



Anekant Education Society's

Tuljaram Chaturchand College
of Arts, Science and Commerce, Baramati
(Empowered Autonomous)

Four Year B.Sc. Degree Program in Statistics

(Faculty of Science & Technology)

CBCS Syllabus

S.Y.B.Sc. (Statistics) Semester – IV

For Department of Statistics

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Choice Based Credit System Syllabus

As Per NEP 2.0 (2024 Pattern)

To be implemented from Academic Year 2025 – 2026

Title of the Programme: S.Y.B.Sc. (Statistics)

Anekant Education Society's

Tuljaram Chaturchand College
of Arts, Science and Commerce Baramati, Dist-Pune, MS, India.
(Empowered Autonomous)

Board of Studies in Statistics
(Academic Year 2025-26 to 2027-28)

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20.	Prof. Gardi Chandrakant Gopal	Subject Expert from Outside the Parent University
21.	Mr. Kadam Saurabh	Representative from industry/corporate sector/allied areas
22.	Dr. Limbore Jaya Laxman	Member of the College Alumni
23.	Miss. Shirke Satakshi Shrikant	UG Student
24.	Miss. Pathak Siddhi Rajendra	PG Student



Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati.

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati is an empowered autonomous & dynamic institute and has successfully implemented the National Education Policy 2.0 2024 pattern since the academic year 2024-25. We are updating our academic policies as per local needs keeping in view the global perspectives. Accordingly, we have updated our program outcomes as per the graduate attributes defined in New Education Policy. In general, program outcomes are categorized into two categories as disciplinary & interdisciplinary outcomes and generic outcomes.

Program Outcomes for B.Sc.

- PO.1. Comprehensive Knowledge and Understanding:** Graduates will possess a profound understanding of their field of study, including foundational theories, principles, methodologies, and key concepts, within a broader multidisciplinary context.
- PO.2. Practical, Professional, and Procedural Knowledge:** Graduates will acquire practical skills and expertise essential for professional tasks within their field. This includes knowledge of industry standards, best practices, regulations, and ethical considerations, with the ability to apply this knowledge effectively in real-world scenarios.
- PO.3. Entrepreneurial Mindset and Knowledge:** Graduates will cultivate an entrepreneurial mindset, identifying opportunities, fostering innovation, and understanding business principles, market dynamics, and risk management strategies.
- PO.4. Specialized Skills and Competencies:** Graduates will demonstrate proficiency in technical skills, analytical abilities, problem-solving, effective communication, and leadership, relevant to their field of study. They will also adapt and innovate in response to changing circumstances.
- PO.5. Capacity for Application, Problem-Solving, and Analytical Reasoning:** Graduates will possess the capacity to apply learned concepts in practical settings,

solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn and take calculated risks.

- PO.6. Communication Skills and Collaboration:** Graduates will effectively communicate complex information, both orally and in writing, using appropriate media and language. They will also collaborate effectively in diverse teams, demonstrating leadership qualities and facilitating cooperative efforts toward common goals.
- PO.7. Research-related Skills:** Graduates will demonstrate observational and inquiry skills, formulate research questions, and utilize appropriate methodologies for data collection and analysis. They will also adhere to research ethics and effectively report research findings.
- PO.8. Learning How to Learn Skills:** Graduates will acquire new knowledge and skills through self-directed learning, adapt to changing demands, and set and achieve goals independently.
- PO.9. Digital and Technological Skills:** Graduates will demonstrate proficiency in using ICT, accessing information sources, and analyzing data using appropriate software.
- PO.10. Multicultural Competence, Inclusive Spirit, and Empathy:** Graduates will engage effectively in multicultural settings, respecting diverse perspectives, leading diverse teams, and demonstrating empathy and understanding of others' perspectives and emotions.
- PO.11. Value Inculcation and Environmental Awareness:** Graduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and take appropriate actions to promote sustainability and environmental conservation.
- PO.12. Autonomy, Responsibility, and Accountability:** Graduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts.
- PO.13. Community Engagement and Service:** Graduates will actively participate in community-engaged services and activities, promoting societal well-being.

Programme Specific Outcomes (PSOs)

- PSO1. Proficiency in basic statistical calculations:** Students should develop the ability to perform basic statistical calculations, such as measures of central tendency, measures of dispersion, and probabilities. They should be able to use appropriate formulas and procedures to calculate these measures accurately.
- PSO2. Competence in data collection and organization:** Students should gain practical skills in collecting and organizing data for statistical analysis. They should be able to identify different types of data (categorical, numerical) and employ appropriate methods for data collection.
- PSO3. Understanding of graphical representation of data:** Students should be able to create and interpret basic graphical representations of data, such as histograms, bar charts, scatter plots, and box plots. They should understand the purpose of these visualizations and how they can aid in data analysis and interpretation.
- PSO4. Effective communication of statistical results:** Students should practice effectively communicating statistical results. They should be able to present findings in a clear and concise manner, both orally and in written form, using appropriate statistical terminology.
- PSO5. Competence in statistical software and programming:** Students should gain proficiency in using statistical software packages (e.g., R, Python, SPSS) and programming languages commonly used in statistical analysis. They should be able to efficiently manipulate, analyse, and visualize data using these tools.
- PSO6. Development of critical thinking and problem-solving skills:** Students should develop the ability to think critically and solve statistical problems using appropriate techniques. They should be able to identify the correct statistical method for a given problem and apply it effectively.
- PSO7. Application of statistical software for data analysis:** Students should gain hands-on experience with statistical software packages, such as R or Excel, to perform basic data analysis tasks. They should be able to input data, perform calculations, generate graphical representations, and interpret the results.

**Credit Distribution Structure for Three/Four Year Honours/Honours with Research Degree Programme With Multiple Entry and Exit options
as per National Education Policy (2024 Pattern as per NEP-2020)**

Level/ Difficulty	Sem	Subject DSC-1				Subject DSC-2	Subject DSC-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5/100	I	2(T)+2(P)				2(T)+2(P)	2(T)+ 2(P)	2(T)	2 (T/P)	2(T) (Generic)	2(T)	2(T)	--	22
	II	2(T)+2(P)				2(T)+2(P)	2(T)+2(P)	2(P)	2 (T/P)	--	2(T)	2(T)	2(T)	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/Internship OR Continue with Major and Minor Continue option: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and other as minor and third subject will be dropped.														
Level/ Difficulty	Sem	Credits Related to Major				Minor	--	GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/CE P/RP									
5.0/200	III	4(T)+2(P)	--	2 (T/P)	2(FP)	2(T)+2(P)	--	2(T)	--	2(T)	2(T)	--	2(T)	22
	IV	4(T)+2(P)	--	2 (T/P)	2(CEP)	2(T)+2(P)	--	2(P)	2 (T/P)	--	2(T)	--	2(T)	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor														
5.5/300	V	8(T)+4(P)	2(T)+2(P)	2 (T/P)	2(FP/CEP)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T)+4(P)	2(T)+2(P)	2 (T/P)	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 3Years		44	8	8	10	18	8	8	6	4	8	4	6	132
Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor														
6.0/400	VII	6(T)+4(P)	2(T)+2 (T/P)	--	4(RP)	4(RM)(T)	--	--	--	--	--	--	--	22
	VIII	6(T)+4(P)	2(T)+2 (T/P)	--	6(RP)	--	--	--	--	--	--	--	--	22
Total 4Years		64	16	8	22	22	8	8	6	4	8	4	6	176
Four Year UG Honours with Research Degree in Major and Minor with 176 credits														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	--	--	4(RM) (T)	--	--	--	--	--	--	--	22
	VIII	10(T)+4(P)	2(T)+2 (T/P)	--	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 4Years		72	16	8	14	22	8	8	6	4	8	4	6	176
Four Year UG Honours Degree in Major and Minor with 176 credits														

T = Theory **P** = Practical **DSC** = Discipline Specific Course **OE** = Open Elective **SEC** = Skill Enhancement Course
IKS = Indian Knowledge System **AEC** = Ability Enhancement Course **VEC** = Value Education Course **CC** = Co-curricular Course
VSC = Vocational Skill Course **OJT** = On Job Training **CEP** = Community Engagement Project **FP** = Field Project **RP** = Research Project

Course Structure for F.Y.B.Sc. (2024 Pattern as per NEP- 2.0)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
I	DSC-I (General)	-101-GEN		T	02
		-102-GEN		P	02
	DSC-II (General)	-101-GEN		T	02
		-102-GEN		P	02
	DSC-III (General)	STA-101-GEN	Descriptive Statistics	T	02
		STA-102-GEN	Statistics Practical-I	P	02
	Open Elective (OE)	STA-103-OE	Commercial Statistics	T	02
	Skill Enhancement Course (SEC)	STA-104-SEC	Statistical Computing using MS-Excel	P	02
	Ability Enhancement Course (AEC)	ENG-104-AEC		T	02
	Value Education Course (VEC)	ENV-105-VEC		T	02
	Generic Indian Knowledge System (GIKS)	GEN-106-IKS		T	02
Total Credits Semester- I					22
II	DSC-I (General)	-151-GEN		T	02
		-152-GEN		P	02
	DSC-II (General)	-151-GEN		T	02
		-152-GEN		P	02
	DSC-III (General)	STA-151-GEN	Discrete Probability and Probability Distributions – I	T	02
		STA-152-GEN	Statistics Practical-II	P	02
	Open Elective (OE)	STA-153-OE	Introduction to MS-Excel and Statistical Computing	P	02
	Skill Enhancement Course (SEC)	STA-154-SEC	Application of Statistics Using Advanced Excel	P	02
	Ability Enhancement Course (AEC)	ENG-154-AEC		T	02
	Value Education Course (VEC)	COS-155-VEC		T	02
	Co-curricular Course (CC)	YOG/PES/CU L/NSS/NCC-156-CC	To be selected from the CC Basket	T	02
Total Credits Semester- II					22
Cumulative Credits Semester I + Semester II					44

