John Wiley & Sons, ISBN: 9780471272144.

		4.	Patel, J. K., Kapadia, C. H. & Owen, D. B. (1996): Handbook of Statistical Distributions, Marcel Dekker, ISBN: 9780824790469.
		5.	Mood, A. M., Graybill, F. A. & Boes, D. C. (1974): Introduction to the Theory of Statistics, McGraw-Hill, ISBN: 9780070380452.
		6.	Rao, C. R. (1965): Linear Statistical Inference and Its Applications, Wiley, ISBN: 9780471754989.
		7.	Arnold, B. C., Balakrishnan, N. & Nagaraja, H. N. (1992): A First Course in Order Statistics, John Wiley & Sons, ISBN: 9780470284439.
		8.	Johnson, N. L., Kotz, S. & Balakrishnan, N. (2000): Discrete Univariate Distributions, 2nd Edition, John Wiley & Sons, ISBN: 9780471584953.
		9.	Johnson, N. L., Kotz, S. & Balakrishnan, N. (2000): Continuous Univariate Distributions (Vol. 1), 2nd Edition, John Wiley & Sons, ISBN: 9780471584946.
		10.	Evans, M., Hastings, N. & Peacock, B. (2000): Statistical Distributions, 3rd Edition, Wiley, ISBN: 9780471371248.
		11.	Gupta, S. C. & Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, 12th Edition, Sultan Chand & Sons, ISBN: 9789351613312.
		12.	Hogg, R. V., McKean, J. W. & Craig, A. T. (2019): Introduction to Mathematical Statistics, 8th Edition, Pearson Education, ISBN: 9780134686998.
Teaching Methodology	Classwork, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments		
Evaluation Method	Internal Assessment : 25 Marks Theory + 25 marks Practical External Assessment : 25 Marks Theory + 25 marks Practical		

[Subject code for Theory-2703000508021101]

[Subject code for Practical-2703000508021102]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc. Sem – VIII STATISTICS PAPER ST-MJ-802
Estimation Theory (Major)
(2 Credits Theory+2 credits Practical)
To be implemented from Academic Year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	8					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Skill Development & Employability					
Subject Type	Discipline Specific					
Course Code	ST-MJ-802					
Course Level	400-499					
Course Title	Estimation Theory					
Credit	Theory:	2	Practical:	2	Total:	4
Effective From	Academic Year: 2026-27					

Course Outcomes	**CO-01:**	Understand the concepts of statistical estimation, estimators and desirable properties of estimators.
	CO-02:	Evaluate estimators using unbiasedness, consistency, efficiency and Pitman's closeness criteria.
	CO-03:	Identify and derive sufficient, minimal sufficient and complete sufficient statistics for statistical models.
	CO-04:	Apply Rao-Blackwell and Lehmann-Scheffé theorems to obtain efficient estimators and UMVUEs.
	CO-05:	Construct estimators using Maximum Likelihood, Method of Moments and other estimation techniques.
	CO-06:	Derive and interpret lower bounds such as Cramér-Rao, Chapman-Robbins and Bhattacharya bounds.
	CO-07:	Construct and interpret confidence intervals and confidence bounds for population parameters.
	CO-08:	Apply estimation procedures to real-life statistical problems using computational tools and data analysis techniques.
	CO-09:	Develop analytical and research skills required for advanced statistical inference and data-driven decision making.
Course Content	**Unit-1**	**Properties of Estimators** • Concept of Estimator and Estimate • Measures of Closeness of an Estimator: Pitman's Closeness Criterion • Unbiased and Biased Estimators • Consistent Estimators and Theorems on Consistency • Efficiency of Estimators • Best Linear Combination of Unbiased Estimators

