



Anekant Education Society's

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

**Four Year B.Sc. Degree Program in Statistics
(Faculty of Science & Technology)**

CBCS Syllabus

F.Y.B.Sc. (Statistics) Semester -II

For Department of Statistics

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2023-2024

**Anekant Education Society's
Tuljaram Chaturchand College, Baramati**

(*Autonomous*)

Board of Studies (BOS) in Statistics

From 2022-23 to 2024-25

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17.	Ms. Ankita G. Deshmukh	Invitee Member

18.	Ms. Shital B. Choudhar	Invitee Member
19.	Ms. Tejashri D. Kawade	Invitee Member
20.	Mr. Shree Sunil Girange (M.Sc. II)	Student Representative
21.	Miss. Sakshi Rajendra Borole (M.Sc. II)	Student Representative
22.	Mr. Siddhi Rajendra Pathak (TYBSc)	Student Representative
23.	Miss. Nikam Shweta Yuvraj (TYBSc)	Student Representative

Program Outcomes (POs) for B.Sc Programme

PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	Social competence: Display the understanding, behavioural skills needed for successful social adaptation , work in groups, exhibit thoughts and ideas effectively in writing and orally
PO4	Research-related skills and Scientific temper : Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	Trans-disciplinary knowledge: Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem
PO6	Personal and professional competence: Performing dependently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Credit Distribution Structure for F.Y.B.Sc.-2023-2024 (Statistics)

Level	Semester	Major		Minor	GE/OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum. Cr./ Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
4.5	I	STA-101-MJM: Descriptive Statistics – I STA-102-MJM: Discrete Probability and Probability Distributions – I STA-103-MJM: Statistics Practical – I Credits-2+2+2	--	--	STA-116-OE: Commercial Statistics STA-117-OE: Introduction to MS-Excel and Statistical Computing Credit- 2+2	STA-121-VSC: Introduction to R Programming Language STA-126-SEC: Statistical Computing Using MS-Excel Credit- 2+2	ENG-131-AEC: Functional English-I STA-137-IKS: Evaluation of Science and Statistics in India EVS-135-VEC: Environmental Science Credit- 2+2+2	CC1: To be selected from the Basket Credit- 2	22	UG Certificate 44
	II	STA-151-MJM: Descriptive Statistics – II STA-152-MJM: Discrete Probability and Probability Distributions – II STA -153-MJM: Statistics Practical – II Credits-2+2+2	--	STA-161-MN: Basic Statistics Credits-2	STA-166-OE: Business Statistics STA-167-OE: Statistics Learning with Software Credit- 2+2	STA-171-VSC: - Data Analysis with R Software STA-176-SEC: Application of Statistics Using Advanced Excel Credit- 2+2	ENG-181-AEC: Functional English-II COS-185-VEC: Digital and Technological Solutions Credit- 2+2	CC2: To be selected from the Basket Credit- 2	22	
	Cum Cr.	12	--	2	8	8	10	4	44	

Course Structure for F.Y.B.SC. Statistics (2023 Pattern)

Sem	Course Type	Course Code	Course Name	Theory / Practical	Credits
I	Major Mandatory	STA-101-MJM	Descriptive Statistics – I	Theory	02
	Major Mandatory	STA-102-MJM	Discrete Probability and Probability Distributions – I	Theory	02
	Major Mandatory	STA-103-MJM	Statistics Practical – I	Practical	02
	Open Elective (OE)	STA-116-OE	Commercial Statistics	Theory	02
	Open Elective (OE)	STA-117-OE	Introduction to MS-Excel and Statistical Computing	Practical	02
	Vocational Skill Course (VSC)	STA-121-VSC	Introduction to R Programming Language	Theory	02
	Skill Enhancement Course (SEC)	STA-126-SEC	Statistical Computing Using MS-Excel	Practical	02
	Ability Enhancement Course (AEC)	ENG-131-AEC	Functional English-I	Theory	02
	Value Education Course (VEC)	ENV-135-VEC	Environmental Science	Theory	02
	Indian Knowledge System (IKS)	STA-137-IKS	Evolution of Science and Statistics in India	Theory	02
	Co-curricular Course (CC)	--	To be selected from the Basket	Theory	02
Total Credits Semester-I					22
II	Major Mandatory	STA-151-MJM	Descriptive Statistics – II	Theory	02
	Major Mandatory	STA-152-MJM	Discrete Probability and Probability Distributions – II	Theory	02
	Major Mandatory	STA-153-MJM	Statistics Practical – II	Practical	02
	Minor	STA-161-MN	Fundamental of Statistics	Theory	02
	Open Elective (OE)	STA-166-OE	Business Statistics	Theory	02
	Open Elective (OE)	STA-167-OE	Statistics Learning with Software	Practical	02
	Vocational Skill Course (VSC)	STA-171-VSC	Data Analysis with R Software	Practical	02
	Skill Enhancement Course (SEC)	STA-176-SEC	Application of Statistics Using Advanced Excel	Practical	02
	Ability Enhancement Course (AEC)	ENG-181-AEC	Functional English-II	Theory	02
	Value Education Course (VEC)	COS-185-VEC	Digital and Technological Solutions	Theory	02
	Co-curricular Course (CC)	--	To be selected from the Basket	Theory	02
Total Credits Semester-II					22
Cumulative Credits Semester I + Semester II					44

**CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Statistics
(2023 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: F.Y.B.Sc.
Semester	: II
Course Type	: Major Mandatory (Theory)
Course Code	: STA-151-MJM
Course Title	: Descriptive Statistics – II
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Understand the basic concepts of correlation and regression analysis, ensuring they can differentiate between these statistical techniques.
2. Computation of correlation coefficients, Regression coefficients and their interpretation.
3. Understand the significance of life tables in demographic analysis and population studies.
4. Construct and complete life tables using demographic data.
5. Provide a comprehensive understanding of population growth factors, including birth rates, death rates, immigration, and emigration.
6. Understand the concept of a Likert scale, classification, notion of manifold classification, dichotomy, class frequency, ultimate class frequency etc.
7. Enable to analyse the qualitative data.

Course Outcomes:

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

- CO1.** compute the correlation coefficient for bivariate data and interpret it.
- CO2.** understand the basic concept of linear regression and fit linear regression model to the bivariate data, interpretation of coefficients, and prediction of outcomes.
- CO3.** fit quadratic and exponential curves to the bivariate data to investigate relation between two variables.
- CO4.** understand the various components of life tables, construct life tables from given

data, interpret life table data.

CO5. analyse data pertaining to attributes and to interpret the results.

CO6. understand the concepts of population growth, birth rate, death rate, and fertility rates, etc.

CO7. compute the coefficient of association and interpret it.

Topics and Learning Points

UNIT – 1 Correlation

(6L)

- 1.1 Bivariate data, bivariate frequency distribution.
- 1.2 Concept of correlation between two variables, positive correlation, negative correlation, no correlation. Interpretation of correlation.
- 1.3 Scatter diagram, interpretation of the type of correlation from scatter diagram.
- 1.4 Covariance between two variables: Definition, computation, the effect of change of origin, and scale.
- 1.5 Karl Pearson's coefficient of correlation (r): Definition, computation for ungrouped data, and interpretation. Properties:
 - (i) $-1 \leq r \leq 1$ (with proof)
 - (ii) Effect of change of origin and scale (with proof).
- 1.6 Spearman's rank correlation coefficient: Definition, derivation of formula, computation, and interpretation (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.)

UNIT – 2 Regression

(7L)

- 2.1 Fitting of curves to the bivariate data.
- 2.2 Fitting of line ($Y = a + b X$),
- 2.3 Fitting of second degree curve ($Y = a + bX + cX^2$),
- 2.4 Fitting of exponential curves of the type $Y = ab^X$ and $Y = aX^b$.
In all these curves parameters are estimated by the method of least squares.
- 2.5 Linear Regression Model
- 2.6 Meaning of regression, the difference between correlation and regression.
- 2.7 Concept of error in regression, error model as a continuous random variable. Simple linear regression model: $Y = a + b X + \epsilon$, where ϵ is a continuous random variable with $E(\epsilon) = 0$, $\text{Var}(\epsilon) = \sigma^2$. Estimation of a , b

by the method of least squares. Interpretation of parameters. The formula of the estimator of σ^2 . Concept of the residual, plot of residual against X, the concept of explained and unexplained variation, the concept of coefficient of determination.