Course Structure for S.Y.B.Sc. (2024 Pattern as per NEP- 2.0)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
III	Major Mandatory	STA-201-MRM	Discrete Probability and Probability Distributions - II	Theory	02
	Major Mandatory	STA-202-MRM	Continuous Probability Distributions – I	Theory	02
	Major Mandatory	STA-203-MRM	Major Statistics Practical – I	Practical	02
	Vocational Skill Course (VSC)	STA-204-VSC	Practicals on Predictive Techniques	Practical	02
	Field Project (FP)	STA-205-FP	Field Project	Practical	02
	Minor	STA-206-MN	Probability Distributions and its Applications	Theory	02
	Minor	STA-207-MN	Minor Statistics Practical – I	Practical	02
	Open Elective (OE)	STA-208-OE	Applied Statistical Techniques	Theory	02
	Subject Specific Indian Knowledge System (IKS)	STA-209-IKS	Evolution of Science and Statistics in India	Theory	02
	Ability Enhancement Course (AEC)	MAR-210-AEC / HIN-210-AEC / SAN-210-AEC		Theory (Any One)	02
	Co-curricular Course (CC)	YOG/PES/CUL/ NSS/NCC-211-CC	To be continued from the Semester - II		02
	Total Credits Semester-III				22
IV	Major Mandatory	STA-251-MRM	Statistical Techniques	Theory	02
	Major Mandatory	STA-252-MRM	Continuous Probability Distributions – II	Theory	02
	Major Mandatory	STA-253-MRM	Major Statistics Practical – II	Practical	02
	Vocational Skill Course (VSC)	STA-254-VSC	Statistical Process Control	Theory	02
	Community Engagement Project (CEP)	STA-255-CEP	Community Engagement Project	Practical	02
	Minor	STA-256-MN	Predictive Techniques	Theory	02
	Minor	STA-257-MN	Practicals on Predictive Techniques	Practical	02
	Open Elective (OE)	STA-258-OE	Practical Based on Applied Statistical Techniques	Practical	02
	Skill Enhancement Course (SEC)	STA-259-SEC	Introduction to Tableau and Power BI	Practical	02
	Ability Enhancement Course (AEC)	MAR-260-AEC / HIN-260-AEC / SAN-260-AEC		Theory (Any One)	02
	Co-curricular Course (CC)	YOG/PES/CUL/ NSS/NCC-261-CC	To be continued from the Semester - III		02
	Total Credits Semester-IV				22
	Total Credits Semester III + IV				44

**CBCS Syllabus as per NEP 2.0 for S.Y.B.Sc. Statistics
(2024 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Major Mandatory (Theory)
Course Code	: STA-251-MRM
Course Title	: Statistical Techniques
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

- 1.To introduce the fundamental concepts of hypothesis testing, including null and alternative hypotheses, types of errors, level of significance, and power of a test.
- 2.To familiarize students with the concept and role of sampling distributions in making statistical inferences.
- 3.To develop an understanding of large sample tests based on the normal distribution, and their application in real-life situations.
- 4.To equip students with the knowledge of small sample tests (t , F , and χ^2 tests) and their use in various statistical analyses.
- 5.To build problem-solving skills through the application of appropriate test procedures in different practical contexts.
- 6.To introduce the basic structure, assumptions, and performance measures of queuing models.
- 7.To enable students to apply probability and statistical concepts in analyzing and interpreting queuing situations arising in service and industrial systems.

Course Outcomes:

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

- CO1:** Explain the fundamental concepts of hypothesis testing and sampling distributions and their role in statistical inference.
- CO2.** Apply large sample tests based on the normal distribution to real-life data analysis problems.
- CO3.** Perform small sample tests such as *t-test*, *chi-square test*, and *F-test* for practical Decision-making under uncertainty.

- CO4.** Differentiate between large and small sample procedures, and select appropriate tests based on sample size and assumptions.
- CO5.** Analyze real-world problems using queuing models, understanding their structure, assumptions, and performance measures.
- CO6.** Integrate concepts from sampling distributions, hypothesis testing, and queuing models to model and solve applied problems in statistics, business, and science.
- CO7.** Interpret test results and queuing model outcomes to draw valid statistical conclusions and communicate findings effectively.

Topics and Learning Points

Unit 1: Basic concept of Testing of Hypothesis and Sampling Distributions: (6 L)

- 1.1** Parameter, random sample from a distribution as i.i.d. r.v.s. $X_1, X_2, \dots, X_n$, statistic, estimator, estimate, critical region. Statistical hypothesis, null and alternative hypothesis, one sided and two sided alternative hypothesis, p-value. Confidence interval.
- 1.2** Sampling distribution of a statistic. Distribution of sample mean $\bar{X}$ from normal, exponential and gamma distribution, Notion of standard error of a statistic.
- 1.3** Distribution of $\frac{nS^2}{\sigma^2} = \frac{1}{\sigma^2} \sum_{i=1}^n (X_i - \bar{X})^2$ for a sample from a normal distribution using orthogonal transformation. Independence $\bar{X}$ and S^2 .

Unit 2: Large Sample Tests (Tests based on Normal distribution) : (6L)

- 2.1** Z-tests for population means:
- 2.1.1** One sample and two sample tests for one-sided and two-sided alternatives
- 2.1.2** Confidence Interval for Population Mean: $100(1 - \alpha)\%$ two sided confidence interval for single population mean (μ) and difference of population means ($\mu_1 - \mu_2$) of two independent normal populations.
- 2.2** Z-tests for population proportions:
- 2.2.1** One sample and two sample tests for one-sided and two-sided alternatives
- 2.2.2** Confidence Interval for Population Proportion: $100(1 - \alpha)\%$ two sided confidence interval for single population proportion (P) and difference of population proportions ($P_1 - P_2$) of two independent normal populations.

Unit 3: Small Sample Tests (Tests based on Normal distribution) : (10L)

- 3.1.** Tests based on Chi-square distribution:
- 3.1.1** Test for independence of two attributes
- 3.1.2** Test for Goodness of Fit (Without rounding off the expected frequencies)

(Problems are not expected)

3.1.3 Test for $H_0 : \sigma^2 = \sigma_0^2$ against one-sided and two-sided alternatives when mean is known, mean is unknown.

3.2. Tests based on t-distribution: t-tests for population means:

3.2.1 One sample and two sample tests for one-sided and two-sided alternatives

3.2.2 Confidence Interval for Population Mean: $100(1 - \alpha) \%$ two sided confidence interval for single population mean (μ) and difference of population means ($\mu_1 - \mu_2$) of two independent normal populations.

3.3. Paired t-test for one-sided and two-sided alternatives.

3.4. Test based on F-distribution: Test for $H_0 : \sigma_1^2 = \sigma_2^2$ against one-sided and two-sided alternatives when means are known and means are unknown.

UNIT 4: Queuing Model:

(8L)

4.1 Introduction to queuing theory

4.2 Terms used in queuing model.

4.3 Queue, Calling Population, Service stations (Or servers), Arrival rate, departure rate, Service discipline.

4.4 M/M/1: FIFO queuing model. An application of exponential distribution, Poisson distribution and geometric distribution: Inter arrival rate (λ), service rate (μ), traffic intensity (ρ), queue discipline, probability distribution of number of customers in queue, average queue length, average waiting time in: i) queue, ii) system.

References:

1. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics.
2. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons.
3. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
4. Gupta S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
5. Parimal Mukhopadhyaya: An Introduction to the Theory of Probability. World Scientific Publishing.
6. Hogg R.V. and Criag A.T.: Introduction to Mathematical Statistics (Third edition), Macmillan Publishing, New York.
7. Introduction to Probability Models, Sheldon M. Ross.

Programme Outcomes and Course Outcomes Mapping:**CO-PO Mapping Table**

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	2	2	1	2	2	1	-	-	1	-
CO2	3	3	1	3	3	1	2	2	2	-	-	2	-
CO3	3	3	1	3	3	1	2	2	2	-	-	2	-
CO4	3	3	1	3	3	1	2	2	1	-	-	2	-
CO5	3	3	2	3	3	1	1	2	2	-	-	2	1
CO6	3	3	2	3	3	1	2	2	2	-	1	2	1
CO7	2	3	1	3	3	3	2	2	2	1	1	2	1

1=Partially Related, 2=Moderately Related, 3=Strongly Related

PO1. Comprehensive Knowledge and Understanding

- CO1, CO2, CO3, CO4, CO5, CO6 → (3) Strongly Related: These directly involve understanding foundational statistical theories (hypothesis testing, sampling distributions, queuing models).
- CO7 → (2) Moderately Related: Involves interpretation and communication, less direct theoretical depth.

PO2. Practical, Professional, and Procedural Knowledge

- CO2, CO3, CO4, CO5, CO6, CO7 → (3): Applying tests and queuing models in real-world contexts reflects procedural/statistical knowledge.
- CO1 → (2): More conceptual, less applied.

PO3. Entrepreneurial Mindset and Knowledge

- CO5, CO6 → (2): Application of queuing models and integrated problem-solving relate to operational efficiency and decision-making in business/entrepreneurial contexts.
- Others → (1): Indirect contribution.

PO4. Specialized Skills and Competencies

- CO2, CO3, CO4, CO5, CO6, CO7 → (3): Strong focus on analytical, technical, and problem-solving skills.
- CO1 → (2): Knowledge-based foundation.

PO5. Capacity for Application, Problem-Solving, and Analytical Reasoning

- **CO2, CO3, CO4, CO5, CO6** → (3): Strongly linked to solving problems and applying reasoning.
- **CO1** → (2): Provides conceptual base.
- **CO7** → (3): Interpreting results is analytical.

PO6. Communication Skills and Collaboration

- **CO7** → (3): Directly linked (interpret and communicate findings).
- **CO1–CO6** → (1): Partially related (application sometimes requires reporting).

PO7. Research-related Skills

- **CO1, CO2, CO3, CO4, CO6** → (2): Formulating tests, analyzing data is research-oriented.
- **CO7** → (2): Reporting findings aligns with research communication.
- **CO5** → (1): Queuing model application is less directly research-driven.

PO8. Learning How to Learn Skills

- **CO1–CO6** → (2): Students learn statistical inference and models, building adaptability.
- **CO7** → (2): Communication of new results supports independent learning.

PO9. Digital and Technological Skills

- **CO2, CO3, CO5, CO6, CO7** → (2): Application usually involves statistical software or ICT tools.
- **CO1, CO4** → (1): More theory-focused.

PO10. Multicultural Competence, Inclusive Spirit, and Empathy

- **CO7** → (1): Communication of results can support diverse collaboration.
- Others → (0/1): Indirect.

PO11. Value Inculcation and Environmental Awareness

- **CO6, CO7** → (1): Applying and interpreting statistical models may contribute to ethical/statistical awareness.

PO12. Autonomy, Responsibility, and Accountability

- **CO2–CO7** → (2): Applying correct tests/models requires independent responsibility.
- **CO1** → (1): Foundation knowledge helps.

PO13. Community Engagement and Service

- **CO6, CO7** → (1): Statistical applications can be used in community studies.
- Others → Indirect.