<table>
<tr><td></td><td></td><td></td><td>• Best Asymptotically Normal (BAN) Estimators
• Sufficient Statistics
• Neyman Factorization Theorem (Discrete Case)
• Minimal Sufficient Statistics
• Complete Sufficient Statistics</td></tr>
<tr><td></td><td></td><td>Unit-2</td><td>Theorem-Inequality, Methods of Estimation and Confidence Intervals
• Minimum Variance Unbiased Estimation (MVUE)
• Cramér-Rao Lower Bound and Cramér-Rao Inequality
• Chapman-Robbins Inequality
• Bhattacharya Inequality
• Rao-Blackwell Theorem
• Lehmann-Scheffé Theorem
• Uniformly Minimum Variance Unbiased Estimator (UMVUE)
• One Parameter Exponential Family of Distributions
• Maximum Likelihood Estimation (MLE) and Its Properties
• Method of Moments
• Method of Minimum Chi-square and Modified Minimum Chi-square
• Method of Scoring
• MLE for Grouped Data
• Location and Scale Invariant Estimators
• Confidence Intervals and Confidence Bounds
• Large Sample Confidence Intervals
• Confidence Intervals for Parameters of Elementary Distributions
• Confidence Bounds of Fixed Length
• Stein's Two-Stage Procedure</td></tr>
<tr><td>Course Code</td><td colspan="3">STP-MJ-802</td></tr>
<tr><td>Course Title</td><td colspan="3">Practical in Estimation Theory</td></tr>
<tr><td>Course practical content</td><td colspan="3"><table>
<tr><td>1.</td><td>Computation of Point Estimates for Population Mean and Variance.</td></tr>
<tr><td>2.</td><td>Comparison of Biased and Unbiased Estimators</td></tr>
<tr><td>3.</td><td>Study of Consistency of Estimator</td></tr>
<tr><td>4.</td><td>Study of Efficiency of Estimators.</td></tr>
<tr><td>5.</td><td>Construction of Best Linear Unbiased Estimators.</td></tr>
<tr><td>6.</td><td>Identification of Sufficient Statistics for Standard Distributions.</td></tr>
<tr><td>7.</td><td>Estimation of Parameters using Method of Moments.</td></tr>
<tr><td>8.</td><td>Estimation of Parameters using Maximum Likelihood Method.</td></tr>
<tr><td>9.</td><td>Estimation of Parameters for Grouped Data.</td></tr>
<tr><td>10.</td><td>Computation of Fisher Information and Cramér-Rao Lower Bound.</td></tr>
<tr><td>11.</td><td>Verification of Rao-Blackwell Improvement of Estimators.</td></tr>
<tr><td>12.</td><td>Construction of UMVUE for Selected Distributions.</td></tr>
<tr><td>13.</td><td>Construction of Confidence Intervals for Population Mean and Population Variance</td></tr>
<tr><td>14.</td><td>Application of Stein's Two-Stage Procedure using Sample Data.</td></tr>
</table></td></tr>
</table>

	15. Comparative Study of MLE and Method of Moments Estimators.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓			✓	✓		✓	✓
CO2	✓	✓	✓	✓	✓		✓	✓
CO3	✓	✓	✓	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓		✓	✓
CO5	✓	✓	✓	✓	✓		✓	✓
CO6	✓	✓	✓	✓	✓		✓	✓
CO7	✓	✓	✓	✓	✓	✓	✓	✓
CO8		✓	✓	✓	✓	✓	✓	✓
CO9	✓	✓	✓	✓	✓	✓	✓	✓

Reference Books

1.	Mood, A. M., Graybill, F. A. & Boes, D. C. (2001): Introduction to the Theory of Statistics, McGraw-Hill, ISBN: 9780070445208.
2.	Goon, A. M., Gupta, M. K. & Dasgupta, B. (2000): An Outline of Statistical Theory, Vol. I & II, World Press, ISBN: 9788187567264.
3.	Rohatgi, V. K. (1976): An Introduction to Probability Theory and Mathematical Statistics, John Wiley & Sons, ISBN: 9780471731351.
4.	Mukhopadhyay, P. (2014): Mathematical Statistics, Books and Allied (P) Ltd., ISBN: 9788187134930.
5.	Rao, C. R. (2001): Linear Statistical Inference and Its Applications, 2nd Edition, Wiley, ISBN: 9780471218753.
6.	Casella, G. & Berger, R. L. (2024): Statistical Inference, 2nd Edition (Reprint), CRC Press, ISBN: 9781032597942.
7.	Mukhopadhyay, N. (2006): Introductory Statistical Inference, Chapman & Hall/CRC, ISBN: 9781574446135.
8.	Hogg, R. V., McKean, J. W. & Craig, A. T. (2019): Introduction to Mathematical Statistics, 8th Edition, Pearson, ISBN: 9780134686998.
9.	Lehmann, E. L. & Casella, G. (1998): Theory of Point Estimation, 2nd Edition, Springer, ISBN: 9780387985022.
10.	Kale, B. K. (1999): A First Course on Parametric Inference, Narosa Publishing House, ISBN: 9788173193958.
11.	Srivastava, M. K., Khan, A. H. & Srivastava, N. (2014): Statistical Inference: Theory of Estimation, Prentice Hall India, ISBN: 9788120349308.
12.	Mukhopadhyay, N. (2006): Introductory Statistical Inference, Chapman & Hall/CRC, ISBN: 9781574446135.