UNIT – 3 Theory of Attributes **(6L)**

- 3.1** Attributes: Concept of a Likert scale, classification, notion of manifold classification, dichotomy, class frequency, order of a class, positive class frequency, negative class frequency, ultimate class frequency, the relationship among different class frequencies (up to three attributes) and dot operator to find the relation between frequencies, fundamental set of class frequencies.
- 3.2** Consistency of data up to 2 attributes. Concepts of independence and association of two attributes.
- 3.3** Yule's coefficient of association (Q), $-1 \leq Q \leq 1$, interpretation (with proof). Definition of odds ratio and its interpretation.

UNIT – 4 Demography **(6L)**

- 4.1** Vital events, vital statistics, methods of obtaining vital statistics, rates of vital events, sex ratios, dependency ratio.
- 4.2** Death/Mortality rates: Crude death rates, specific (age, sex etc.) death rate, standardized death rate (direct and indirect), infant mortality rate.
- 4.3** Fertility/Birth rate: Crude birth rates, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rates.
- 4.4** Growth/Reproduction rates: Gross reproduction rate, net reproduction rate.
- 4.5** Interpretations of different rates, uses, and applications.
- 4.6** Trends in vital rates due to the latest census.

Unit 5: Life Table **(5L)**

- 5.1** Introduction, Construction of life table, functions ($l_x, d_x, p_x, q_x, L_x, T_x, e_x$) and their interpretation, expectation of life, example, and problems.

References:

- 1.** Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.

2. Gupta and Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3. Sharma K. V. S. (2001) Statistics made it simple: Do it yourself on PC. Prentice Hall of India, New Delhi.
4. Gupta S. C. and Kapoor V. K. (1987): Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
5. B. L. Agarwal : Programmed Statistics, New Age International Publishers, New Delhi.
6. David Freedman, Robert Pisani, Roger Purves: Statistics
7. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye: Probability & Statistics for Engineers & Scientists.
8. Gupta S. P.: Statistical Methods, Sultan Chand and Sons, 23, Daryaganj, New Delhi
9. Mukhopadhyay Parimal (1999): Applied Statistics, New Central Book Agency, Pvt. Ltd. Calcutta.
10. Snedecor G. W. and Cochran W. G.(1989). Statistical Methods, Eighth Ed. East.
11. Shailaja R. Deshmukh (2009): Actuarial Statistics An Introduction Using R, University Press (India) Private Limited.
12. Moore D. S., Norz W. I, Flinger M. A., (2013), The Basic Practice of Statistics, Sixth Edition, Freeman and Company New York
13. Brase C.H. and Brase C. P, (2018), Understandable Statistics, Twelfth Edition, Cengage Learning
14. Biston Feedman D., Pisani R., Purves R. (2007), Statistics, Fourth Edition, W. W. Norton and Company, New York.

Programme Outcomes and Course Outcomes Mapping:

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

PO1. Disciplinary Knowledge

CO1. Compute the correlation coefficient for bivariate data and interpret it.

Weightage: 3 - Strongly Related)

Justification: This outcome directly contributes to disciplinary knowledge by focusing on understanding and interpreting the correlation coefficient, a fundamental concept in statistics.

PO2. Critical Thinking and Problem Solving

CO2. Understand the basic concept of linear regression and fit linear regression model to the bivariate data, interpretation of coefficients, and prediction of outcomes.

CO3. Fit quadratic and exponential curves to the bivariate data to investigate the relation between two variables.

Weightage: 3 - Strongly Related

Justification: Both outcomes require critical thinking and problem-solving skills to analyze relationships between variables and make predictions based on regression models.

PO3. Social Competence

CO5. Analyze data pertaining to attributes and interpret the results.

CO6. Understand the concepts of population growth, birth rate, death rate, and fertility rates, etc.

Weightage: 2 - Moderately Related

Justification: These outcomes provide skills that can be applied to understand social phenomena, although they are not directly focused on social interaction or communication.

PO4. Research-related Skills and Scientific Temper

All COs

Weightage: 3 - Strongly Related

Justification: These outcomes involve research-related skills such as data analysis, interpretation, and modeling, contributing to the development of scientific temper.

PO5. Trans-disciplinary Knowledge

CO4. Understand the various components of life tables, construct life tables from given data, interpret life table data.

Weightage: 1 - Partially Related

Justification: Life tables are often used in demographic studies, which may intersect with various disciplines, but this outcome is more specialized and less trans-disciplinary in nature.

PO6. Personal and Professional Competence

CO2. Understand the basic concept of linear regression and fit linear regression model to the bivariate data, interpretation of coefficients, and prediction of outcomes.

CO3. Fit quadratic and exponential curves to the bivariate data to investigate the relation between two variables.

Weightage: 2 - Moderately Related

Justification: Proficiency in regression analysis contributes to personal and professional competence in fields where such analysis is commonly used.

PO7. Effective Citizenship and Ethics

All COs

Weightage: 1 - Partially Related

Justification: While ethical considerations may arise in data analysis and interpretation, they are not explicitly addressed in these outcomes.

PO8. Environment and Sustainability

All COs

Weightage: 1 - Partially Related

Justification: The outcomes do not directly relate to environmental or sustainability concerns.

PO9. Self-directed and Life-long Learning

All COs

Weightage: 2 - Moderately Related

Justification: Mastering statistical analysis techniques requires ongoing learning and adaptation, contributing to the goal of self-directed and lifelong learning. However, the outcomes themselves do not explicitly address this aspect.

**CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Statistics
(2023 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: F.Y.B.Sc.
Semester	: II
Course Type	: Major Mandatory (Theory)
Course Code	: STA-152-MJM
Course Title	: Discrete Probability and Probability Distributions – II
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Gain knowledge of discrete bivariate random variable and its probability distributions.
2. To obtain a probability distribution of bivariate random variable in the given situation.
3. Students will develop a strong foundation to various discrete probability distributions.
4. Identify real life situations where Binomial distribution can be applied, and compute the probabilities of the given event.
5. Identify real life situations where Hyper-geometric distribution can be applied, and compute the probabilities of the given event.
6. Identify real life situations where Poisson distribution can be applied, and compute the probabilities of the given event.
7. Identify real life situations where Geometric distribution can be applied, and compute the probabilities of the given event.

Course Outcomes:

Student will be able to:

- CO1.** describe bivariate random variable, joint distribution function, joint probability mass function, marginal and conditional distributions, mathematical expectation, and independence of random variables, and apply their properties in problem-solving.
- CO2.** apply binomial distribution in different real life situations.

- CO3. apply Hyper-geometric distribution in different real life situations.
- CO4. apply Poisson distribution in different real life situations.
- CO5. apply Geometric distribution in different real life situations.
- CO6. study the properties of the distributions.
- CO7. study the interrelation between the standard probability distributions learnt above.

Topics and Learning Points

Unit – 1 Bivariate Discrete Probability Distribution: (6L)

- 1.1 Definition of a bivariate discrete random variable (X,Y) on finite sample space, Joint p.m.f., and c.d.f., Properties of c.d.f. (without proof).
- 1.2 Computation of probabilities of events in the bivariate probability distribution, the concept of a marginal and conditional probability distribution, independence of two discrete r.v.s. Examples.

Unit – 2 Mathematical Expectation (Bivariate Random Variable): (6L)

- 2.1 Mathematical Expectation: Definition of expectation of a function of r.v. in bivariate distribution, Theorems on expectations: (i) $E(X+Y) = E(X) + E(Y)$ (ii) $E(XY) = E(X) \cdot E(Y)$ when X and Y are independent, expectation and variance of a linear combination of two discrete r.v.s.
- 2.2 Conditional mean, conditional variance, covariance and correlation coefficient, $Cov(aX+bY, cX+dY)$, the distinction between uncorrelated and independent variables,
- 2.3 M.G.F., proof of the m.g.f. of sum of two independent random variables as the product of their m.g.f., examples.