**CBCS Syllabus as per NEP 2.0 for S.Y.B.Sc. Statistics
(2024 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Major Mandatory (Theory)
Course Code	: STA-252-MRM
Course Title	: Continuous Probability Distributions – II
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. To acquaint students with the Exact Sampling Distributions and their applications.
2. To understand concept of some continuous distributions with real life situations.
3. To find various measures of random variable and probabilities using its probability distributions.
4. To know the relations among the different distributions.
5. To understand the concept of transformation of univariate continuous random variables.
6. To study derived distributions and their applications.
7. To apply testing of hypothesis in real life situations.

Course Outcomes:

Students should be able to:

- CO1.** understand Chi-Square distribution, Student's t- distribution, Snedecor's F distribution.
- CO2.** compute means, mode, variance, moments, cumulants for above Distributions.
- CO3.** apply Exact Sampling Distributions.
- CO4.** know the relations among the different distributions.
- CO5.** learn exponential and Gamma distributions and its applications.
- CO6.** learn the concept of transformation of continuous random variables which help to study derived distributions.
- CO7.** understand the interrelations among, χ^2 , t and F variates.

Topics and Learning Points

UNIT 1: Exponential Distribution

(6 L)

1.1 Probability density function (p. d. f.) $f(x) = \begin{cases} \alpha e^{-\alpha x}; & x \geq 0; \alpha > 0 \\ 0 & ; \text{ otherwise} \end{cases}$

Notation: $X \sim \text{Exp}(\alpha)$

1.2 Nature of p. d. f., density curve, interpretation of α as rate and $1/\alpha$ as mean, variance,

1.3 M.G.F., C.G.F., c.d.f., graph of c.d.f., lack of memory property, median, quartiles.

1.4 Distribution of $\min(X, Y)$ with X, Y i. i. d. exponential r. v. s.

UNIT 2: Gamma Distribution:

(6 L)

2.1 Probability density function (p. d. f.) $f(x) = \begin{cases} \frac{\alpha^\lambda}{\Gamma(\lambda)} x^{\lambda-1} e^{-\alpha x} & ; x \geq 0; \alpha > 0, \lambda > 0 \\ 0 & ; \text{ Otherwise} \end{cases}$

Notation: $X \sim G(\alpha, \lambda)$.

2.2 Nature of probability curve, special cases: i) $\alpha=1$, ii) $\lambda=1$,

2.3 M.G.F., C.G.F., moments, cumulants, $\beta_1, \beta_2, \gamma_1, \gamma_2$, mode, additive property.

2.4 Distribution of sum of n i. i. d. Gamma variates.

UNIT 3: Chi-square (χ_n^2) Distribution:

(8 L)

3.1 Definition of χ^2 r. v. as sum of squares of i.i.d. standard normal variables, derivation of p.d.f. of χ^2 with n degrees of freedom (d.f.) using M.G.F., nature of p.d.f. curve, computations of probabilities using tables of χ^2 distribution. Mean variance, M.G.F., C.G.F., central moments, $\beta_1, \beta_2, \gamma_1, \gamma_2$, mode, and additive property.

3.2 Normal approximation: $\frac{\chi_n^2 - n}{\sqrt{2n}}$ with proof.

3.3 Distribution of $\frac{X}{X+Y}$ and $\frac{X}{Y}$, where X and Y are two independent chi-square random variables.

UNIT 4: Student's t-distribution:

(5 L)

4.1 Definition of T r. v. with n d.f. in the form $\frac{U}{\sqrt{\chi_n^2/n}}$ where $U \rightarrow N(0, 1)$ and χ_n^2 is a χ^2

r. v. with n d.f. and U and χ_n^2 are independent r.v.s.

4.2 Derivation of p. d. f., nature of probability curve, mean, variance, moments, mode, use of tables of t-distribution for calculation of probabilities, statement of normal approximation.

UNIT 5: Snedecore's F-distribution:

(5 L)

5.1 Definition of F r.v. with n_1 and n_2 d.f. as $F_{n_1, n_2} = \frac{\chi_{n_1}^2/n_1}{\chi_{n_2}^2/n_2}$ where $\chi_{n_1}^2$ and $\chi_{n_2}^2$ are

independent chi-square r.v.s. with n_1 and n_2 d.f. respectively.

5.2 Derivation of p.d.f., nature of probability curve, mean, variance, moments, mode.

5.3 Distribution of $1/F_{n_1, n_2}$, use of tables of F-distribution for calculation of probabilities.

5.4 Interrelations among, χ^2 , t and F variates.

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3. Parimal Mukhopadhyaya: An Introduction to the Theory of Probability. World Scientific Publishing.
4. Hogg R.V. and Criag A.T.: Introduction to Mathematical Statistics (Third edition), Macmillan Publishing, New York.
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COs and POs Mapping

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	3	3	2	3	2	2	1	1		
CO2	3	2	1	3	3	2	3	2	3	1	1		
CO3	3	3	1	3	3	2	3	2	3	1	1		
CO4	3	2	1	3	3	2	3	2	2	1	1		
CO5	3	2	1	3	2	1	3	2	2	1	1		
CO6	3	2	1	3	3	2	3	3	3	1	1		
CO7	3	2	1	3	3	2	3	2	2	1	1		
CO8	3	2	1	3	3	2	3	2	2	1	1		
CO9	3	2	1	3	3	2	3	2	3	1	1		

PO-CO Mapping and Justification

PO1: Comprehensive Knowledge and Understanding

CO1 (3): Strongly related because understanding Chi-Square, t, and F distributions involves mastering foundational theories in statistics.

CO2 (3): Strongly related because computing means, variance, moments, and cumulants requires deep knowledge of statistical distributions.

CO3 (3): Strongly related because applying exact sampling distributions requires a solid understanding of their foundational principles.

CO4 (3): Strongly related because knowing the relations among different distributions enhances comprehensive statistical knowledge.

CO5 (3): Strongly related as learning exponential and Gamma distributions, along with their applications, is essential for deep understanding of probability theory.

CO6 (3): Strongly related because understanding the transformation of continuous random variables contributes to advanced statistical knowledge.

CO7 (3): Strongly related as understanding the interrelations among χ^2 , t, and F variates is fundamental in theoretical statistics.

PO2: Practical, Professional, and Procedural Knowledge

CO1 (2): Moderately related because Chi-Square, t, and F distributions are used in practical applications like hypothesis testing.

CO2 (2): Moderately related because computing distribution parameters has direct relevance to professional tasks in data analysis.

CO3 (3): Strongly related because applying exact sampling distributions is essential in professional and real-world data analysis.

CO4 (2): Moderately related because understanding the relationships among distributions helps in choosing appropriate methods for practical applications.

CO5 (2): Moderately related because exponential and Gamma distributions are applied in reliability analysis, which is relevant to professional work.

CO6 (2): Moderately related as transformation of variables is important for practical problem-solving in data analysis.

CO7 (2): Moderately related because understanding the interrelations among distributions aids in applying appropriate tests in professional settings.

PO3: Entrepreneurial Mindset and Knowledge

CO1 (1): Partially related as Chi-Square, t, and F distributions don't directly promote entrepreneurial thinking but help with data-driven decision making.

CO2 (1): Partially related as computing statistical measures is more technical than entrepreneurial.

CO3 (1): Partially related as applying exact sampling distributions supports data analysis but doesn't foster entrepreneurial innovation directly.

CO4 (1): Partially related because understanding distribution relationships is more technical than entrepreneurial.

CO5 (1): Partially related as knowledge of exponential and Gamma distributions helps in business decision-making but not directly entrepreneurial.

CO6 (1): Partially related because transformations enhance technical problem-solving rather than entrepreneurial mindset.

CO7 (1): Partially related as interrelations among distributions are useful for technical decision-making rather than entrepreneurial innovation.

PO4: Specialized Skills and Competencies

CO1 (3): Strongly related because understanding these distributions is a specialized skill in statistics.

CO2 (3): Strongly related because computing moments, variance, and cumulants involves advanced technical skills.

CO3 (3): Strongly related because applying exact sampling distributions is an advanced skill required for specialized data analysis.

CO4 (3): Strongly related because understanding distribution interrelations is a specialized analytical competency.

CO5 (3): Strongly related as learning exponential and Gamma distributions is key for specialized analysis in fields like actuarial science or reliability.

CO6 (3): Strongly related because mastering transformations and derived distributions is a key technical competency.

CO7 (3): Strongly related because understanding the interrelations among χ^2 , t, and F variates is crucial for advanced statistical analysis.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO1 (3): Strongly related because applying Chi-Square, t, and F distributions in hypothesis testing requires strong analytical reasoning.

CO2 (3): Strongly related because computing means, variance, and moments requires problem-solving in statistical analysis.

CO3 (3): Strongly related as applying exact sampling distributions is key in solving real-world problems using statistical methods.

CO4 (3): Strongly related because understanding distribution relationships helps solve complex statistical problems.

CO5 (2): Moderately related as exponential and Gamma distributions have practical applications in real-world problems.

CO6 (3): Strongly related because transformations of continuous random variables are critical for solving problems involving derived distributions.

CO7 (3): Strongly related as understanding interrelations among χ^2 , t, and F distributions helps in solving complex statistical problems.

PO6: Communication Skills and Collaboration

CO1 (2): Moderately related because effective communication of statistical results requires understanding distributions like Chi-Square and t.

CO2 (2): Moderately related because interpreting and communicating statistical measures requires clarity.

CO3 (2): Moderately related as applying exact sampling distributions requires collaboration in research settings.

CO4 (2): Moderately related because understanding relationships among distributions supports clear communication of statistical concepts.

CO5 (1): Partially related because exponential and Gamma distributions are more technical and less related to direct communication skills.

CO6 (2): Moderately related because understanding transformations aids in clear communication of complex results.

CO7 (2): Moderately related as explaining interrelations among distributions requires strong communication skills.

PO7: Research-related Skills

CO1 (3): Strongly related because these distributions are fundamental in statistical research and hypothesis testing.

CO2 (3): Strongly related because computing statistical parameters is crucial for research analysis.

CO3 (3): Strongly related as applying exact sampling distributions is essential in statistical research methodologies.

CO4 (3): Strongly related because understanding relationships among distributions is critical for advanced research in statistics.

CO5 (3): Strongly related as exponential and Gamma distributions are widely used in various research fields.

CO6 (3): Strongly related because transformations are key in research for deriving new distributions and models.

CO7 (3): Strongly related because understanding interrelations among χ^2 , t, and F variates is essential for advanced research.

PO8: Learning How to Learn Skills

CO1 (2): Moderately related as learning these distributions helps students adapt to new statistical challenges.

CO2 (2): Moderately related because learning to compute statistical parameters fosters adaptive learning.