Teaching Methodology	Classwork, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments
Evaluation Method	Internal Assessment : 25 Marks Theory + 25 marks Practical External Assessment : 25 Marks Theory + 25 marks Practical

[Subject code for Theory-2703000508031101]

[Subject code for Practical-2703000508031102]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc. Sem – VIII STATISTICS PAPER ST-MJ-803
Multivariate Analysis (Major)
(2 Credits Theory+2 credits Practical)
To be implemented from Academic Year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	8					
NCrF Credit Level	6					
Course Type	Major					
Course Subtype	Skill Development & Employability					
Subject Type	Discipline Specific					
Course Code	ST-MJ-803					
Course Level	400-499					
Course Title	Multivariate Analysis					
Credit	Theory:	2	Practical:	2	Total:	4
Effective From	Academic Year: 2026-27					

Course Outcomes	**CO-01:**	Understand multivariate probability distributions and their statistical properties.
	CO-02:	Derive and apply marginal, conditional and sampling distributions associated with multivariate normal populations.
	CO-03:	Analyse generalized variance and Wishart distributions in multivariate statistical inference.
	CO-04:	Compute and interpret multiple and partial correlation coefficients and perform associated significance tests.
	CO-05:	Apply Hotelling's T^2 statistic and MANOVA techniques for multivariate hypothesis testing.
	CO-06:	Solve classification problems using Fisher's discriminant analysis and evaluate misclassification probabilities.
	CO-07:	Apply dimension reduction techniques such as Principal Component Analysis, Factor Analysis and Canonical Correlation Analysis.
	CO-08:	Utilize statistical software and computational tools for analysing multivariate datasets and interpreting results.
	CO-09:	Apply multivariate statistical techniques to real-world problems in research, industry, healthcare, business analytics and public policy.
Course Content	**Unit-1**	**Multivariate Distributions and Correlation Analysis** • Multinomial Distribution: Marginal and Conditional Distributions, Characteristic Function • Multivariate Normal Distribution: Properties, Marginal and Conditional Distributions • Distribution of Linear Functions and Sample Mean Vector • Characteristic Function of Multivariate Normal Distribution • Generalized Variance and Distribution of Sample Generalized Variance

		• Wishart Distribution: Probability Density Function and Properties • All properties of Wishart Distribution • Characteristic Function of Wishart Distribution • Multiple Correlation Coefficient and Partial Correlation Coefficient • Null and Non-null Distribution of Sample Correlation Coefficient • Tests of Significance of Multiple and Partial Correlation Coefficients
	Unit-2	**Multivariate Inference and Dimension Reduction Techniques** • Hotelling's T^2 Statistic and its Null Distribution • Tests on Single Mean Vector • Tests for Two Independent Multivariate Normal Populations (Equal and Unequal Covariance Matrices) • Tests for Dependent Samples • Problem of Symmetry • Multivariate Analysis of Variance (MANOVA): One-Way Classification • Classification Problems and Fisher's Linear Discriminant Function • Probabilities of Misclassification • Classification with More Than Two Multivariate Normal Populations • Introduction to Factor Analysis and Applications • Principal Component Analysis (PCA): Concepts and Applications • Canonical Correlation Analysis: Concepts and Applications
Course Code	STP- MJ-803	
Course Title	Practical in Multivarite Analysis	
Course practical content	1.	Computation of mean, variance and covariance matrix of Multinomial Distribution and Multivariate Normal Distribution
	2.	Computation of Marginal and Conditional Distributions of Multinomial Distribution and Multivariate Normal Distribution
	3.	Testing Significance of Multiple Correlation Coefficient
	4.	Testing Significance of Partial Correlation Coefficient
	5.	Hotelling's T^2 Test for a Single Population Mean Vector
	6.	Hotelling's T^2 Test for Two Independent Mean Vectors (Equal Covariance Matrices)
	7.	Hotelling's T^2 Test for Two Independent Mean Vectors (Unequal Covariance Matrices)
	8.	Hotelling's T^2 Test for Paired Multivariate Observations
	9.	Testing the Problem of Symmetry
	10.	One-Way MANOVA
	11.	Fisher's Linear Discriminant Function for Two/more than two-Group Classification and misclassification
	12.	Comparative Study of PCA and Factor Analysis