Unit – 3 Some Standard Discrete Probability Distributions: (Finite sample space): (10L)

- 3.1 Review of a random variable based on finite sample space.
- 3.2 Degenerate Distribution:
- 3.3 Discrete Uniform Distribution: p.m.f., mean and variance.
- 3.4 Bernoulli distribution: p.m.f., mean, variance, distribution of the sum of independent and identically distributed Bernoulli variables.
- 3.5 Binomial Distribution: Binomial random variable, p.m.f. with parameters (n, p), Recurrence relation for successive probabilities, Computation of probabilities of different events, mean and variance, mode, skewness, m.g.f., deduction of

moments from m.g.f. Additive property of binomial variables. Examples. The conditional distribution of X given $(X+Y)$ for Binomial distributions.

- 3.6** Hypergeometric Distribution: p.m.f. with parameters (N, M, n) , Computation of probability of different events, Recurrence relation for successive probabilities, mean and variance of distribution assuming $n \leq N - M \leq M$, approximation of Hypergeometric to Binomial.

Unit – 4 Standard Discrete Probability Distributions for Countable infinite sample

space: (8L)

- 4.1** Review of a random variable based on countably infinite sample space.
- 4.2** Poisson distribution: Definition of Poisson with parameter λ . Mean, variance, mode, m.g.f., c.g.f. skewness, kurtosis, Recurrence relation for successive Probabilities, Additive property of Poisson distribution, and Real life situations.
- 4.3** Poisson distribution as a limiting case of Binomial distribution, examples.
- 4.4** Conditional distribution of X given $(X+Y)$ for Poisson distributions.
- 4.5** Geometric Distribution: Definition of Geometric with parameter p in both cases with support $\{0, 1, 2, \dots\}$ and with support $\{1, 2, \dots\}$. Mean, Variance, distribution function, Lack of memory property, examples.

References:

1. Bhat B. R., Srivenkatramana T and Madhava Rao K. S. (1997): Statistics: a Beginner's Text, Vol. II, New Age International (P) Ltd.
2. Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
3. Hogg R. V. and Crag R. G.: Introduction to Mathematical Statistics Ed.4.
4. Gupta and Kapoor : Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
5. Meyer P.L.(1970): Introductory Probability and Statistical Applications, Edition Wesley.
6. Rohatgi V. K. and Saleh A. K. Md. E. (2002): An Introduction to probability and statistics. John wiley & Sons (Asia)
7. Gupta and Kapoor : Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
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Delhi.

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11. Biston Moore D. S., Notz W. I., Flinger M. A., (2013), The Basic Practice of Statistics, Sixth Edition, Freeman and Company New York
12. Hoel P. G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
13. M. B. Kulkarni and S. B. Ghatpande : Discrete Probability and Probability Distributions, SIPF Academy, Nashik.

Programme Outcomes and Course Outcomes Mapping:

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

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

PO1. Disciplinary Knowledge

CO1. Describe bivariate random variable, joint distribution function, joint probability mass function, marginal and conditional distributions, mathematical expectation, and independence of random variables, and apply their properties in problem-solving.

Weightage: 3 - Strongly Related)

Justification: This outcome directly aligns with disciplinary knowledge by focusing on understanding and applying foundational concepts in probability and statistics.

PO2. Critical Thinking and Problem Solving

All COs

Weightage: 3 - Strongly Related

Justification: Each outcome requires critical thinking skills to understand and apply probability distributions in various real-life scenarios, solving problems effectively.

PO3. Social Competence

All COs

Weightage: 1 - Partially Related

Justification: While probability and statistics concepts may be applicable in social contexts, these outcomes do not directly address social interactions or competencies.

PO4. Research-related Skills and Scientific Temper

All COs

Weightage: 3 - Strongly Related

Justification: Understanding and applying probability distributions are essential research skills, contributing to scientific temper and rigorous data analysis.

PO5. Trans-disciplinary Knowledge

All COs

Weightage: 1 - Partially Related

Justification: Probability distributions may have applications across various disciplines, but the outcomes themselves do not explicitly address trans-disciplinary knowledge.

PO6. Personal and Professional Competence

CO1. Describe bivariate random variable, joint distribution function, joint probability mass function, marginal and conditional distributions, mathematical expectation, and independence of random variables, and apply their properties in problem-solving.

Weightage: 2 - Moderately Related

Justification: Mastery of foundational probability concepts contributes to personal and professional competence, but the other outcomes are more directly related to problem-solving skills.

PO7. Effective Citizenship and Ethics

All COs

Weightage: 1 - Partially Related

Justification: While ethical considerations may arise in the application of probability distributions, the outcomes themselves do not explicitly address citizenship or ethical issues.

PO8. Environment and Sustainability

All COs

Weightage: 1 - Partially Related

Justification: Probability distributions may have applications in environmental and sustainability studies, but the outcomes do not directly address these concerns.

PO9. Self-directed and Life-long Learning

All COs

Weightage: 2 - Moderately Related

Justification: Mastering probability concepts requires ongoing learning and adaptation, contributing to the goal of self-directed and lifelong learning, although the outcomes do not explicitly address this aspect.

**CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Statistics
(2023 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: F.Y.B.Sc.
Semester	: II
Course Type	: Major Mandatory (Practical)
Course Code	: STA-153-MJM
Course Title	: Statistics Practical – II
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

- 1) Computation of correlation coefficients, Regression coefficients and their interpretation.
- 2) Understand the significance of life tables in demographic analysis and population studies.
- 3) Construct and complete life tables using demographic data.
- 4) Understand the concepts of population growth, birth rate, death rate, and fertility rates, etc.
- 5) Analyze the data with respect to bivariate discrete distributions.
- 6) Know applications of some standard discrete probability distributions.
- 7) Computation of probabilities to solve real-world problems.

Course Outcome:

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

- CO1.** compute correlation coefficient, regression coefficients and to interpret the results.
- CO2.** construct life tables from given data, interpret life table data.
- CO3.** compute population growth, birth rate, death rate, and fertility rates, etc.
- CO4.** fit the linear and non-linear regression models.
- CO5.** fit the binomial and Poisson distributions.
- CO6.** analyse data pertaining to attributes and to interpret the results.
- CO7.** analyse the data with respect to Bivariate discrete distributions and.
- CO8.** know applications of Binomial and Hyper-geometric probability distributions.

CO9. know applications of Poisson and Geometric probability distributions.

Topics and Learning Points

Sr. No.	Title of Experiments
1	Scatter diagram, correlation coefficient (ungrouped data). Fitting of line of regression, residual plot
2	Fitting of second degree curve, exponential curve of type $y = ab^x$, $y = ax^b$
3	Theory of Attribute
4	Life Tables
5	Demography
6	Bivariate Discrete Probability distribution – I (Computations of probabilities, Conditional Probability, Independence)
7	Bivariate Discrete Probability distribution – II (Expectations, Variances, Covariance, Correlation)
8	Applications of Binomial and Hyper-geometric Distribution
9	Applications of Poisson and Geometric Distribution.
10	Fitting of binomial distribution
11	Fitting of Poisson distribution
12	Model sampling from binomial and Poisson distribution
13	Project equivalent to 4 Practicals

Note:

1. Every practical is equivalent to four hours per batch per week
2. Practical batch should be of 15 students
3. For project, a group of maximum 15 students be made
4. Different data sets from newspapers, internet and magazines may be collected and students will be asked to use Statistical techniques/tools which they have learnt.
5. Students must complete all the practicals to the satisfaction of the teacher concerned.
6. Students must produce at the time of practical examination, the laboratory journal along with the completion certificate signed by the Head of the Department.

Programme Outcomes and Course Outcomes Mapping:

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

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

PO1. Disciplinary Knowledge

CO1. Compute correlation coefficient, regression coefficients and to interpret the results.

Weightage: 3 - Strongly Related

Justification: Understanding and interpreting correlation and regression coefficients are foundational concepts in statistics, directly contributing to disciplinary knowledge.

PO2. Critical Thinking and Problem Solving

All COs

Weightage: 3 - Strongly Related

Justification: Each outcome requires critical thinking skills to analyze data, interpret results, and solve problems effectively.