CO3 (2): Moderately related because applying sampling distributions encourages continuous learning in statistics.

CO4 (2): Moderately related because learning distribution relationships fosters adaptive thinking.

CO5 (2): Moderately related as understanding exponential and Gamma distributions involves continuous learning of new applications.

CO6 (3): Strongly related because mastering transformations requires adaptive learning to new statistical methods.

CO7 (2): Moderately related because understanding interrelations encourages further exploration in statistics.

PO9: Digital and Technological Skills

CO1 (2): Moderately related as technology is often used to apply Chi-Square, t, and F distributions.

CO2 (3): Strongly related because computing statistical measures often involves using statistical software.

CO3 (3): Strongly related because applying exact sampling distributions requires technological tools for data analysis.

CO4 (2): Moderately related because understanding relationships among distributions supports using statistical software.

CO5 (2): Moderately related as exponential and Gamma distributions are often applied using technology in data analysis.

CO6 (3): Strongly related because transformations of variables often require the use of software for implementation.

CO7 (2): Moderately related because understanding distribution interrelations can be enhanced using technological tools.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO1 (1): Partially related because statistical distributions are applied universally but not directly linked to multicultural competence.

CO2 (1): Partially related because computing statistical measures does not directly enhance multicultural competence.

CO3 (1): Partially related as exact sampling distributions are technical and not closely related to multicultural contexts.

CO4 (1): Partially related because understanding distribution relationships is more technical than multicultural.

CO5 (1): Partially related as exponential and Gamma distributions are more relevant to technical fields than multicultural settings.

CO6 (1): Partially related because transformations of variables are not directly linked to multicultural competence.

CO7 (1): Partially related as understanding interrelations among distributions is more about technical skills than empathy.

PO11: Value Inculcation and Environmental Awareness

CO1 (1): Partially related because understanding statistical distributions may involve ethical considerations but not environmental awareness.

CO2 (1): Partially related because computing statistical measures does not directly relate to value inculcation.

CO3 (1): Partially related as applying sampling distributions is technical and not strongly linked to environmental awareness.

CO4 (1): Partially related because understanding distribution relationships is technical rather than ethical.

CO5 (1): Partially related as learning exponential and Gamma distributions is not closely linked to ethical or environmental concerns.

CO6 (1): Partially related because transformations of variables are not directly related to value inculcation.

CO7 (1): Partially related as understanding interrelations among distributions is more about technical.

**CBCS Syllabus as per NEP 2.0 for S.Y.B.Sc. Statistics
(2024 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Major Mandatory (Practical)
Course Code	: STA-253-MRM
Course Title	: Major Statistics Practical – II
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. To develop computational proficiency in applying statistical methods using R software for solving practical problems involving probability distributions and hypothesis testing.
2. To enable students to model and analyze data by simulating samples from continuous probability distributions such as Exponential and Gamma using R software.
3. To provide hands-on experience in fitting Exponential distribution to empirical data and evaluating goodness of fit using R software.
4. To train students in the application of quality control techniques by constructing and interpreting control charts such as $\bar{X}$ chart, R-chart, p-chart, and c-chart for process monitoring and improvement.
5. To familiarize students with parametric testing procedures including tests for means, proportions, variances, and tests based on t, F, and chi-square distributions using both manual calculations and R software.
6. To cultivate data analysis and interpretation skills through case studies that integrate various statistical tests to solve real-life problems.
7. To enhance analytical thinking and decision-making abilities by applying appropriate statistical tests for quality-related investigations.

Course Outcomes:

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

- CO1:** Apply R software to compute probabilities and visualize properties of continuous probability distributions such as Normal, Exponential, and Gamma.

- CO2:** Perform model fitting for continuous distributions (e.g., Exponential distribution) and assess the goodness of fit using statistical techniques and R software.
- CO3:** Simulate random samples from continuous probability distributions and interpret sampling variability and distributional behavior using R.
- CO4:** Construct and interpret various Statistical Process Control charts such as $\bar{X}$ -chart, R-chart, p-chart, and c-chart to monitor process stability and control.
- CO5:** Conduct hypothesis tests for means, proportions, variances, and goodness of fit using Normal, t, F, and Chi-square distributions, both manually and with R software.
- CO6:** Analyze real-life datasets through appropriate statistical tests and control chart techniques, demonstrating the ability to draw valid inferences from data.
- CO7:** Integrate computational and analytical skills through a comprehensive case study, demonstrating problem-solving ability, critical thinking, and statistical interpretation using R software.

Practical Index

Sr. No.	Title of Experiments
1	Computations of probabilities of continuous probability distributions using R Software.
2	Fitting of Exponential Distribution (Also using R Software).
3	Model sampling from continuous probability distributions using R Software.
4	Application of Exponential and Gamma distribution.
5	Construction of $\bar{X}$ Chart and R Chart.
6	Construction of p-chart.
7	Construction of c-chart.
8	Test for means based on normal distribution (Also using R Software).
9	Test for proportions based on normal distribution (Also using R Software).
10	Test based on t distributions (Also using R Software).
11	Test based on F distributions (Also using R Software).
12	Tests based on chi-square distribution (Independence of attributes and Goodness of fit test) (Also using R Software).
13	Case Study (Equivalent to 3 Practicals).

Programme Outcomes and Course Outcomes Mapping:

CO-PO Mapping Table

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	2	3	1	1	2	3	1	1	2	1
CO2	3	3	1	2	3	1	2	2	3	1	1	2	1
CO3	3	3	1	2	3	1	2	2	3	1	1	2	1
CO4	2	3	2	3	3	2	1	2	3	1	2	3	1
CO5	3	3	1	2	3	2	2	2	3	1	1	2	1
CO6	3	3	2	3	3	2	3	2	3	1	2	3	2
CO7	3	3	2	3	3	3	3	3	3	2	2	3	3

1=Partially Related, 2=Moderately Related, 3=Strongly Related

PO1: Comprehensive Knowledge and Understanding

Students demonstrate understanding of key statistical theories (distributions, hypothesis testing, SPC) and apply them through R software in all COs, especially CO1–CO3, CO5–CO7.

Strongly related (3) to all core computational and analytical outcomes.

PO2: Practical, Professional, and Procedural Knowledge

Each CO emphasizes practical data analysis, model fitting, control chart construction, and R programming — mirroring real-world statistical practice.

Strongly related (3) to all COs.

PO3: Entrepreneurial Mindset and Knowledge

Though not directly entrepreneurial, understanding data-driven decision-making (CO4, CO6, CO7) supports quality improvement and innovation in industry.

Moderately related (2) for CO4, CO6, CO7; **partially related (1)** for others.

PO4: Specialized Skills and Competencies

Learners gain analytical, computational, and problem-solving competencies through R-based applications, modeling, and quality control.

Strongly related (3) for CO4, CO6, CO7; **moderately related (2)** for others.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

All COs involve applying statistical concepts to analyze and interpret data, promoting analytical reasoning and critical thinking.

Strongly related (3) across all COs.

PO6: Communication Skills and Collaboration

Students explain findings and collaborate in lab-based tasks and group case studies.

Moderately related (2) for CO4–CO7; **partially related (1)** for CO1–CO3.

PO7: Research-related Skills

CO2, CO3, CO5, CO6, and CO7 involve designing experiments, conducting tests, and interpreting results — foundational for research.

Strongly related (3) for CO6–CO7; **moderately related (2)** for CO2–CO3–CO5.

PO8: Learning How to Learn Skills

Students use R software and statistical reasoning to self-learn, interpret results, and extend applications independently.

Moderately related (2) for most COs; **strongly related (3)** for CO7.

PO9: Digital and Technological Skills

All COs emphasize the use of **R software**, data visualization, and computational tools.

Strongly related (3) across all COs.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Although less direct, teamwork and respect for diverse viewpoints may emerge in collaborative practical and case study work.

Partially related (1) for most; **moderately related (2)** for CO7 (case study teamwork).

PO11: Value Inculcation and Environmental Awareness

Some applications (quality control, case studies) indirectly connect to responsible practice and ethical data analysis.

Partially related (1–2) for CO4, CO6, CO7.

PO12: Autonomy, Responsibility, and Accountability

Students independently perform data analysis, construct charts, and report outcomes with accuracy and accountability.

Strongly related (3) for CO4, CO6, CO7; **moderately related (2)** for others.

PO13: Community Engagement and Service

Statistical case studies and applications can address community or industrial problems, promoting societal well-being.

Strongly related (3) for CO7 (case study), **partially related (1–2)** for others.

**CBCS Syllabus as per NEP 2.0 for S.Y.B.Sc. Statistics
(2024 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Vocational Skill Course (Theory)
Course Code	: STA-254-VSC
Course Title	: Statistical Process Control
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Develop a comprehensive understanding of quality management principles and the role of Statistical Process Control (SPC) in maintaining and improving process quality.
2. Apply the concept of 3σ control limits to design and analyze control charts for both variables and attributes, ensuring effective monitoring of process performance.
3. Differentiate between chance causes and assignable causes of variation in manufacturing or service processes and understand their implications for process stability.
4. Master the techniques for constructing and interpreting control charts for variables and utilize these charts to detect process variations.
5. Gain proficiency in constructing and interpreting control charts for attributes to monitor product quality.
6. Calculate and interpret key process capability indices (e.g., C_p , C_{pk}) to evaluate the ability of a process to meet specification limits and identify areas for improvement.
7. Evaluate the stability and capability of processes through control charts and capability indices, enabling informed decisions on process improvement and quality assurance.

Course Outcomes:

Student will be able to

- CO1.** Understand the concept of quality, SPC and process control tools.
- CO2.** build the 3σ control limits for variables and attributes control charts
- CO3.** compare chance causes and assignable causes of variation
- CO4.** construct and interpret control charts for variables
- CO5.** construct and interpret control charts for attributes
- CO6.** calculate and interpret process capability indices
- CO7.** assess the stability of a process using control charts and evaluate its capability using capability indices

Topics and Learning Points**UNIT 1: Introduction to SPC****(8L)**

- 1.1** Meaning and Purpose of Statistical Process Control (SPC), Online process control methods (control charts) and offline process control methods (Sampling plans), Quality of product.
- 1.2** Seven Process Control (PC) Tools of SPC (i) Check Sheet, (ii) Cause and effect diagram (CED), (iii) Pareto Diagram, (iv) Histogram, (v) Control chart, (vi) Scatter Diagram, (vii) Design of Experiments (DOE).