Mapping between Cos and		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
	CO1	✓				✓		✓	✓

PSOs		CO2	✓		✓	✓	✓		✓	✓
		CO3	✓	✓	✓	✓	✓		✓	✓
		CO4	✓	✓	✓	✓	✓	✓	✓	✓
		CO5	✓	✓	✓	✓	✓	✓	✓	✓
		CO6	✓	✓	✓	✓	✓	✓	✓	✓
		CO7	✓	✓	✓	✓	✓	✓	✓	✓
		CO8		✓	✓	✓	✓	✓	✓	✓
		CO9	✓	✓	✓	✓	✓	✓	✓	✓

Reference Books

1.	Anderson, T. W. (2003): An Introduction to Multivariate Statistical Analysis, 3rd Edition, Wiley-Inter science, ISBN: 9780471360919.
2.	Johnson, R. A. & Wichern, D. W. (2008): Applied Multivariate Statistical Analysis, 6th Edition, Pearson Education, ISBN: 9788131722220.
3.	Fienberg, S. E., Olkin, I. & Jobson, J. D. (1994): Applied Multivariate Data Analysis: Volume II, Springer, ISBN: 9780387978048.
4.	Kshirsagar, A. M. (1972): Multivariate Analysis, Marcel Dekker, ISBN: 9780824713867.
5.	Mardia, K. V., Kent, J. T. & Bibby, J. M. (1980): Multivariate Analysis, Academic Press, ISBN: 9780124712522.
6.	Morrison, D. F. (2004): Multivariate Statistical Methods, 4th Edition, Thomson Brooks/Cole, ISBN: 9780534387785.
7.	Marcoulides, G. A., Hershberger, S. L. (1997): Multivariate Statistical Methods: A First Course, Lawrence Erlbaum Associates, ISBN: 9780805825725.
8.	Muirhead, R. J. (2005): Aspects of Multivariate Statistical Theory, Wiley, ISBN: 9780471769859.
9.	Seber, G. A. F. (1984): Multivariate Observations, Wiley, ISBN: 9780471881049.
10.	Srivastava, M. S. & Khatri, C. G. (1979): An Introduction to Multivariate Statistics, North-Holland, ISBN: 9780444003027.
11.	Srivastava, M. S. (2002): Methods of Multivariate Statistics, Wiley, ISBN: 9780471223818.
12.	Härdle, W. & Hlávka, Z. (2007): Multivariate Statistics: Exercises and Solutions, Springer, ISBN: 9780387707846.
13.	Rencher, A. C. & Christensen, W. F. (2012): Methods of Multivariate Analysis, 3rd Edition, Wiley, ISBN: 9780470178966.
14.	Izenman, A. J. (2013): Modern Multivariate Statistical Techniques, Springer, ISBN: 9780387781884.
15.	Everitt, B. S. & Hothorn, T. (2011): An Introduction to Applied Multivariate Analysis with R, Springer, ISBN: 9781441996497.