PO3. Social Competence

All COs

Weightage: 1 - Partially Related

Justification: While understanding demographic data may have social implications, the outcomes themselves do not directly address social interactions or competencies.

PO4. Research-related Skills and Scientific Temper**All COs****Weightage:** 3 - Strongly Related**Justification:** Analysing data, fitting regression models, and understanding probability distributions are fundamental research skills, contributing to scientific temper and rigorous data analysis.**PO5. Trans-disciplinary Knowledge****All COs****Weightage:** 1 - Partially Related**Justification:** While probability distributions and demographic analysis may have applications across various disciplines, the outcomes themselves do not explicitly address trans-disciplinary knowledge.**PO6. Personal and Professional Competence****All COs****Weightage:** 2 - Moderately Related**Justification:** Mastering statistical techniques contributes to personal and professional competence, but the outcomes do not explicitly address broader professional skills.**PO7. Effective Citizenship and Ethics****All COs****Weightage:** 1 - Partially Related**Justification:** While ethical considerations may arise in data analysis, the outcomes themselves do not explicitly address citizenship or ethical issues.**PO8. Environment and Sustainability****All COs****Weightage:** 1 - Partially Related

Justification: The outcomes do not directly address environmental or sustainability concerns.

PO9. Self-directed and Life-long Learning

All COs

Weightage: 2 - Moderately Related

Justification: Mastering statistical techniques requires ongoing learning and adaptation, contributing to the goal of self-directed and lifelong learning, although the outcomes do not explicitly address this aspect.

**CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Statistics
(2023 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: F.Y.B.Sc.
Semester	: II
Course Type	: Minor Theory
Course Code	: STA-161-MN
Course Title	: Fundamental of Statistics
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Gain knowledge about population and sample.
2. Gain knowledge of different types of data.
3. Students will develop a strong foundation to analyse and interpret data in various fields.
4. Summarize data using frequency distributions and graphical representations.
5. Compute various measures of central tendency.
6. Compute various measures of dispersion.
7. Develop critical thinking and problem-solving skills by applying descriptive statistics techniques to real-world scenarios and data sets.

Course Outcomes:

The students will acquire knowledge about;

- CO1. understanding of types data.
- CO2. the statistical population and sample.
- CO3. summarize and organize data effectively using appropriate graphical representations.
- CO4. interpretation of graphical and diagrammatical representations.
- CO5. summarize data effectively using descriptive statistics techniques.
- CO6. understanding of the measures of central tendency.
- CO7. understanding of the measures of dispersion.

Topics and Learning Points**UNIT 1: Population and Sample (6L)**

- 1.1 Types of characteristics : Attributes: Nominal scale, ordinal scale, Variable: Interval scale, ratio scale, discrete and continuous variables
- 1.2 Types of data
 - (a) Primary data: Design of Questionnaire, secondary data
 - (b) Cross-sectional data, chronological data.
- 1.3 Notion of a statistical population: Finite population, infinite population, homogeneous population and heterogeneous population. Notion of a sample and a random sample.
- 1.4 Methods of sample (Description only): Simple random sampling with and without replacement (SRSWR and SRSWOR), stratified random sampling, systematic sampling, cluster sampling and two-stage sampling.

UNIT 2: Presentation of Data (7L)

- 2.1 Classification : Raw data and its classification, ungrouped frequency distribution, Sturges' rule, method of classification inclusive and exclusive, open end classes , (grouped frequency distribution cumulative frequency distribution), relative frequency distribution
- 2.2 Diagrams: Simple bar diagram, Subdivided bar diagram, multiple bar diagram, Pie diagram, Stem and leaf diagram.
- 2.3 Graphs: Histogram, Frequency Polygon, Ogive Curve.

UNIT 3: Measures of Central Tendency (9L)

- 3.1 Concept of central tendency of statistical data, statistical average, characteristics of a good statistical average.
- 3.2 Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, weighted mean, trimmed mean, Harmonic Mean, Geometric Mean
- 3.3 Mode: Definition, merits and demerits.
- 3.4 Median: Definition, merits and demerits.
- 3.5 Empirical relation between mean, median and mode (without proof)
- 3.6 Quartiles, Deciles, Percentiles: Definition (for ungrouped and grouped data), merits and demerits.

UNIT 4: Measures of Dispersion**(8L)**

- 4.1 Concept of dispersion, characteristics of good measures of dispersion.
- 4.2 Range, semi-inter quartile range (quartile deviation): Definition, merits and demerits.
- 4.3 Mean deviation: Definition, merits and demerits, minimality property (without proof).
- 4.4 Variance and standard deviation: Definition merits and demerits, effect of change of origin and scale, combined variance for n groups.
- 4.5 Measures of dispersion for comparison: coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (CV)

References:

1. Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
2. Gupta and Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3. Sharma K. V. S. (2001) Statistics made it simple: Do it yourself on PC. Prentice Hall of India, New Delhi.
4. Gupta and Kapoor : Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
5. B. L. Agarwal : Programmed Statistics, New Age International Publishers, New Delhi.
6. David Freedman, Robert Pisani, Roger Purves: Statistics
7. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye: Probability & Statistics for Engineers & Scientists.
8. Brase C. H. and Brace C. P. (2018), Understandable Statistics, Twelfth Edition, Cengage Learning, Boston
9. Moore 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:

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

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

PO1. Disciplinary Knowledge

CO1. Understand the statistical population and sample.

Weightage: 3 - Strongly Related

Justification: Understanding statistical population and sample is fundamental to disciplinary knowledge in statistics.

PO2. Critical Thinking and Problem Solving

CO2. Summarize and organize data effectively using appropriate graphical representations and descriptive statistics techniques.

Weightage: 3 - Strongly Related

Justification: Critical thinking is required to effectively summarize and organize data for analysis.

PO3. Social Competence

CO7. Different real-life situations to find the probability of different types of events.

Weightage: 2 - Moderately Related

Justification: Understanding probability in real-life situations enhances communication and collaboration in group settings.

PO4. Research-related Skills and Scientific Temper

CO6. Understand the concepts of probability.

Weightage: 2 - Moderately Related

Justification: Probability concepts are often used in research and experimentation.

PO5. Trans-disciplinary Knowledge

CO4. Understand the difference between random and non-random experiments.

Weightage: 2 - Moderately Related

Justification: Understanding experimental design transcends disciplinary boundaries and contributes to addressing common problems.

PO6. Personal and Professional Competence

CO3. Demonstrate a solid understanding of the fundamental concepts of descriptive statistics, including measures of central tendency and measures of dispersion.

Weightage: 3 - Strongly Related

Justification: Effective collaboration and interpersonal relationships are enhanced by a solid understanding of descriptive statistics.

PO7. Effective Citizenship and Ethics

CO5. Understand the concepts of experiment, sample spaces, and events.

Weightage: 1- Partially Related.

Justification: While understanding experimental concepts can involve ethical considerations, the direct link to citizenship and ethics may be less evident.

PO8. Environment and Sustainability

CO5. Understand the concepts of experiment, sample spaces, and events.

Weightage: 1 - Partially Related.

Justification: Understanding experimental concepts may indirectly contribute to addressing societal and environmental issues.

PO9. Self-directed and Life-long Learning

CO6. Understand the concepts of probability.

Weightage: 2 - Moderately related.

Justification: Probability concepts support lifelong learning by providing a foundation for understanding uncertainty and risk.

**CBCS Syllabus as per NEP 2020 for F.Y.B. Sc. Statistics
(2023 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: F.Y.B.Sc.
Semester	: II
Course Type	: OE (Theory)
Course Code	: STA-166-OE
Course Title	: Business Statistics
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Understanding the concept of Dispersion and various types of measures of dispersion.
2. Learn the concept of correlation.
3. Computation of various measures of correlation.
4. Learn about various types of regression.
5. Develop critical thinking and problem-solving skills by applying descriptive statistics techniques to real-world scenarios and data sets.
6. Understand concept of demography and its applications.
7. Analyse data pertaining to attributes and to interpret the results.