UNIT – 2: Introduction to Control charts**(4L)**

- 2.1** Chance causes and assignable causes of variation, statistical basis of control charts, exact probability limits, k -sigma limits, justification for the use of 3-sigma limits
- 2.2** Criteria for detecting lack of control situations:
 - 2.2.1** At least one point outside the control limits
 - 2.2.2** A run of seven or more points above or below the central line.
 - 2.2.3** Presence of a non-random pattern eg. cyclic or linear trends etc.
 - 2.2.4** Construction of control charts for (i) standards given, (ii) standards not given.

UNIT – 3 Control Charts for Variables**(10L)**

- 3.1** R chart and $\bar{X}$ chart: Purpose of R and $\bar{X}$ chart, Equivalence between control chart and testing of hypothesis problem.
- 3.2** Construction of R chart when the process standard deviation is specified: control limits, drawing of control chart, plotting of sample ranges. Drawing conclusion -

determination of state of control process,

- 3.3 Construction of $\bar{X}$ chart when the process average is specified: control limits, drawing of control chart, plotting of sample means. Drawing conclusion - determination of state of control of process, corrective action if the process is out of statistical control.
- 3.4 Construction of R chart when the process standard deviation (σ) is not given: control limits, drawing of control chart, plotting sample range values, revision of control limits if necessary, estimate of σ for future use.
- 3.5 Construction of $\bar{X}$ chart when the process average μ is not given: Drawing of control chart, plotting sample means, revision of control limits of $\bar{X}$ chart, if necessary.

UNIT 4: Control charts for Attributes

(8L)

4.1 p – chart:

- 4.1.1 Construction of p-chart when subgroup sizes are same and the standard is known: control limits, drawing of control chart, plotting of sample fraction defectives. Determination of state of control of the process.
- 4.1.2 Construction of p-chart when subgroup sizes are different and the value of the process fraction defective P is not specified with separate control limits, drawing of control chart, plotting sample fraction defectives, determination of the state of control of the process. Interpretation of high and low spots. Identification of real-life situations.

4.2 C chart:

- 4.2.1 Construction of c-chart when the standard is given; control limits justification of 3 sigma limits, drawing of control chart, plotting number of defects per unit.
- 4.2.2 Construction of c chart when the standard is not given; control limits, explanation for the use of 3 sigma limits, drawing of control chart. Plotting number of defects per unit. Determination of state of control, interpretation of high and low spots.

Reference :

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2. Besterfield ,D.H. and Michna , C.B. et al. (2009). Total Quality Management, 3rd edition, Pearson Education, Delhi.34
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7. Brase C. H. and Brase C. P. (2018), Understandable Statistics, Twelfth Edition, Cengage Learning, Biston
8. Moor D. S., Notz W. I., Flinger M. A., (2013), The Basic Practice of Statistics Sixth Edition, Freeman and Company New York

Programme Outcomes and Course Outcomes Mapping:

CO-PO Mapping Table

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3			2				2					
CO2	2	3		3	3				2			2	
CO3	2				3		2		2	1			
CO4		3		3	3	2			2				
CO5		3		3	3	2			2				
CO6	2		2	3	3		2						
CO7	3	3	2	3	3		2	2		1	1	2	1

1=Partially Related, 2=Moderately Related, 3=Strongly Related

PO1: Comprehensive Knowledge and Understanding

CO1: 3 - Understanding quality, SPC, and process control tools provides a profound understanding of essential concepts in the field of quality management.

CO2: 2 - Building control limits require a solid understanding of statistical methodologies.

CO3: 2 - Differentiating between chance and assignable causes of variation is a key concept in SPC.

CO6: 2 - Calculating and interpreting process capability indices builds on foundational statistical knowledge.

CO7: 3 - Assessing process stability and capability requires a comprehensive understanding of SPC concepts.

PO2: Practical, Professional, and Procedural Knowledge

CO2: 3 - Building 3σ control limits is a practical skill crucial for real-world quality control tasks.

CO4: 3 - Constructing and interpreting control charts for variables directly applies

professional knowledge in process control.

CO5: 3 - Constructing and interpreting control charts for attributes is essential for practical quality management.

CO7: 3 - Assessing process stability using control charts is a core practical competency in quality management.

PO3: Entrepreneurial Mindset and Knowledge

CO6: 2 - Calculating and interpreting process capability indices can inform decisions in process improvement and innovation, aligning with an entrepreneurial mindset.

CO7: 2 - Evaluating process capability can help identify opportunities for innovation and improvement in manufacturing or business processes.

PO4: Specialized Skills and Competencies

CO1: 2 - Understanding quality and SPC tools contributes to specialized knowledge in quality management.

CO2: 3 - Building control limits is a specialized skill critical for quality professionals.

CO4: 3 - Constructing and interpreting control charts for variables is a highly specialized skill in SPC.

CO5: 3 - Constructing and interpreting control charts for attributes also represents specialized technical knowledge.

CO6: 3 - Proficiency in calculating and interpreting process capability indices is a specialized technical competency.

CO7: 3 - Assessing process stability and capability requires a high level of specialized skill in SPC.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO2: 3 - Building control charts involve strong analytical reasoning and problem-solving skills.

CO3: 3 - Comparing causes of variation requires critical thinking and the ability to solve complex quality problems.

CO4: 3 - Interpreting control charts involves significant problem-solving and application of statistical reasoning.

CO5: 3 - Similarly, interpreting control charts for attributes requires strong analytical skills.

CO6: 3 - Calculating and interpreting capability indices demands the application of analytical reasoning to assess process performance.

CO7: 3 - Evaluating process stability and capability involves complex problem-solving

skills.

PO6: Communication Skills and Collaboration

CO4: 2 - Interpreting control charts and communicating findings is essential for collaboration in quality teams.

CO5: 2 - Communicating the results of control charts for attributes is also crucial for team collaboration.

PO7: Research-related Skills

CO3: 2 - Comparing causes of variation involves observational and inquiry skills, which are essential in research.

CO6: 2 - Interpreting process capability indices often requires research-related skills, such as data collection and analysis.

CO7: 2 - Assessing stability and capability using control charts can be part of research and process improvement studies.

PO8: Learning How to Learn Skills

CO1: 2 - Understanding SPC concepts encourages lifelong learning and adaptability to new quality management techniques.

CO7: 2 - Evaluating process stability and capability encourages continuous learning and improvement.

PO9: Digital and Technological Skills

CO2: 2 - Building control limits typically involve the use of statistical software, requiring digital skills.

CO4: 2 - Constructing and interpreting control charts often requires proficiency with digital tools.

CO5: 2 - Similarly, working with control charts for attributes necessitates digital competence.

CO6: 2 - Calculating capability indices frequently involves the use of technology.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO3: 1 - Understanding variation and its causes can involve considering diverse perspectives in quality management.

PO11: Value Inculcation and Environmental Awareness

CO7: 1 - Assessing process capability and stability can include considerations of sustainability and ethical responsibility in process improvement.

PO12: Autonomy, Responsibility, and Accountability

CO2: 2 - Building control charts independently reflects autonomy and responsibility in professional tasks.

CO7: 2 - Evaluating process capability and stability requires accountability in ensuring accurate and reliable analysis.

PO13: Community Engagement and Service

CO7: 1 - Assessing and improving process capability can contribute to broader community or societal well-being by enhancing product quality and safety.

**CBCS Syllabus as per NEP 2.0 for S.Y.B.Sc. Statistics
(2024 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: S.Y.B.Sc.
Semester	: III
Course Type	: Minor (Theory)
Course Code	: STA-256-MN
Course Title	: Predictive Techniques
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. To understand the basic concepts of correlation
2. To understand the basic concepts of regression analysis.
3. To computation of correlation coefficients, Regression coefficients and their interpretation.
4. To identify real life situations where multiple regression can be used.
5. To understand the properties of regression coefficients
6. To fit the appropriate time series model that can be used in real life situations. Study of various index numbers and utilities with real life situations.
7. To develop the skills to interpret the results from time series analysis.

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

- CO1. Understand the concept of Simple regression.
- CO2. Understand the concept of multiple regression.
- CO3. Fit quadratic and exponential curves to the bivariate data to investigate relation between two variables.
- CO4. Compute the correlation coefficient for bivariate data and interpret it.
- CO5. Fit linear regression model to the bivariate data, interpretation of coefficients, And prediction of outcomes.
- CO6. Forecasting the time series variable.
- CO7. Identify and distinguish between the various components of time series data.

Topics and Learning Points**UNIT– 1 Correlation (7L)**

- 1.1. Bivariate data and concept of correlation
- 1.2. Scatter Diagram, Types of correlation: positive, negative, and zero correlation, Importance of correlation in data analysis and predictive modelling.
- 1.3. Covariance: definition and computation
- 1.4. Karl Pearson's coefficient of correlation (r): definition, computation for ungrouped and grouped data, and interpretation, Properties of correlation coefficient (without proof)
- 1.5. Spearman's rank correlation coefficient: definition, formula, computation, applications of correlation in real-world data-driven decision making.

UNIT– 2 Regression (for ungrouped data) (10L)

- 2.1 Concept of linear and nonlinear regression.
- 2.2 Illustrations, appropriate situations for regression and correlation
- 2.3 Linear regression: Fitting of both lines of regression using least square method.
- 2.4 Concept of regression coefficients.
- 2.5 Properties of regression coefficients: $b_{xy} \cdot b_{yx} = r^2$, $b_{xy} \cdot b_{yx} \leq 1$, $b_{xy} = r \frac{\sigma_x}{\sigma_y}$

$$\text{and } b_{yx} = r \frac{\sigma_y}{\sigma_x}$$

- 2.6 Nonlinear regression models: Second degree curve, exponential curves of the type $Y = ab^x$, and $Y = ax^b$
- 2.7 Numerical problems related to real life situations

UNIT– 3 Multiple Linear Regression (For Trivariate Data) (7L)

- 3.1 Concept of multiple regressions, Yule's Notations.
- 3.2 Fitting of multiple regression planes. [Derivation of equation to the plane of regression of X_1 on X_2 and X_3 is expected. Remaining two equations to be written analogously]
- 3.3 Concept of partial regression coefficients, interpretations.
- 3.4 Concept of multiple correlation: Definition of multiple correlation coefficient and its formula
- 3.5 Concept of partial correlation. Definition of partial correlation coefficient and its formula

UNIT– 4 Time Series Analysis (6L)

- 4.1 Meaning and utility
- 4.2 Components of time series

4.3 Additive and multiplicative models

4.4 Methods of estimating trend, moving average method, least squares method and exponential smoothing method (with graph and interpretation).