Teaching Methodology	Classwork, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments
Evaluation Method	Internal Assessment : 25 Marks Theory + 25 marks Practical External Assessment : 25 Marks Theory + 25 marks Practical

[Subject code-2703000508051101]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc. Sem – VIII STATISTICS PAPER ST-MJ-804-1
Actuarial Statistics (Major)
(4 Credits Theory)
To be implemented from Academic Year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	8					
NCrF Credit Level	**6**					
Course Type	Major					
Course Subtype	Skill Development & Employability					
Subject Type	Discipline Specific					
Course Code	ST-MJ-804-1					
Course Level	400-499					
Course Title	Actuarial Statistics					
Credit	Theory:	4	Practical:	0	Total:	4
Effective From	Academic Year : 2026-27					

Course Outcomes

CO-01:	Clear understanding of basics of Actuarial Science.
CO-02:	Understand the concept of interest and tools for applying actuarial methods in phenomena for financial research and insurance.
CO-03:	Understand the Life Table Construction, Mortality Modelling and Insurance products.
CO-04:	Understand the concept of life insurance and the existing insurance products of different insurance company.
CO-05:	Understand the concept of Corporate Finance & Capital Structure.
CO-06:	Understand the concept of Stationary population and various models.
CO-07:	Know about Advanced Risk Modelling & Multi-State Contingencies.

Course Content

Unit-1	• Basics of Probability & Interest: Theory of Interest, Variable interest rates, continuous time payment streams, Interest rates or discount rates in terms of different time periods. • Interest & Mortality: Annuities, Loan Amortization and Mortgage Refinancing, Mortality and Analytical models, Generalized Cash flow model, discounted cash flow techniques.
Unit-2	• Life Tables: Concepts of Life Tables, Assumptions related to life tables, columns of life tables, Complete and Abridged life tables, Construction of life tables, Estimation from life table data. • Finance & financial reporting: Principal terms in investment and asset management, Key principles of finance, Structure of joint Stock Company and the different methods of financing by which it may be financed, Basic principle of personal and corporate taxation, The characteristics of principal forms of financial instrument used by companies, Factors to be considered by a company when deciding on its capital structure and divided policy.

	Unit-3 • Expected present values of payments, Continuous contracts & residual life, Premium calculations, Repayment of loan by regular instalment of interest and capital, m-payment net single premiums. • Population functions and indicator notations, Stationary population concepts.
	Unit-4 • The investment and risk characteristics of the following types of asset available for investment purposes. • Risk models: Proportional Hazard models, excess risk models, multiple decrement models, death rate estimators, causes specific life insurance premiums.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✓	✓					✓	✓
CO2	✓	✓	✓	✓	✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓
CO4		✓	✓		✓	✓		✓
CO5	✓	✓	✓		✓		✓	✓
CO6	✓	✓	✓		✓		✓	✓
CO7	✓	✓	✓	✓	✓	✓	✓	✓

Reference Books

1. Barcley G.W. (1970). Techniques of Population Analysis. John Wiley, New York.
2. Borowiak, D.S., and A. F. Shapiro. (2013). Financial and Actuarial Statistics: An Introduction, Second Edition. CRC Press.
3. Donald, D.W.A. (1970). Compound interest and annuities, Second Edition, The Institute of Actuaries and the Faculty of Actuaries at the University Press.
4. Spurgeon, E.T. (2011), Life Contingencies, Third Edition, Cambridge University Press.
5. Eric V. Slud (2001): Actuarial Mathematics and Life Table Statistics (Mathematics Department, University of Maryland).
6. Borowiak, D. S., & Shapiro, A. F. (2014). Financial and Actuarial Statistics: An Introduction (2nd ed.). Chapman & Hall/CRC.
7. Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., & Nesbitt, C. J. (1997). Actuarial Mathematics (2nd ed.). Society of Actuaries.
8. Denuit, M., Hainaut, D., & Trufin, J. (2019). Effective Statistical Learning Methods for Actuaries I: GLMs and Extensions. Springer.
9. Dickson, D. C. M., Hardy, M. R., & Waters, H. R. (2020). Actuarial Mathematics.
10. Kellison, S. G. (2008). The Theory of Interest (3rd ed.). McGraw-Hill.
11. McQuire, P., & Kume, A. (2015). R Programming for Actuarial Science. John Wiley & Sons.
12. Miller, I., & Miller, M. (2013). John E. Freund's Mathematical Statistics with Applications (8th ed.). Pearson.
13. Promislow, S. D. (2015). Fundamentals of Actuarial Mathematics (3rd ed.). John Wiley & Sons.
14. Atkinson, M.E. and Dickson, D.C.M. (2011): An Introduction to Actuarial