Course Outcomes:

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

- CO1.** demonstrate a understanding of the fundamental concepts, measures of variability.
- CO2.** calculate and interpret various types of correlation.
- CO3.** apply critical thinking and problem-solving skills to data sets, effectively utilizing descriptive statistics techniques to draw meaningful conclusions.
- CO4.** communicate descriptive statistics results clearly and effectively through written reports and oral presentations.

CO5. understanding of the concept of correlation coefficient for bivariate data and interpret it.

CO6. apply critical thinking and problem-solving skills of simple regression in real life.

CO7. applications of demography in the field of insurance, government etc.

Topics and Learning Points

UNIT – 1 Measures of Dispersion (7L)

- 1.1 Concept of dispersion, characteristics of good measures of dispersion. Concept of Dispersion.
- 1.2 Measures of dispersion: Range, Variance, Standard deviation (SD) for grouped and ungrouped data Range: Definition merits and demerits.
- 1.3 Measures of relative dispersion: Coefficient of range, coefficient of variation.
- 1.4 Examples and problem

UNIT –2 Correlation and Regression (10L)

- 2.1 Bivariate data, Concept of correlation between two variables, positive correlation, negative correlation, no correlation. Interpretation of correlation using scatter diagram.
- 2.2 Karl Pearson's coefficient of correlation: computation for ungrouped data, interpretation, properties of correlation coefficient.
- 2.3 Spearman's rank correlation coefficient: Definition, Interpretation.
- 2.4 Meaning of regression, the difference between correlation and regression. Regression lines of regression. properties of regression coefficients.
- 2.5 Concept of Multiple Linear regression
- 2.6 Examples and problem.

Unit 3 Theory of Attributes (6L)

- 3.1 Attributes: Concept of a Likert scale, classification, notion of manifold classification, dichotomy, class-frequency, order of a class, positive class-frequency, negative class frequency, ultimate class frequency.
- 3.2 Relationship among different class frequencies (up to three attributes) and dot operator to find the relation between frequencies, fundamental set of class frequencies.
- 3.3 Consistency of data upto 2 attributes.
- 3.4 Concepts of independences and association of two attributes. Yule's coefficient of association (Q), $-1 \leq Q \leq 1$, interpretation (with proof).

UNIT – 4 Demography**(7L)**

- 4.1 Vital events, vital statistics, methods of obtaining vital statistics, rates of vital events, sex ratios, dependency ratio.
- 4.2 Death/Mortality rates: Crude death rates, specific (age, sex etc.) death rate, standardized death rate (direct and indirect), infant mortality rate.
- 4.3 Fertility/Birth rate: Crude birth rates, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rates.
- 4.4 Growth/Reproduction rates: Gross reproduction rate, net reproduction rate.
- 4.5 Interpretations of different rates, uses, and applications.

References:

1. Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol. II, World Press, Calcutta.
2. Gupta and Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3. Sharma K. V. S. (2001) Statistics made it simple: Do it yourself on PC. Prentice Hall of India, New Delhi.
4. Gupta and Kapoor: Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
5. B. L. Agarwal: Programmed Statistics, New Age International Publishers, New Delhi.
6. David Freedman, Robert Pisani, Roger Purves: Statistics
7. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye: Probability & Statistics for Engineers & Scientists.
8. Introduction to Linear Regression Analysis, Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Wiley.
9. Brase C. H. and Brase C. P. (2018), Understandable Statistics, Twelfth Edition, Cengage Learning, Boston
10. Moore 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:

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

Weight: 1 - Partially related 2 - Moderately Related

3 - Strongly related

PO1. Disciplinary Knowledge

CO1: Strongly Related (Weightage: 3)

Justification: Understanding fundamental concepts and measures of variability directly contributes to disciplinary knowledge in statistics and data analysis.

PO2. Critical Thinking and Problem Solving

CO3: Strongly Related (Weightage: 3)

Justification: Applying critical thinking and problem-solving skills to data sets using descriptive statistics techniques requires analytical abilities aligned with critical thinking and problem-solving.

PO3. Social Competence

CO4: Moderately Related (Weightage: 2)

Justification: Communicating descriptive statistics results effectively through written reports and oral presentations can contribute to social competence by fostering clear communication skills.

PO4. Research-related Skills and Scientific Temper

CO3: Strongly Related (Weightage: 3)

Justification: Applying critical thinking and problem-solving skills to data sets demonstrates research-related skills and a scientific temper in data analysis and interpretation.

PO5. Trans-disciplinary Knowledge

CO7: Strongly Related (Weightage: 3)

Justification: Understanding the applications of demography in various fields such as insurance and government demonstrates trans-disciplinary knowledge by integrating demographic concepts into different domains.

PO6. Personal and Professional Competence

CO3: Moderately Related (Weightage: 2)

Justification: Applying critical thinking and problem-solving skills of simple regression in real life contributes to personal and professional competence by enhancing analytical abilities and decision-making skills.

PO7. Effective Citizenship and Ethics

Not directly addressed in the provided COs.

PO8. Environment and Sustainability

Not directly addressed in the provided COs.

PO9. Self-directed and Life-long Learning

CO3: Moderately Related (Weightage: 2)

Justification: Applying critical thinking and problem-solving skills to data sets fosters a mindset of self-directed and life-long learning by encouraging continuous skill development and adaptation to new challenges.

**CBCS Syllabus as per NEP 2020 for F.Y.B. Sc. Statistics
(2023 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: F.Y.B.Sc.
Semester	: II
Course Type	: OE (Practical)
Course Code	: STA-167-OE
Course Title	: Statistics Learning with Software
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. Learn Fundamentals of R-software.
2. Student can learn Statistics using R-software.
3. Read data into R, accessing residing data sets and organizing data using R- functions.
4. Create and import the data in R-software
5. Study how to use different functions in R.
6. Draw various graphical and diagrammatic techniques using R-software.
7. Interpret the results from output of R-software.

Course Outcomes:

Student will be able to

- CO1.** use R-software for statistical computing.
- CO2.** to import data from other form to R-software
- CO3.** to create data file using R-software.
- CO4.** to visualize data with various graphical and diagrammatic techniques and interpretation using R software in exploratory data analysis.
- CO5.** to summarize and analyze the data using R software.
- CO6.** to interpret summary statistics of R-software output.
- CO7.** to access the residing data in R-software for data analysis.

Topics and Learning Points**UNIT 1: Fundamentals of R**

- 1.1 Introduction to R, History of R, features of R, Need and importance of R-software, starting and ending R session, getting help in R, R commands and casesensitivity.
- 1.2 Open RStudio and explore the RStudio interface
- 1.3 Vectors and vector arithmetic
 - a) Creation of vectors using functions c, seq, rep.
 - b) Creating a vector using scan function, other types of objects.
 - c) Arithmetic operations on vectors using operators +, -, *, /, ^.
 - d) Arithmetic expressions, Relational Operators, Logical Operators
 - e) Numerical functions: log10, log, sort, max, min, unique, range, length, var, prod, sum, summary, fivenum, mean, min, max, etc.
 - f) Accessing vectors

UNIT 2: Data frames:

- 2.1 Creation using data.frame, subset and transform commands
- 2.2 Creating a data frame using edit command, fix command. Importing data from MS-Excel file using read.table, read.csv command.
- 2.3 Resident data sets: Accession and summary

UNIT 3: Diagrams and Graphs

- 3.1 **Diagrams:** Simple bar diagram, Subdivided bar diagram, multiple bar diagram, Pie diagram, Stem and leaf diagram.
- 3.2 **Graphs:** Scatter Plot, Histogram, Frequency Polygon, Ogive Curve, histogram for raw data with and for both equal and unequal class intervals, Boxplot for one and more than one variables, rod or spike plot, empirical, Saving the diagram and graph in MS-Word file.

UNIT 4: Some Standard Discrete Probability Distributions

- 4.1 Introduction to Standard Discrete probability distributions.
- 4.2 Generate random samples from Standard Discrete probability distributions
- 4.3 Calculate probabilities and percentiles for discrete probability distributions.