4.5 Numerical problems related to real life situations

References:

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2. Time Series Methods, Brockwell and Davis, Springer, 2006.
3. Time Series Analysis, 4th Edition, Box and Jenkin, Wiley, 2008.
4. Fundamentals of Applied Statistics(3rd Edition), Gupta and Kapoor, S. Chand and Sons, New Delhi, 1987.
5. Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). The World Press Pvt. Ltd., Calcutta
6. Statistical Computing Using R- Software, Vishwas R. Pawgi, Third Edition
7. Dr. Manisha Sane, (2018), ,Regression analysis, Nirali Prakashan

Programme Outcomes and Course Outcomes Mapping:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	2	3	1	3	3	2	2	2	2	1	1	2	1
CO2	2	3	1	3	3	2	2	2	2	1	1	2	1
CO3	1	2	1	2	2	1	2	1	1	1	1	1	1
CO4	2	2	1	3	3	1	2	1	1	1	1	1	1
CO5	3	3	1	3	3	2	2	2	2	1	1	2	1
CO6	1	2	1	3	3	1	2	2	2	1	1	2	1
CO7	1	2	1	2	2	1	2	1	1	1	1		

1=Partially Related, 2=Moderately Related, 3=Strongly Related

PO1: Comprehensive Knowledge and Understanding

CO1 (2): Moderately related because understanding simple regression involves foundational statistical concepts within a specific context.

CO2 (2): Moderately related as multiple regression extends understanding into more complex statistical methodologies.

CO3 (1): Partially related because fitting curves is specific to statistical modeling and not broadly multidisciplinary.

CO4 (2): Moderately related as correlation coefficient interpretation requires foundational statistical knowledge.

CO5 (3): Strongly related because interpreting regression coefficients deepens understanding of statistical principles.

CO6 (1): Partially related because time series forecasting is a specialized area within statistics.

CO7 (1): Partially related as time series components are specific to statistical analysis.

PO2: Practical, Professional, and Procedural Knowledge

CO1 (3): Strongly related because understanding regression is essential for practical statistical analysis.

CO2 (3): Strongly related because multiple regressions is crucial in professional data analysis scenarios.

CO3 (2): Moderately related as curve fitting contributes to practical applications in data analysis.

CO4 (2): Moderately related as correlation analysis informs decision-making in various professional contexts.

CO5 (3): Strongly related because applying regression models is practical in professional data-driven environments.

CO6 (2): Moderately related as time series forecasting requires practical application of statistical knowledge.

CO7 (2): Moderately related because understanding time series components aids in procedural data analysis.

PO3: Entrepreneurial Mindset and Knowledge

CO1 (1): Partially related as regression concepts may inform decision-making but are not central to entrepreneurship.

CO2 (1): Partially related because multiple regression may be used in business analytics but does not define entrepreneurial mindset.

CO3 (1): Partially related because curve fitting is less directly relevant to entrepreneurial activities.

CO4 (1): Partially related as correlation coefficients may inform risk assessment but are not exclusive to entrepreneurship.

CO5 (1): Partially related as regression for prediction can be used in entrepreneurial planning but is not definitive of an entrepreneurial mindset.

CO6 (1): Partially related because time series forecasting may support business planning but is not core to entrepreneurial mindset.

CO7 (1): Partially related because time series analysis is applied in business contexts but does not define entrepreneurial thinking.

PO4: Specialized Skills and Competencies

CO1 (3): Strongly related because understanding regression is a specialized statistical competency.

CO2 (3): Strongly related because multiple regression skills are specialized in statistical analysis.

CO3 (2): Moderately related as curve fitting requires specialized statistical modeling skills.

CO4 (3): Strongly related because computing and interpreting correlation coefficients are specialized skills.

CO5 (3): Strongly related because regression interpretation and prediction are specialized technical skills.

CO6 (2): Moderately related as time series forecasting involves specialized analytical skills.

CO7 (2): Moderately related because identifying time series components is a specialized skill in data analysis.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO1 (3): Strongly related because applying regression models requires analytical reasoning and problem-solving skills.

CO2 (3): Strongly related because interpreting regression outputs involves applied analytical reasoning.

CO3 (2): Moderately related because curve fitting requires problem-solving in statistical modeling.

CO4 (3): Strongly related because interpreting correlation coefficients involves analytical reasoning.

CO5 (3): Strongly related because applying regression for prediction demands problem-solving and analytical reasoning.

CO6 (3): Strongly related because time series forecasting requires advanced analytical reasoning and problem-solving.

CO7 (2): Moderately related because understanding time series components enhances analytical reasoning in data analysis.

PO6: Communication Skills and Collaboration

CO1 (2): Moderately related because effective communication of regression results requires clarity.

CO2 (2): Moderately related as communicating multiple regression findings demands clarity and accuracy.

CO3 (1): Partially related as curve fitting communication may require less extensive communication skills.

CO4 (1): Partially related because correlation coefficient communication may not always involve complex communication.

CO5 (2): Moderately related because communicating regression predictions requires effective communication skills.

CO6 (1): Partially related because time series forecasting communication may not always be complex.

CO7 (1): Partially related as time series components communication may not require extensive collaboration.

PO7: Research-related Skills

CO1 (2): Moderately related because research may involve regression analysis.

CO2 (2): Moderately related because research often uses regression techniques for data analysis.

CO3 (2): Moderately related because research may involve curve fitting in data analysis.

CO4 (2): Moderately related as research often includes correlation analysis.

CO5 (2): Moderately related because research may require regression for data interpretation.

CO6 (2): Moderately related because research often uses time series forecasting for analysis.

CO7 (2): Moderately related as research includes identifying time series components.

PO8: Learning How to Learn Skills

CO1 (2): Moderately related because learning regression involves adaptive learning and skill development.

CO2 (2): Moderately related because continuous learning in regression techniques fosters skill development.

CO3 (1): Partially related because learning curve fitting is specific to statistical learning.

CO4 (1): Partially related as learning correlation coefficients is specific to statistical learning outcomes.

CO5 (2): Moderately related because learning regression with prediction enhances adaptive learning.

CO6 (2): Moderately related because learning time series forecasting requires adaptive learning skills.

CO7 (1): Partially related because learning time series components is specific to statistical learning.

PO9: Digital and Technological Skills

CO1 (2): Moderately related because digital tools are used in regression analysis.

CO2 (2): Moderately related because digital tools are integral in multiple regression analysis.

CO3 (1): Partially related as curve fitting may require specific digital tools.

CO4 (1): Partially related as digital tools are used in correlation coefficient calculations.

CO5 (2): Moderately related because R software is commonly used for regression and prediction.

CO6 (2): Moderately related because digital tools support time series forecasting.

CO7 (1): Partially related as digital tools may support identification of time series components.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO1 (1): Partially related because regression analysis may include diverse datasets.

CO2 (1): Partially related as multiple regression may analyze data from diverse perspectives.

CO3 (1): Partially related because curve fitting may involve data from diverse contexts.

CO4 (1): Partially related as correlation analysis may consider diverse datasets.

CO5 (1): Partially related because regression prediction may impact decisions with diverse impacts.

CO6 (1): Partially related because forecasting outcomes may involve diverse stakeholders.

CO7 (1): Partially related as time series components may impact diverse groups differently.

PO11: Value Inculcation and Environmental Awareness

CO1 (1): Partially related because statistical analysis may include environmental data considerations.

CO2 (1): Partially related because statistical analysis can inform decisions impacting ethical considerations.

CO3 (1): Partially related as curve fitting may involve ethical considerations in data use.

CO4 (1): Partially related because correlation analysis may include ethical implications in decision-making.

CO5 (1): Partially related as regression prediction may impact ethical decision-making.

CO6 (1): Partially related because time series forecasting may consider ethical implications.

CO7 (1): Partially related because time series components may involve ethical considerations.

PO12: Autonomy, Responsibility, and Accountability

CO1 (2): Moderately related because autonomy in learning regression requires responsibility.

CO2 (2): Moderately related because using regression models involves accountable decision-making.

CO3 (1): Partially related as learning curve fitting may not directly enhance autonomy.

CO4 (1): Partially related because understanding correlation coefficients may not directly enhance accountability.

CO5 (2): Moderately related because using regression for decision-making requires responsibility.

CO6 (2): Moderately related because time series forecasting demands accountable decision-making.

CO7 (1): Partially related as understanding time series components may not enhance accountability directly.

PO13: Community Engagement and Service

CO1 (1): Partially related as statistical analysis may inform community-related data.

CO2 (1): Partially related because community service may benefit from multiple regression insights.

CO3 (1): Partially related because curve fitting may not directly influence community engagement.

CO4 (1): Partially related as correlation analysis may inform community-based decisions.

**CBCS Syllabus as per NEP 2.0 for S.Y.B.Sc. Statistics
(2024 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Minor (Practical)
Course Code	: STA-257-MN
Course Title	: Practical on Predictive Techniques
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. To understand the concepts of correlation and regression analysis and apply them to bivariate data for identifying relationships between variables.
2. To develop skills in visualizing and interpreting linear relationships using scatter plots in Excel.
3. To gain proficiency in fitting and evaluating linear, quadratic, and non-linear models
4. To learn and implement simple and multiple linear regression models using Excel and R software for predictive analysis.
5. To compute and interpret multiple and partial correlation coefficients for assessing the strength of relationships among several variables.
6. To acquire knowledge of time series analysis by estimating trend components using moving averages, AR(1) models, and exponential smoothing methods.
7. To apply the above statistical techniques in real-world case studies, thereby enhancing analytical and problem-solving skills for practical decision-making.

Course Outcomes:

Students should be able to

CO1: calculate and interpret correlation and regression coefficients for bivariate data.

CO2: construct and interpret scatter plots in Excel to explain linear relationships

between variables.

CO3. fit and analyze linear, quadratic, exponential, and power-type regression models to data.

CO4. implement simple and multiple regression models using Excel and R software for prediction and analysis.

CO5. Compute multiple and partial correlation coefficients and interpret their practical significance.

CO6. Students will be able to apply time series techniques such as moving averages, AR(1) models, and exponential smoothing for estimation and forecasting.

CO7. Students will be able to analyze case studies using statistical techniques and provide data- driven insights for real-world applications.