	Studies, Elgar Publishing.
Teaching Methodology	Class work, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments Lectures, Problem-solving sessions.
Evaluation Method	Internal Assessment: 50 Marks Theory External Assessment:50 Marks Theory

[Subject code-2703000508051102]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT Fourth Year B.Sc. Sem – VIII STATISTICS PAPER ST-MJ-804-2 Mathematical Statistics (Major) (4 Credits Theory) To be implemented from Academic Year 2026-27						
Program Name	B. Sc. (Statistics)					
Semester	8					
NCrF Credit Level	**6**					
Course Type	**Major**					
Course Subtype	**Employability**					
Subject Type	**Discipline Specific**					
Course Code	**ST-MJ-804-2**					
Course Level	**400-499**					
Course Title	**Mathematical Statistics**					
Credit	**Theory:**	**4**	**Practical:**	**0**	**Total:**	**4**
Effective From	**Academic Year : 2026-27**					
Course Outcomes	**CO1**: Understand and apply key probability distributions (trinomial, bivariate normal) in statistical analysis. **CO2:** Analyze and interpret sampling distributions (chi-square, t, F) for inference. **CO3:** Use moment generating functions and marginal/conditional distributions for problem-solving. **CO4:** Apply statistical concepts to analyze data and draw inferences.					
Course Content	**Unit-1 Trinomial Distribution** • Definition • Moment Generating function. • Moments, correlation coefficient, Marginal Distribution, Conditional Distribution **Unit – 2 Bivariate Normal Distribution** • moment generating function. • Marginal Distribution. • Conditional Distribution. **Unit 3 - Concept of sampling distributions** • Chi-Square distribution, moment generating function, mean, Variance, measures of skewness and Kurtosis. • Fisher's t distribution, moments, skewness and kurtosis. • F distribution, first two moments, mean and variance. • Relation between t, F and χ^2 distributions **Unit 4 - Distribution of Order Statistics** • Definition • Cumulative distribution function of a single order statistics.					

<table>
<tr><td>Mapping between Cos and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td>✓</td><td></td><td>✓</td><td></td><td></td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>CO2</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>CO3</td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>CO4</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td></tr>
</table>
</td></tr>
<tr><td>Reference Books</td><td>1. Leove M : Probability Theory.
2. Burrill C.W : Measure, Integration and Probability.
3. Ash Robert: Real Analysis and Probability Theory.
4. Chang K.L: A course in Probability.
5. Dudely R.M: Real analysis and Probability; Wardsworth & books.</td></tr>
<tr><td>Teaching Methodology</td><td>Class work, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments Lectures, Problem-solving sessions.</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 50 Marks Theory
External Assessment:50 Marks Theory</td></tr>
</table>

[Subject code-2703000508051103]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT **Fourth Year B.Sc. Sem – VIII STATISTICS PAPER ST-MJ-804-3** **Time Series Analysis (Major)** **(4 Credits Theory)** **To be implemented from Academic Year 2026-27**	
Program Name	B. Sc. (Statistics)
Semester	8
NCrF Credit Level	6
Course Type	Major
Course Subtype	Employability
Subject Type	Discipline Specific
Course Code	ST-MJ-804-3
Course Level	400-499
Course Title	Time Series Analysis
Credit	4 Credit Theory
Effective Form	Academic Year: 2026-‘27
Course Outcomes	CO1: Identify and classify different types of time series data and decompose them into trend, seasonal, cyclical, and irregular components. CO2: Apply various methods to measure and analyse trend in time series data including moving averages, semi-averages, and curve fitting techniques. CO3: Compute and interpret seasonal variations using simple averages, ratio to trend, ratio to moving average, and link relative methods. CO4: Analyze cyclical variations, identify business cycle phases, and distinguish between different types of fluctuations in time series. CO5: Understand the concept of stationary and apply Box-Jenkins models including AR, MA, ARMA, and ARIMA for time series modeling. CO6: Implement time series models to predict future values and interpret results.
Course Content(Theory)	**Unit-1: Introduction and fundamental concepts.** • Meaning and definition, Types, Components and Importance of time series analysis. • Additive and Multiplicative Models. • Concept of Trend. • Methods of Measuring Trend: ➢ Graphical Method. ➢ Method of Semi Averages. ➢ Method of Moving Averages. ➢ Method of Curve Fitting: (Fitting of Straight line by Method of Least Squares. Fitting Second Degree Parabolic Trend. Fitting Exponential curve.) **Unit-2: Analysis of Seasonal, Cyclical and Random Component.** • Meaning of Seasonal Variation. • Methods of Measuring Seasonal Variations: ➢ Simple Averages Method ➢ Ratio to Trend Method