UNIT 5: Correlation and Simple Linear Regression

- 5.1** Scatterplots: Creating scatterplots to visualize the relationship between variables. Identifying patterns and outliers in scatterplots.
- 5.2** Correlation: Measuring the strength and direction of the linear relationship between two variables. Calculating correlation coefficients (e.g., Pearson correlation coefficient).
- 5.3** Simple Linear Regression Model: Formulating the simple linear regression equation. Understanding the assumptions of the model.
- 5.4** Model Estimation: Estimating the regression coefficients (slope and intercept) using the least squares method.
- 5.5** Model Evaluation: Assessing the goodness of fit. Evaluating the significance of regression coefficients. Interpreting the regression equation.
- 5.6** Prediction and Inference: Using the regression model for prediction.

List of Practicals:

Sr. No.	Title of the Experiment	No. of Experiment
1	Introduction to R- software and R-studio	2
2	Introduction to Numerical Functions and Vector Access using R Software.	1
3	Combinatorial Techniques and Statistical computing Using R	1
4	Managing Data Frames and Importing from Excel in R Software.	1
5	Diagrammatic representation	1
6	Graphical representation	1
7	Measures of central tendency for both grouped and ungrouped data using R Software.	1
8	Measures of dispersion for both grouped and ungrouped data using R Software	1
9	Model sampling and Probability computation of some standard discrete probability distributions using R	1
10	Correlation and Regression	2

Note:

1. Every practical is equivalent to four hours per batch per week

Reference:

1. W. John Braun and Duncan J. Murdoch, (2016), A First Course in Statistical Programming with R, Cambridge University Press.
2. Sudha G. Purohit, Sharad D. Gore, Shailaja R. Deshmukh (2008), Statistics Using R, Alpha Science International
3. Dhawal Mehata (2015), Statistical Data Analysis using R-Software, Excel Books
4. Robert L. Kabacoff (2023), R in Action, Dreamtech Press.
5. Vishwas R. Pawgi (2022), Statistical Computing Using R Software, NiraliPrakashan.
6. Garrett Golemund (2014). Hands-On Programming with R: Write Your Own Functions and Simulations.
7. Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol. II, World Press, Calcutta

Programme Outcomes and Course Outcomes Mapping:

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

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

PO1: Disciplinary Knowledge

CO1. use R-software for statistical computing. (3)

CO2. to import data from other form to R-software (3)

CO3. to create data file using R-software. (2)

CO4. to visualize data with various graphical and diagrammatic techniques and interpretation using R software in exploratory data analysis. (3)

CO5. to summarize and analyze the data using R software. (3)

CO6. to interpret summary statistics of R-software output. (3)

CO7. to access the residing data in R-software for data analysis. (3)

Justification:

Disciplinary knowledge in this context refers to the understanding and proficiency in using R-software for statistical analysis and data manipulation. Each of the specified course outcomes directly corresponds to a skill or knowledge area required for utilizing R-software effectively in data analysis. For instance, CO1, CO2, and CO7 focus on the technical skills of using R-software for statistical computing, importing data, and accessing data, which are fundamental aspects of disciplinary knowledge in this domain. CO3, CO4, CO5, and CO6 emphasize the application of R-software for data manipulation, visualization, analysis, and interpretation, which are core components of statistical analysis and data science, thereby strongly aligning with disciplinary knowledge.

PO2. Critical Thinking and Problem Solving

CO1. use R-software for statistical computing. (3)

CO4. to visualize data with various graphical and diagrammatic techniques and interpretation using R software in exploratory data analysis. (3)

CO5. to summarize and analyze the data using R software. (3)

CO6. to interpret summary statistics of R-software output. (3)

Justification:

Critical thinking and problem-solving involve the ability to analyze information, identify patterns, and derive meaningful insights to solve complex problems. The specified course outcomes (CO1, CO4, CO5, and CO6) directly contribute to this by requiring students to use R-software to perform statistical analysis, visualize data, interpret results, and draw conclusions. These activities necessitate critical thinking skills to understand the data, select appropriate analytical techniques, and interpret findings effectively, thus aligning with the objectives of critical thinking and problem-solving.

PO3. Social Competence

No direct mapping.

Justification:

Social competence primarily involves interpersonal skills, collaboration, and communication, which are not directly addressed by the specified course outcomes focused on technical skills in R-software and data analysis. However, the ability to effectively communicate findings and collaborate with others in a data analysis context could indirectly contribute to social competence, but this mapping would be less direct compared to other POs.

PO4. Research-related Skills and Scientific Temper

CO1. use R-software for statistical computing. (3)

CO2. to import data from other form to R-software (3)

CO3. to create data file using R-software. (2)

CO4. to visualize data with various graphical and diagrammatic techniques and interpretation using R software in exploratory data analysis. (3)

CO5. to summarize and analyze the data using R software. (3)

CO6. to interpret summary statistics of R-software output. (3)

CO7. to access the residing data in R-software for data analysis. (3)

Justification:

Research-related skills and scientific temper involve the ability to conduct systematic investigations, analyze data, and draw valid conclusions. The specified course outcomes (CO1 through CO7) directly contribute to these objectives by equipping students with the technical skills necessary for data analysis using R-software. These outcomes enable students to engage in various stages of the research process, from data acquisition to interpretation, thereby fostering research-related skills and a scientific temper.

PO5. Trans-disciplinary Knowledge

No direct mapping.

Justification:

Trans-disciplinary knowledge involves understanding and integrating principles from multiple disciplines to address complex problems. While the use of R-software and data analysis techniques may have applications across various domains, the specified course outcomes primarily focus on technical skills within the context of statistical analysis and data science. Therefore, the mapping to trans-disciplinary knowledge would be indirect, as it would depend on the specific application domains of the skills learned.

PO6. Personal and Professional Competence

No direct mapping.

Justification:

Personal and professional competence encompass a wide range of skills and attributes, including self-awareness, adaptability, professionalism, and leadership. While proficiency in using R-software and conducting data analysis could enhance one's professional competence, the specified course outcomes primarily focus on technical skills and do not directly address the broader aspects of personal and professional development.

PO7. Effective Citizenship and Ethics

No direct mapping.

Justification:

Effective citizenship and ethics involve understanding one's responsibilities within society and adhering to ethical principles in decision-making and actions. While the skills learned in using R-software and conducting data analysis could be applied in various contexts, the specified course outcomes do not explicitly address ethical considerations or societal responsibilities, thus making the mapping indirect.

PO8. Environment and Sustainability

No direct mapping.

Justification:

Environment and sustainability involve understanding the impact of human activities on the environment and promoting practices that ensure the sustainable use of resources. The specified course outcomes focus on technical skills in R-software and data analysis, which do not directly relate to environmental issues or sustainability considerations.

PO9. Self-directed and Life-long Learning

CO1. use R-software for statistical computing. (3)

CO2. to import data from other form to R-software (3)

CO3. to create data file using R-software. (2)

CO4. to visualize data with various graphical and diagrammatic techniques and interpretation using R software in exploratory data analysis. (3)

CO5. to summarize and analyze the data using R software. (3)

CO6. to interpret summary statistics of R-software output. (3)

CO7. to access the residing data in R-software for data analysis. (3)

Justification:

Self-directed and life-long learning involve the ability to acquire new skills and knowledge independently and continuously throughout one's life. The specified course outcomes (CO1 through CO7) directly contribute to this by providing students with the technical skills necessary for data analysis using R-software. These skills empower students to continue learning and adapting to new tools and technologies in the field of data science, thus fostering self-directed and life-long learning abilities.

**CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Statistics
(2023 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: F.Y.B.Sc.
Semester	: II
Course Type	: VSC Practical
Course Code	: STA-171-VSC
Course Title	: Data Analysis with R Software
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. To provide fundamental skills and knowledge with effective utilization of R Software for data analysis and management.
2. To understand the basics of R Software and its various applications.
3. To introduce basic concepts, formulas, functions, and tools within R Software, enabling students to create, edit, format, and analyze data and perform calculations.
4. To convert mixed data types into appropriate types using R Software.
5. To enhance the skill of effectively clean data by Using R software.
6. To compute descriptive statistics, such as mean, median, mode, standard deviation, and variance etc. using R Software in data analysis point of view.
7. To identify and understand pattern of data by using data visualization in R Software.