Practical Index

Sr. No.	Title of Experiments	No. of Practical
1	Correlation and Regression Analysis (for bivariate raw data)	1
2	Correlation and regression (use of scatter plot for explaining the linear Relationship between two variables) (using Excel)	1
3	Correlation and regression (use of scatter plot for explaining the linear Relationship between two variables) (using R-Software)	1
4	Fitting of second degree curve, exponential curve of type $y = ab^x$, $y = ax^b$ (using Excel)	1
5	Fitting of the Simple linear regression model (using R-Software)	1
6	Fitting of Multiple Regression Plane and Computation of Multiple and Partial Correlation Coefficients. (using Excel)	1
7	Fitting of Multiple Regression Plane and Computation of Multiple and Partial Correlation Coefficients. (using R-Software)	1
8	Time Series- Estimation of trend by using the method of moving averages.	1
9	Time series: Estimation and forecasting of trend by fitting of AR (1) model, exponential smoothing.	1
10	Index Number	2
11	Case Study	(4 Practical)

Programme Outcomes and Course Outcomes Mapping:

CO-PO Mapping Table

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	3	3	2	3	2	2	1	1	2	
CO2	1	2	1	2	2	1	2	2	3	1	1	2	
CO3	2	3	1	3	3	3	3	3	3	1	1	2	
CO4	1	2	1	2	2	2	2	2	2	1	1	2	
CO5	1	2	1	2	2	2	2	2	2	1	1		
CO6	3	3	1	3	3	3	3	3	2	1	1		
CO7	2	3	1	3	3	3	3	2	2	1	1		

1=Partially Related, 2=Moderately Related, 3=Strongly Related

Justification for Mapping PO and CO

PO1: Comprehensive Knowledge and Understanding

CO1 (3): Strongly related because computing and interpreting correlation and regression coefficients require deep understanding of statistical theories and methodologies.

CO2 (1): Partially related as basic mechanics of R software are more procedural and less theoretical.

CO3 (2): Moderately related because proficiency in R for data analysis enhances understanding of methodologies within a specific context.

CO4 (1): Partially related because creating charts and graphs, while part of data analysis, is more about practical application than deep understanding.

CO5 (1): Partially related as writing basic R code is procedural rather than foundational knowledge.

CO6 (3): Strongly related because computing descriptive statistics involves foundational statistical concepts.

CO7 (2): Moderately related because creating reports and presentations involves both technical skills and theoretical understanding.

PO2: Practical, Professional, and Procedural Knowledge

CO1 (3): Strongly related because practical knowledge of computing correlation and regression coefficients is essential in professional data analysis.

CO2 (2): Moderately related because basic R software navigation is procedural knowledge useful in practical scenarios.

CO3 (3): Strongly related because proficiency in R for data analysis is directly applicable in professional tasks.

CO4 (2): Moderately related because creating clear charts and graphs supports effective communication in professional settings.

CO5 (2): Moderately related because writing basic R code is a practical skill needed in professional data analysis.

CO6 (3): Strongly related because applying descriptive statistics is crucial in practical data analysis tasks.

CO7 (3): Strongly related because creating reports and presentations summarizes professional data analysis findings.

PO3: Entrepreneurial Mindset and Knowledge

CO1 (1): Partially related because understanding correlation and regression is more about analytical skills than entrepreneurial mindset.

CO2 (1): Partially related because basic R software skills are more procedural than entrepreneurial.

CO3 (1): Partially related as R programming proficiency is more technical than fostering an entrepreneurial mindset.

CO4 (1): Partially related as chart creation is practical rather than fostering entrepreneurial skills.

CO5 (1): Partially related as writing basic R code is procedural rather than fostering entrepreneurial mindset.

CO6 (1): Partially related because descriptive statistics are analytical rather than entrepreneurial.

CO7 (1): Partially related because report creation is more about technical communication than entrepreneurial mindset.

PO4: Specialized Skills and Competencies

CO1 (3): Strongly related because proficiency in computing correlation and regression coefficients is a specialized statistical competency.

CO2 (2): Moderately related as basic R software navigation supports technical skills but is not as specialized as statistical competency.

CO3 (3): Strongly related because R programming proficiency is a specialized skill in data analysis.

CO4 (2): Moderately related because creating charts and graphs is a specialized skill in data presentation.

CO5 (2): Moderately related because writing basic R code is a specialized skill in data manipulation and analysis.

CO6 (3): Strongly related because applying descriptive statistics is a specialized analytical competency.

CO7 (3): Strongly related because creating reports and presentations is a specialized skill in communicating data analysis findings.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO1 (3): Strongly related because applying correlation and regression involves problem-solving and analytical reasoning.

CO2 (2): Moderately related because basic R software navigation supports applied data analysis.

CO3 (3): Strongly related because using R for data analysis requires problem-solving and analytical reasoning.

CO4 (2): Moderately related because creating charts and graphs supports effective problem-solving in data communication.

CO5 (2): Moderately related because writing basic R code involves applying analytical reasoning in data manipulation.

CO6 (3): Strongly related because applying descriptive statistics requires analytical reasoning and problem-solving skills.

CO7 (3): Strongly related because creating reports and presentations summarizes analytical findings requiring problem-solving.

PO6: Communication Skills and Collaboration

CO1 (2): Moderately related because communicating correlation and regression results requires clear communication.

CO2 (1): Partially related as basic R software navigation does not directly enhance communication skills.

CO3 (2): Moderately related because using R involves communicating findings through visualizations and reports.

CO4 (2): Moderately related because creating charts and graphs supports effective communication of complex information.

CO5 (1): Partially related because writing basic R code focuses more on technical skills than communication.

CO6 (2): Moderately related because descriptive statistics communication requires clear presentation of results.

CO7 (3): Strongly related because creating reports and presentations demonstrates communication skills.

PO7: Research-related Skills

CO1 (3): Strongly related because research often involves using correlation and regression for data analysis.

CO2 (2): Moderately related because R software navigation supports research-related data analysis.

CO3 (3): Strongly related because R programming skills are crucial in research for data manipulation and analysis.

CO4 (2): Moderately related because creating charts and graphs aids in visualizing research findings.

CO5 (2): Moderately related because writing basic R code is necessary for implementing research methodologies.

CO6 (3): Strongly related because descriptive statistics are fundamental in summarizing research data.

CO7 (3): Strongly related because creating reports and presentations is essential in research for communicating findings.

PO8: Learning How to Learn Skills

CO1 (2): Moderately related because learning correlation and regression involves adaptive learning and skill development.

CO2 (2): Moderately related because learning R software navigation requires self-directed learning.

CO3 (3): Strongly related because learning R programming involves significant self-directed learning and adaptation.

CO4 (2): Moderately related because learning to create charts and graphs involves adapting to data presentation needs.

CO5 (2): Moderately related because learning basic R code requires self-directed learning and adaptation.

CO6 (3): Strongly related because learning descriptive statistics involves adapting to different data sets and analysis methods.

CO7 (2): Moderately related because learning to create reports and presentations involves adapting to communication needs.

PO9: Digital and Technological Skills

CO1 (2): Moderately related because digital tools are used in computing correlation and regression.

CO2 (3): Strongly related because R software navigation is a fundamental digital skill in data analysis.

CO3 (3): Strongly related because proficiency in R programming enhances digital skills in data manipulation and analysis.

CO4 (2): Moderately related because creating charts and graphs develops digital skills in data presentation.

CO5 (2): Moderately related because writing basic R code develops digital skills in data manipulation.

CO6 (2): Moderately related because applying descriptive statistics involves digital skills in data analysis.

CO7 (2): Moderately related because creating reports and presentations develops digital skills in data communication.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO1 (1): Partially related because statistical analysis may involve data from diverse contexts.

CO2 (1): Partially related because R software navigation does not specifically address multicultural competence.

CO3 (1): Partially related because R programming proficiency does not directly enhance multicultural competence.

CO4 (1): Partially related because creating charts and graphs does not directly involve multicultural competence.

CO5 (1): Partially related because writing basic R code is procedural and does not enhance multicultural competence.

CO6 (1): Partially related because descriptive statistics focus on analytical skills rather than multicultural competence.

CO7 (1): Partially related because creating reports and presentations primarily involves technical communication.

PO11: Value Inculcation and Environmental Awareness

CO1 (1): Partially related because statistical analysis may consider ethical implications.

CO2 (1): Partially related because R software navigation does not directly address value inculcation or environmental awareness.

CO3 (1): Partially related because R programming proficiency does not directly enhance value inculcation or environmental awareness.

CO4 (1): Partially related because creating charts and graphs does not directly involve ethical considerations.

CO5 (1): Partially related because writing basic R code does not directly involve ethical considerations.

CO6 (1): Partially related because descriptive statistics focus on analytical skills rather than ethical considerations.

CO7 (1): Partially related because creating reports and presentations primarily involves technical communication.

PO12: Autonomy, Responsibility, and Accountability

CO1 (2): Moderately related because applying correlation and regression requires accountable decision-making.

CO2 (2): Moderately related because navigating R software requires responsible use of data analysis tools.

CO3 (2): Moderately related because using R programming involves responsible data handling.

CO4 (2): Moderately related because creating charts and graphs involves accountable presentation of data.

PO13: Community Engagement and Service

Not directly related to any specific COs.

**CBCS Syllabus as per NEP 2.0 for S.Y.B.Sc. Statistics
(2024 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Open Elective (Practical)
Course Code	: STA-258-OE
Course Title	: Practical Based on Applied Statistical Techniques
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. To understand and compute various measures of dispersion and their significance in data analysis
2. To learn and apply Karl Pearson's coefficient of correlation to study the relationship between two variables.
3. To develop the ability to interpret correlation results in real-life situations and practical datasets.
4. To understand the concept of regression and its application in modelling relationships between variables.
5. To understand the concept and application of simple and multiple regression analysis for prediction
6. To learn to apply time series techniques for analyzing and forecasting real-world data.
7. To develop skills to use statistical tools and software for performing statistical computations.

Course Outcomes:

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

- CO1.** describe and distinguish various measures of dispersion.
- CO2.** compute and interpret measures of dispersion for different types of data.
- CO3.** understand the concept of correlation and determine the strength of relationships between variables.
- CO4.** calculate and interpret Karl Pearson's correlation coefficient.
- CO5.** apply correlation analysis to real-life datasets and draw meaningful conclusions.

CO6. fit simple and multiple regression models and interpret regression coefficients.

CO7. identify and analyze the components of time series data.

CO8. understand the concept, need, and importance of index numbers in economic and business analysis.