<table>
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Ratio to Moving Average Method
Link Relative Method

Cyclical Variations: Meaning, Characteristics and Measurement.
Business Cycle and its Phases.
Random component & Variate Difference method.

Unit-3: Models For Stationary Time Series

Autoregressive (AR) Model
Moving Average (MA) Models
Autoregressive Moving Average (ARMA) Model

Unit-4 Models For Non-Stationary Time Series

Box-Jenkins Models.
Autoregressive Integrated Moving Average (ARIMA) Model
Properties of these models.

</td></tr>
<tr><td>Mapping between Cos and PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td><td>PSO7</td><td>PSO8</td></tr>
<tr><td>CO1</td><td>✔</td><td></td><td>✔</td><td></td><td>✔</td><td>✔</td><td>✔</td><td></td></tr>
<tr><td>CO2</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td><td>✔</td><td>✔</td><td></td></tr>
<tr><td>CO3</td><td>✔</td><td></td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td></td><td></td></tr>
<tr><td>CO4</td><td>✔</td><td></td><td>✔</td><td></td><td>✔</td><td>✔</td><td>✔</td><td>✔</td></tr>
<tr><td>CO5</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td><td>✔</td></tr>
<tr><td>CO6</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td></tr>
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</td></tr>
<tr><td>Reference Books</td><td>
1. Kendall M.G. (1976): Time Series, Charles Griffin.
2. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
3. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied.
4. Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor
5. Anderson. T. W. (1971). The Statistical Analysis of Time Series Wiley, N. Y, ISBN 13: 978-0471029007
6. Waller Vancuels: Applied Time Series and Box Jenkins Models, ISBN 13: 9780127126500.
7. Box, G. E. P., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (2015). Time Series Analysis:Forecasting and Control (5th ed.). Wiley.
8. Hyndman, R. J., & Athanasopoulos, G. (2021). Forecasting: Principles and Practice (3rd ed.). OTexts.
9. Shumway, R. H., & Stoffer, D. S. (2017). Time Series Analysis and Its Applications (4th ed.). Springer.
10. Wei, W. W. S. (2006). Time Series Analysis: Univariate and Multivariate Methods (2nd ed.). Pearson.
</td></tr>
<tr><td>Teaching Methodology</td><td>Lectures, problem-solving sessions, discussions, assignments and self study.</td></tr>
<tr><td>Evaluation Method</td><td>Internal Assessment: 50 Theory
External Assessment: 50 Theory</td></tr>
</table>

[Subject code-2703000508051104]

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT
Fourth Year B.Sc. Sem – VIII STATISTICS PAPER ST-MJ-804-4
Industrial Statistics (Major)
(4 Credits Theory)
To be implemented from Academic Year 2026-27

Program Name	B. Sc. (Statistics)					
Semester	**8**					
NCrF Credit Level	**6**					
Course Type	**Major**					
Course Subtype	**Employability**					
Subject Type	**Discipline Specific**					
Course Code	**ST-MJ-804-4**					
Course Level	**400-499**					
Course Title	**Industrial Statistics**					
Credit	**Theory:**	**4**	**Practical:**	**0**	**Total:**	**4**
Effective From	**Academic Year : 2026-27**					