Course Outcomes:

Student will be able to

- CO1.** demonstrate the basic mechanics and navigation of an R Software.
- CO2.** proficiency in using the R programming language for data analysis, which includes data manipulation, visualization, and statistical analysis.
- CO3.** create charts and graphs student can easily explain complex information or data.
- CO4.** to write and understand basic R code.
- CO5.** to understand and be able to compute descriptive statistics to summarize and describe datasets, including measures of central tendency and variability.
- CO6.** to create clear and concise reports and presentations summarizing their data analysis

findings using tools like R Software.

CO7. proficiently utilizes R software for data exploration, data pre-processing, data transformation, data visualization, and basic statistical analysis.

Topics and Learning Points

UNIT 1: Data Exploration and data Pre-processing using R software:

1. Data Exploration:

Explore it using R, including summary statistics, data visualization, and identifying any initial patterns or outliers.

2. Data Cleaning :

Remove Duplicate Rows in R. Handling Missing Values in R, Correcting Data Entry Errors in R

UNIT2: Data Transformation with R:

1. Converting Data Types in R: Provide a dataset with mixed data types and require students to convert them into the appropriate types (e.g., character to numeric).
2. Scaling or Normalizing Variables in R: Provide numerical variables and instruct students to scale or normalize them using methods like Min-Max scaling or z-score standardization.
3. Creating New Variables in R: Provide a dataset and ask students to create new variables by performing operations on existing ones, such as calculating percentages or creating categorical variables from continuous ones.

UNIT 3: Data Visualization with R:

Creating Bar Charts, Histograms in R: Constructing histograms to visualize data distribution, Box Plots for Data Comparison:

UNIT 4: Data Analysis Using Statistical techniques:

Measuring Central Tendency, Exploring Variability: Practical Exercises on Range, Variance, and Standard Deviation, Skewness and Kurtosis: Identifying Data Distribution Characteristics.

List of Practical's:

Sr.No.	Title of the Experiment	No. of Experiments
1	Data Exploration using R Software:	1
2	Data Cleaning using R Software	1
3	Data Transformation Using R Software	1
4	Handling Outliers using R Software	1
5	Merging and Joining Datasets in R Software.	1
6	Diagrammatic representation of the Data in R software	1
7	Graphical representation of the Data in R software	1
8	Measuring Central Tendency for Categorical as well as continuous data In R Software:	1
9	Exploring Variability in the data: Practical Exercises on Range, Variance, and Standard Deviation in R Software."	1
10	Identifying Data Distribution Characteristics: Skewness and Kurtosis Analysis in R	1
11	Applying R skills for analysing and interpreting case studies from different fields.	2

Note: Every practical is equivalent to four hours per batch per week

References:

1. Shailaja R. Deshmukh, Sharad D.Gore (12 March 2008), Statistics Using R, Alpha science international Ltd,
2. Vishwas R. Pawgi (2022). Statistical Computing Using R Software, Nirali Prakashan.
3. Garrett Grolemund (2014). Hands-On Programming with R: Write Your Own Functions and Simulations.
4. K.G. Srinivasa , G. M. Siddesh (5 June 2007) .Statistical programming in R , Oxford University Press
5. Dr. Sangita Birajdar (2020). Descriptive Statistics, Parijat Prakashan
6. S.C. Gupta (2002). Fundamentals of Mathematical Statistics.

Programme Outcomes and Course Outcomes Mapping:

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

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

PO1. Disciplinary Knowledge

- CO1: 3 (Strongly Related)
- CO2: 3 (Strongly Related)
- CO3: 2 (Moderately Related)
- CO4: 2 (Moderately Related)
- CO5: 3 (Strongly Related)
- CO6: 2 (Moderately Related)
- CO7: 3 (Strongly Related)

Justification: CO1 to CO7 directly contribute to disciplinary knowledge in data analysis and programming using R software. They cover essential skills and knowledge required for data analysis, statistical computation, and visualization, which are foundational aspects of disciplinary knowledge in this domain.

PO2. Critical Thinking and Problem solving

- CO1: 3 (Strongly Related)
- CO2: 3 (Strongly Related)

- CO3: 3 (Strongly Related)
- CO4: 3 (Strongly Related)
- CO5: 3 (Strongly Related)
- CO6: 3 (Strongly Related)
- CO7: 3 (Strongly Related)

Justification: Critical thinking and problem-solving skills are central to using R for data analysis. CO1 to CO7 involve various aspects of data analysis, including data manipulation, visualization, statistical computation, and reporting, which require critical thinking and problem-solving abilities to interpret and present results effectively.

PO3. Social competence

- CO1: 1 (Partially Related)
- CO2: 1 (Partially Related)
- CO3: 2 (Moderately Related)
- CO4: 1 (Partially Related)
- CO5: 1 (Partially Related)
- CO6: 2 (Moderately Related)
- CO7: 1 (Partially Related)

Justification: While the use of R software may involve collaboration and communication, the technical skills emphasized in CO1 to CO7 are not directly related to social competence. However, CO3 and CO6, which involve creating clear reports and presentations, have some relevance to communicating complex information effectively, which is a component of social competence.

PO4. Research-related skills and Scientific temper

- CO1: 3 (Strongly Related)
- CO2: 3 (Strongly Related)
- CO3: 3 (Strongly Related)
- CO4: 2 (Moderately Related)

- CO5: 3 (Strongly Related)
- CO6: 3 (Strongly Related)
- CO7: 3 (Strongly Related)

Justification: CO1 to CO7 directly contribute to research-related skills and scientific temper by equipping students with the necessary tools and techniques for data analysis and interpretation using R software. These objectives emphasize data manipulation, statistical analysis, visualization, and reporting, all of which are crucial aspects of research in various fields.

PO5. Trans-disciplinary knowledge

- CO1: 2 (Moderately Related)
- CO2: 2 (Moderately Related)
- CO3: 2 (Moderately Related)
- CO4: 2 (Moderately Related)
- CO5: 2 (Moderately Related)
- CO6: 2 (Moderately Related)
- CO7: 2 (Moderately Related)

Justification: While R programming skills are applicable across various disciplines, the specific focus of CO1 to CO7 on data analysis using R limits their direct trans-disciplinary relevance. However, the skills learned can be valuable in diverse fields requiring data analysis and interpretation.

PO6. Personal and professional competence

- CO1: 3 (Strongly Related)
- CO2: 3 (Strongly Related)
- CO3: 3 (Strongly Related)
- CO4: 3 (Strongly Related)
- CO5: 3 (Strongly Related)
- CO6: 3 (Strongly Related)

- CO7: 3 (Strongly Related)

Justification: CO1 to CO7 contribute significantly to personal and professional competence by enhancing students' skills in data analysis, statistical computation, visualization, and reporting using R software. These objectives are directly relevant to developing proficiency and expertise in data analysis, which is valuable in various professional settings.

PO7. Effective Citizenship and Ethics

- CO1: 1 (Partially Related)
- CO2: 1 (Partially Related)
- CO3: 1 (Partially Related)
- CO4: 1 (Partially Related)
- CO5: 1 (Partially Related)
- CO6: 2 (Moderately Related)
- CO7: 1 (Partially Related)

Justification: While ethical considerations may arise in data analysis and reporting, the technical skills emphasized in CO1 to CO7 are not directly related to effective citizenship and ethics. However, CO6, which involves creating clear and concise reports, has some relevance to presenting data ethically and accurately.

PO8. Environment and Sustainability

- CO1: 1 (Partially Related)
- CO2: 1 (Partially Related)
- CO3: 1 (Partially Related)
- CO4: 1 (Partially Related)
- CO5: 1 (Partially Related)
- CO6: 1 (Partially Related)
- CO7: 1 (Partially Related)

Justification: The objectives of the course do not directly address environmental or sustainability concerns.

PO9. Self-directed and Life-long learning

- CO1: 3 (Strongly Related)
- CO2: 3 (Strongly Related)
- CO3: 3 (Strongly Related)
- CO4: 3 (Strongly Related)
- CO5: 3 (Strongly Related)
- CO6: 3 (Strongly Related)
- CO7: 3 (Strongly Related)

Justification: CO1 to CO7 promote self-directed and life-long learning by equipping students with essential skills and knowledge in data analysis using R software. These objectives emphasize independent problem-solving, critical thinking, and effective communication, all of which are vital for continuous learning and professional development.

**CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Statistics
(2023 Pattern)**

Name of the Programme	: B.Sc. Statistics
Programme Code	: USST
Class	: F.Y.B.Sc.
Semester	: II
Course Type	: Skill Enhancement Course (SEC) Practical
Course Code	: STA-176-SEC
Course Title	: Application of Statistics Using Advanced Excel
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. To provide students with the fundamental skills and knowledge necessary to effectively utilize MS Excel for data analysis and management.
2. Introduce basic concepts, formulas, functions, and tools within Excel, enabling students to create, edit, format, and analyse data and perform calculations
3. Computation of correlation coefficients, and fitting of regression models using excel and their interpretation.
4. Use of MS-Excel for computation of probabilities and model sampling from some standard discrete probability distributions.
5. Effectively utilize Microsoft Excel for Data visualization using Pivot table and Pivot charts.
6. Explore advanced features such as conditional formatting and filtering.
7. Develop skills in managing and organizing large datasets through hands-on exercises and projects.

Course Outcomes:

Student will be able to

- CO1.** demonstrate the basic mechanics and navigation of an Excel.
- CO2.** proficient in basic functionalities, creating and formatting worksheets.
- CO3.** gain working knowledge use of MS-Excel for computation of probabilities and model sampling from some standard discrete probability distributions
- CO4.** apply regression analysis to model relationships between variables and make predictions or identify factors that influence an outcome
- CO5.** summaries data using various statistical measures.

- CO6.** create charts and graphs can easily explain complex information or data using Pivot analysis.
- CO7.** explore advanced features such as conditional formatting and filtering.
- CO8.** manage and organize real datasets through hands-on exercises and projects.

Topics and Learning Points

UNIT 1: Advanced Formulas and Functions:

- 1.1** Nested functions: Combining multiple functions within a formula.
- 1.2** Array formulas: Performing calculations on arrays of data.
- 1.3** Logical: IF, AND, NOT, OR, LET, LAMBDA, TRUE, FALSE, SWITCH, etc.
- 1.4** IF functions: Complex logical tests and multiple nested IF statements.
- 1.5** Advanced functions like SUMIF, COUNTIF, AVERAGEIF, COUNTIFS, SUMIFS, and AVERAGEIFS. Lookup functions: LOOKUP, VLOOKUP, HLOOKUP, XLOOKUP, INDEX, and MATCH for data retrieval, Conditional Formatting.

UNIT 2: Data Analysis and Visualization

- 2.1** PivotTables and Pivot Charts: Creating PivotTables for multidimensional data analysis. Customizing PivotTables with calculated fields and items. Building interactive Pivot Charts for visualizing data.
- 2.2** Dashboards Excel
 - **Define the Purpose and Audience:** Clearly understand the purpose of your dashboard and who your audience is. What key metrics or insights are you trying to convey?
 - **Data Preparation:** Ensure your data is clean, structured, and up-to-date. Consider using Excel tables (also known as lists) to make data management easier.
 - **Select the Visual Elements:** Choose the appropriate charts, graphs, and visuals to represent your data. Common options include bar charts, line charts, pie charts, and gauges.
 - **Layout and Design:** Create a clean and organized layout for your dashboard. Use gridlines, shapes, and text boxes to arrange elements. Choose a consistent color scheme and fonts to enhance readability and aesthetics. Consider using Excel's built-in themes and styles for a professional look.
 - **Interactive Elements:** Make your dashboard interactive by using features like dropdown lists, slicers, or form controls.

List of Practicals:

Sr. No.	Title of Experiment	No. of Experiment
1.	Logical functions	1
2.	Conditional formatting	1
3.	Lookup functions	1
4.	Pivot Table and Pivot Chart	1
5.	Scatter diagram, correlation coefficient (ungrouped data). Fitting of line of regression, residual plot	1
6.	Fitting of second degree curve, exponential curve of type $y = ab^x$, $y = ax^b$	1
7.	Model sampling from some standard discrete probability distributions.	1
8.	Applications of Binomial, Poisson, Geometric and Hyper-geometric Distribution	1
9.	Fitting of Binomial and Poisson distribution	1
10.	Dashboards in excel	2
11.	Case Study	1

Note:

1. Every practical is equivalent to four hours per batch per week

References:

1. M. L. Humphrey, Excel for Beginners
2. William Fischer, Excel: Quick start Guide for Beginner to Expert
3. Michkel Alexander, Dick Kusleika, John Walkenbeach, Microsoft Excel 2019 Bible The Comprehensive Tutorial Resource, Wiley Publication
4. Frag Curtis (2013). Step by Step Microsoft Excel 2013, MS Press
5. Frye Curtis D. (2007). Step by step Microsoft Office Excel 2007, Microsoft Press,
6. John Walkenbach (2013), 101 Excel 2013 Tips, Tricks and Time savers, Wiley.
7. Kumar Bittu (2013). Microsoft Office 2010, V&S Publishers.
8. Salkind Neil J. and Frey Bruce B (2021). Statistics for people who (Think They) Hate Statistics, Using MS- Excel, Sage Publications.
9. Sanjay Saxen (2007). MS Office 2000 for everyone, Vikas Publishing House.
10. Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol. II, World Press, Calcutta.

Programme Outcomes and Course Outcomes Mapping:

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

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

PO1. Disciplinary Knowledge

CO3: Gain working knowledge use of MS-Excel for computation of probabilities and model sampling from some standard discrete probability distributions (Weight: 3)

CO4: Apply regression analysis to model relationships between variables and make predictions or identify factors that influence an outcome (Weight: 3)

Justification: These course outcomes directly involve the application of disciplinary knowledge in the context of data analysis and statistics using Excel.

PO2. Critical Thinking and Problem-solving

CO3: Gain working knowledge use of MS-Excel for computation of probabilities and model sampling from some standard discrete probability distributions (Weight: 2)

CO4: Apply regression analysis to model relationships between variables and make predictions or identify factors that influence an outcome (Weight: 3)

CO5: Summarize data using various statistical measures (Weight: 2)

Justification: These outcomes involve the application of critical thinking and problem-solving skills to analyze data, compute probabilities, model relationships, and summarize statistical measures using Excel.

PO3. Social Competence

No direct mapping.

PO4. Research-related Skills and Scientific Temper

CO3: Gain working knowledge use of MS-Excel for computation of probabilities and model sampling from some standard discrete probability distributions (Weight: 1)

CO4: Apply regression analysis to model relationships between variables and make predictions or identify factors that influence an outcome (Weight: 2)

CO8: Manage and organize real datasets through hands-on exercises and projects (Weight: 2)

Justification: These outcomes involve using Excel as a tool for data analysis, which is often a part of research projects, and require scientific temper to interpret results accurately.

PO5. Trans-disciplinary Knowledge

No direct mapping.

PO6. Personal and Professional Competence

CO1: Demonstrate the basic mechanics and navigation of an Excel (Weight: 2)

CO2: Proficient in basic functionalities, creating and formatting worksheets (Weight: 2)

CO7: Explore advanced features such as conditional formatting and filtering (Weight: 2)

Justification: These outcomes involve developing personal and professional competence in using Excel effectively for various tasks, from basic navigation to advanced features.

PO7. Effective Citizenship and Ethics

No direct mapping.

PO8. Environment and Sustainability

No direct mapping.

PO9. Self-directed and Life-long Learning

CO1: Demonstrate the basic mechanics and navigation of an Excel (Weight: 1)

CO2: Proficient in basic functionalities, creating and formatting worksheets (Weight: 1)

CO7: Explore advanced features such as conditional formatting and filtering (Weight: 1)

CO8: Manage and organize real datasets through hands-on exercises and projects (Weight: 1)

Justification: These outcomes involve developing skills in using Excel as a tool for self-directed learning and lifelong learning, as Excel is widely used in various fields and continuous learning is necessary to keep up with advancements in its usage.