Practical Index:

Sr. No.	Title of Experiment	No. of Practical
1.	Preliminaries of measures of dispersion	1
2.	Measures of Dispersion	1
3.	Preliminaries of Karl Pearson's Correlation Coefficient	1
4.	Correlation	1
5.	Preliminaries of Regression Analysis	1
6.	Regression Analysis	1
7.	Preliminaries of Time Series	1
8.	Time Series	1
9.	Preliminaries of Index Number	1
10.	Index Number	1
11.	Case Study	3

Programme Outcomes and Course Outcomes Mapping

Course Outcomes (COs)	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	2	2	1	1	2	2	1	1	2	1
CO2	3	3	1	2	3	1	1	2	3	1	1	2	1
CO3	3	2	1	2	3	2	1	2	2	1	1	2	1
CO4	3	3	1	3	3	2	1	2	3	1	1	2	1
CO5	3	3	2	3	3	3	2	3	3	1	2	3	2
CO6	3	3	2	3	3	3	2	3	3	1	1	3	2
CO7	3	3	2	3	3	3	2	3	3	1	1	3	2
CO8	3	3	2	3	3	2	2	3	3	1	2	3	2

1=Partially Related, 2=Moderately Related, 3=Strongly Related

PO1 – Comprehensive Knowledge and Understanding

Strongly related (3) to all COs

Justification: students gain foundational understanding of dispersion, correlation, regression, time series, and index numbers — core areas of applied statistics.

PO2 – Practical, Professional, and Procedural Knowledge

Strongly related (3) to CO2, CO4–CO8

Justification: students apply statistical techniques and software tools to real-world datasets, reflecting procedural and professional competence.

PO3 – Entrepreneurial Mindset and Knowledge

Moderately related (2) to CO5–CO8

Justification: since understanding and analyzing business data (e.g., index numbers, time series) nurtures data-driven decision-making useful in entrepreneurship and market analysis.

PO4 – Specialized Skills and Competencies

Strongly related (3) to CO4–CO8

Justification: students develop analytical reasoning, interpretation, and technical competence in data analysis and forecasting.

PO5 – Capacity for Application, Problem-Solving, and Analytical Reasoning

Strongly related (3) to CO2–CO8

Justification: these involve data interpretation, model fitting, and analytical thinking to solve real-world problems.

PO6 – Communication Skills and Collaboration

Moderately related (2) to CO5–CO8

Justification: since students must communicate analytical findings and collaborate during practical work or group projects.

PO7 – Research-related Skills

Moderately related (2) to CO5–CO8

Justification: students use statistical methods relevant to data collection, analysis, and interpretation in applied research.

PO8 – Learning How to Learn Skills

Strongly related (3) to CO5–CO8

Justification: learners must continuously adapt and use new statistical techniques, software, and analytical methods.

PO9 – Digital and Technological Skills

Strongly related (3) to CO2, CO4–CO8

Justification: since the course emphasizes computation using statistical software (Excel, R, SPSS) for correlation, regression, and time series analysis.

PO10 – Multicultural Competence, Inclusive Spirit, and Empathy

Partially related (1)

Justification: since teamwork and data interpretation from social or demographic datasets promote appreciation of diversity.

PO11 – Value Inculcation and Environmental Awareness

Partially related (1–2) where case studies and index number analyses may involve economic and environmental datasets, fostering responsible data interpretation.

PO12 – Autonomy, Responsibility, and Accountability

Moderately to strongly related (2–3)

Justification: students conduct independent data analysis, manage practical assignments, and ensure accuracy and integrity in results.

PO13 – Community Engagement and Service

Moderately related (2) to CO5–CO8

Justification: applied data analysis (e.g., on social, economic, or health datasets) supports informed community and societal decisions.

**CBCS Syllabus as per NEP 2.0 for S.Y.B.Sc. Statistics
(2024 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Skill Enhancement Course (SEC) (Practical)
Course Code	: STA-259-SEC
Course Title	: Introduction to Tableau and Power BI
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. The main focus of Tableau and Power BI software is for better understand datasets.
2. To introduce students to the fundamentals of data visualization and the role of Tableau in business intelligence.
3. To equip students with the skills to connect Tableau to various data sources and prepare data for analysis.
4. To develop students' ability to create and customize basic and advanced visualizations using Tableau.
5. To teach students how to design interactive dashboards in Tableau using filters, actions, and parameters.
6. To provide an understanding of Power BI as a modern data visualization tool and its integration with diverse data sources.
7. To enable students to perform data transformation tasks in Power BI using Power Query Editor.
8. To guide students in building interactive dashboards and reports in Power BI, following best design practices.

Course Outcomes:

At the end of this course, students will be able to

- CO 1.** explain the key concepts and interface elements of Tableau and understand its role in business intelligence.
- CO 2.** connect to and prepare data from various sources in Tableau for analysis and visualization.

- CO 3.** create, customize, and interpret basic and advanced visualizations in Tableau, including the use of calculations and parameters.
- CO 4.** design and build interactive dashboards in Tableau that integrate multiple visualizations with interactivity.
- CO 5.** describe the capabilities of Power BI and connect it to different data sources using Import and Direct Query modes.
- CO 6.** apply data cleaning and transformation techniques in Power BI using Power Query Editor.
- CO 7.** construct interactive and well-structured dashboards in Power BI using visualizations, slicers, themes, and best practices.
- CO 8.** interactive visualizations and dashboards in Tableau and Power BI.

Topics and Learning Points

Unit 1. Introduction to Tableau:

(10 L)

1.1 Introduction to Tableau

Overview of Tableau and its role in data visualization and business intelligence, understanding the Tableau interface and key components, basic concepts: Dimensions, Measures, and Data Types.

1.2 Connecting to Data Sources

Introduction to data connections in Tableau, Importing data from Excel, CSV, databases, and other sources, working with live connections vs. data extracts, Preparing and cleaning data within Tableau.

1.3 Creating Basic Visualizations

Introduction to Tableau visualizations (Bar charts, Line charts, Pie charts, etc.), using the Show Me panel to create visualizations, understanding continuous vs. discrete fields, customizing visualizations: colors, labels, tooltips.

1.4 Advanced Visualizations and Calculations

Creating advanced charts: Maps, Scatter plots, Histograms, and Gantt charts, introduction to calculated fields and basic calculations, using Tableau's in-built functions for data manipulation, creating and using parameters in visualizations.

1.5 Building Interactive Dashboards

Introduction to dashboards in Tableau, Combining multiple visualizations into a single dashboard, Adding interactivity with filters, actions, and parameters, Best practices for dashboard design and layout.

Unit 2. Introduction to Power BI:**(20 L)****2.1.Connecting to Data Sources**

Introduction to data sources supported by Power BI, Importing data from Excel, CSV, and other common formats, Connecting to databases (SQL Server, Azure, etc.), Direct Query vs. Import Mode.

2.2.Data Transformation with Power Query

Introduction to Power Query Editor, Data cleaning and shaping, Transformations: filtering, merging, appending, and grouping data. Creating calculated columns and measures.

2.3.Data Modeling

Understanding data modeling concepts, Creating relationships between tables, Understanding DAX (Data Analysis Expressions) basics, Building calculated columns, measures, and tables.

2.4.Creating Visualizations

Introduction to Power BI visuals (charts, tables, maps, etc.), Customizing, visualizations (formatting, filtering, sorting), Creating slicers and filters, Using visual interaction features.

2.5.Building Interactive Dashboards

Designing effective dashboards, combining multiple visualizations in a single report, Using themes and layouts for dashboards, Best practices for dashboard design.

Sr. No.	Title of the Practical
1.	Exploring the Tableau Interface
2.	Connecting to Data Sources Using Tableau
3.	Creating Basic Visualizations Using Tableau
4.	Advanced Visualizations and Calculations Using Tableau
5.	Building an Interactive Dashboard Using Tableau
6.	Exploring the Power BI Interface
7.	Connecting to Data Sources Using Power BI
8.	Data Transformation with Power Query
9.	Data Modelling and Relationships Using Power BI
10.	Creating Visualizations Using Power BI
11.	Building a Dashboard Using Power BI
12.	Case Study

Programme Outcomes and Course Outcomes Mapping:

1=Partially Related, 2=Moderately Related, 3=Strongly Related

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	2	2	1	1	2	3	1	1	2	1
CO2	3	3	1	2	3	1	1	2	3	1	1	2	1
CO3	3	3	1	3	3	2	1	2	3	1	1	3	1
CO4	2	3	1	3	3	2	1	2	3	1	1	3	1
CO5	3	3	1	2	3	1	1	2	3	1	1	2	1
CO6	2	3	1	3	3	2	1	2	3	1	1	3	1
CO7	2	3	1	3	3	2	1	2	3	1	1	3	1

PO1: Comprehensive Knowledge and Understanding – Strongly Related (3)

All COs (CO1–CO8) require solid understanding of data visualization principles, business intelligence, and software functionalities. These tools are built on foundational data concepts, fitting well under PO1.

PO2: Practical, Professional, and Procedural Knowledge – Strongly Related (3)

CO2–CO8 emphasize hands-on skills with Tableau and Power BI. Learners apply industry-relevant tools in real-world-like scenarios, aligning with practical application and procedural knowledge.

PO3: Entrepreneurial Mindset – Partially Related (1)

Although this course doesn't directly teach entrepreneurship, data visualization is a critical skill for startups and innovators to present and analyze business data. Hence, a minimal mapping.

PO4: Specialized Skills and Competencies – Strong to Moderate Relation (2–3)

CO3–CO8 involve complex technical skills like creating dashboards, using calculated fields, and applying parameters. These are specialized data competencies, making the mapping strong.

PO5: Application, Problem-Solving, and Analytical Reasoning – Strongly Related (3)

CO2–CO8 deal with analyzing data, interpreting trends, and building analytical dashboards, directly supporting PO5. Critical thinking is used for visualization design and data insight extraction.

PO6: Communication and Collaboration – Moderately Related (1–2)

While direct collaboration isn't a focus, communicating insights visually is a key objective. Visualizations serve as data storytelling tools, fostering clearer communication.

PO7: Research Skills – Partially Related (1)

Basic research skills apply to data sourcing, cleaning, and preparing, especially in CO2 and

CO6. However, deep research methodology isn't a central component, so mapping is limited.

PO8: Learning to Learn – Moderately Related (2)

Students learn two platforms—self-learning and adaptability are necessary. Course encourages independent exploration and adaptation to new tools or updates.

PO9: Digital and Technological Skills – Strongly Related (3)

Every CO directly involves digital platforms (Tableau, Power BI) and data software tools. Learners demonstrate high ICT and software proficiency.

PO10: Multicultural Competence and Empathy – Partially Related (1)

Limited direct connection. Possible in the context of designing inclusive and audience-friendly dashboards.

PO11: Ethical Values and Environmental Awareness – Partially Related (1)

Ethical considerations may be briefly addressed in the context of data privacy or responsible data usage.

PO12: Autonomy and Responsibility – Moderately to Strongly Related (2–3)

Students independently handle projects, build dashboards, and make visualization decisions. Critical for self-driven work in analytics contexts.

PO13: Community Engagement – Partially Related (1)

Dashboards and visualizations may be used in community-driven initiatives, but this is not a core part of the course.