Course Outcomes

CO-01:	Understand basic of production process monitoring and apply concept of control charts on it.
CO-02:	Apply the acceptance and continuous sampling plans in production process.
CO-03:	Know and apply the concept of weighted control charts, six sigma, SO: 9000 series standards and Taguchi design.
CO-04:	Understand the concepts of quality control, chance and assignable causes of variation, control charts for variables and attributes, producer's and consumer's risk - Acceptance sampling plans.
CO-05:	Get idea of important lifetime distributions such as for exponential, Weibull, gamma and lognormal distributions.
CO-06:	Use of estimation in the reliability analysis.

Course Content

Unit-1	Introduction of Statistical Quality • Introduction, concept of quality and quality control, Process control and product control, variation in quality, theory of runs, specification limits, process limits and modify limits, advantages(uses) of S.Q.C.
Unit-2	Statistical Quality Control techniques to control process • Theory of Control charts i. Control charts for variables: X-bar, R-chart and sigma chart. ii. Control charts for attributes: p-chart, np-chart, c-chart and u-chart.

		iii. Comparison between for variables and control charts for attributes. iv. Cumulative sum chart Statistical Quality Control techniques to control product quality i. Principle of acceptance sampling plans. ii. Single and double sampling plan for attribute and their OC, AQL, AOQL, ASN, TI Functions with graphical interpretation, Use and interpretation of Dodge and Romig's sampling inspection plan tables iii. Double Sampling plan. iv. Plan for acceptance sampling by measurement.
	Unit - III	Introduction to six sigma i. overview of six sigma, lean manufacturing and Total Quality Management (TQM) ii. Organizational structure and six sigma training plans-Selection criteria for six -sigma roles and training plans. iii. Voice of customers (VOC). iv. Importance and VOC data collection. v. criteria to Quality. vi. Introduction to DMAIC using one case study: Define Phase, Measure Phase, analyze phase, Improve Phase and control phase.
	Unit - IV	Reliability i. Basic concepts and distributions for product life, failure rate. ii. Reliability function for Exponential, Normal, Lognormal, Weibull Gamma Distributions. iii. Analysis of complete Data. iv. Linear analysis and maximum likelihood analysis of censored data for exponential distribution only. v. System reliability.

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	✔	✔	✔		✔			
CO2	✔		✔	✔	✔			
CO3	✔		✔	✔	✔			
CO4	✔			✔	✔			✔
CO5	✔	✔				✔		✔
CO6	✔	✔				✔	✔	✔

Reference Books

1.	Hopper A.G. (1969):"Basic Statistical Quality Control"; McGraw Hill, London. ISBN 100070941092, ISBN 13 9780070941090
2.	Gupta R.C. (1998): "Statistical Quality Control"; 10th edition Khanna Publishers, New Delhi. ISBN-13 978-81-7409-111-6

	3.	Ryan T.P. (2011): “Statistical Methods for Quality Improvement”; John Wiley & Sons. ISBN:9780470590744, ISBN:9781118058114
	4.	Sinha S.K. (1986): “Reliability and Life Testing”; Wiley Eastern Ltd., New Delhi.
	5.	Bazovksy I. (2004): “Reliability Theory and Practice”; Prentice Hall International Series in Engineering. ISBN-10 0486438678, ISBN-13 978-0486438672
	6.	Grant E. L. and Leavenworth R. (2017): “Statistical Quality Control”; 7th edition Tata Mc Graw Hill Publishing Co. Ltd., New Delhi. ISBN-10 0070435553, ISBN-13 978 0070435551
	7.	Irving W.B. (2020): “Elementary Statistical Quality Control”; 2ed edition Marcel Dekker, Inc., New York. ISBN-10 0367578123, ISBN-13 978-0367578121
	8.	Douglas C. Montgomery: (2020) “Introduction to statistical quality control”; 8th edition WileyISBN-10 1119723094, ISBN-13 978-1119723097
Teaching Methodology	Classwork, Discussion, Self-Study through SWAYAM, Seminar and/or Assignments	
Evaluation Method	Internal Assessment: 50 Marks External Assessment: 50 Marks	