



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 -I

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

(Eligibility : 12th Science)

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

Preamble

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Statistics and related subjects, the Board of Studies in Statistics at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the first semester of F.Y.B.Sc. Statistics, which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCrF, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May 2023.

The word Statistics is used in different ways in different contexts. To a cricket fan, Statistics is the information about runs scored or wicketstaken by a player. To the manager of a manufacturing unit, Statistics may be the information about the process control. To a medical researcher investigating the effects of a new drug, Statistics are evidence of research efforts. To a college student, Statistics are the grades or marks scored in a course. Thus, in all

these illustrations Statistics word refers to quantitative data in the area under study. Statistics as a subject is an important branch of knowledge and is devoted to various techniques of collection, presentation, analysis and interpretation of data. It is a science of learning from data.

This Statistics syllabus serves as a guide to the course content, objectives, and expectations for students pursuing a degree in Statistics. This program is designed to provide you with a solid foundation in statistical theory, methods, and applications, equipping you with the necessary skills to analyze and interpret data effectively. Statistics is a discipline that revolves around the collection, analysis, interpretation, presentation, and organization of data. In today's data-driven world, the need for statisticians has never been greater. This program aims to foster your understanding of statistical concepts, develop your analytical thinking, and enhance your ability to make informed decisions based on data-driven evidence.

Throughout this program, you will be exposed to a wide range of statistical topics, including probability theory, mathematical statistics, regression analysis, experimental design, multivariate analysis, time series analysis, and more. You will also gain proficiency in statistical software and programming languages commonly used in the field, such as SPSS, Minitab, R, Python, etc.

The BSc in Statistics program is structured to provide a balance between theoretical knowledge and practical applications. You will engage in hands-on data analysis projects, where you will have the opportunity to apply statistical techniques to real-world problems. These projects will strengthen your problem-solving skills and help you develop a critical approach to statistical analysis. Additionally, this program encourages a multidisciplinary approach. Statistics finds applications in various fields, such as social sciences, finance, economics, healthcare, environmental sciences, and market research.

In summary, the BSc in Statistics program offers a comprehensive education in statistical theory and practice. It equips you with the skills needed to analyze data, draw meaningful conclusions, and make evidence-based decisions. We are excited to embark on this educational journey with you and look forward to your growth as a skilled statistician.

Overall, revising the Statistics syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing global landscape.

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.

Anekant Education Society's
Tuljaram Chaturchand College, Baramati
(Autonomous)

Board of Studies (BOS) in Statistics

From 2022-23 to 2024-25

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

19.	Miss. Kiran Banda (M.Sc. II)	Student Representative
20.	Mr. Rushikesh Pandhare (M.Sc. II)	Student Representative
21.	Mr. Bharat Jambhulkar (TYBSc)	Student Representative
22.	Miss. Prapti Mane (TYBSc)	Student Representative

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 STA-135-VEC: Environmental Science Credit- 2+2+2	CC1: To be selected from the Basket Credit- 2	22	UG Certificate 44
		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 STA-185-VEC: Digital and Technological Solutions Credit- 2+2 * 1 credit = 15 Hr.	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)	STA-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	Basic 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)	STA -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	: USSTA
Class	: F.Y.B.Sc.
Semester	: I
Course Type	: Major Mandatory (Theory)
Course Code	: STA-101-MJM
Course Title	: Descriptive Statistics – I
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Students will develop a strong foundation to analyze and interpret data in various fields.
2. Compute various measures of central tendency and dispersion.
3. Summarize data using frequency distributions and graphical representations.
4. Gain knowledge of different types of data.
5. Acquire proficiency in calculating and interpreting various quantiles.
6. Develop critical thinking and problem-solving skills by applying descriptive statistics techniques to real-world scenarios and data sets.
7. Develop effective written and oral communication skills to present and explain descriptive statistics results clearly and accurately.

Course Outcomes:

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

- CO1.** Demonstrate a solid understanding of the fundamental concepts of descriptive statistics, including measures of central tendency and measures of variability.
- CO2.** Summarize and organize data effectively using appropriate graphical representations and descriptive statistics techniques.
- CO3.** Interpret and analyze data sets accurately, identifying patterns and trends.
- CO4.** Apply the appropriate descriptive statistics techniques to different types of data, such as categorical, ordinal, and continuous variables.
- CO5.** Calculate and interpret various quantiles.

CO6. Apply critical thinking and problem-solving skills to data sets, effectively utilizing descriptive statistics techniques to draw meaningful conclusions.

CO7. Communicate descriptive statistics results clearly and effectively through written reports and oral presentations.

Topics and Learning Points

UNIT – 1 Population and Sample

(5L)

1.1 Types of characteristics

Attributes: Nominal scale, ordinal scale

Variable: Interval scale, ratio scale, discrete and continuous variables

1.2 Types of data

i) Primary data: Design of Questionnaire, secondary data

ii) 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.

1.5 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

UNIT – 2 Measures of Central Tendency (10L)

2.1 Concept of central tendency of statistical data, statistical average, characteristics of a good statistical average.

2.2 Arithmetic Mean (AM): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, trimmed arithmetic mean.

2.3 Median: Definition, merits and demerits, Partition values: Quartiles deciles and percentiles (for ungrouped and grouped data).

2.4 Mode: Definition, merits and demerits, empirical relation between mean, median and mode (without proof)

2.5 Geometric Mean (GM): Definition, formula, merits and demerits Harmonic Mean (HM): Definition, formula, merits and demerits Relation between H.M., G.M. and A.M.

UNIT – 3 Measures of Dispersion

(8L)

- 3.1 Concept of dispersion, characteristics of good measures of dispersion. Range, semi-interquartile range (quartile deviation): Definition, merits and demerits. Mean deviation.
- 3.2 Definition, merits and demerits, minimality property (without proof).
- 3.3 Variance and standard deviation: Definition merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups).
- 3.4 Mean squared deviation: Definition, minimality property of mean squared deviation (without proof), merits and demerits measures of dispersion for comparison: coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation(CV)

UNIT – 4 Moments, Skewness and Kurtosis

(7L)

- 4.1 Raw moments μ'_r ; $r = 1, 2, 3, 4$ for ungrouped and grouped data.
- 4.2 Central moments μ_r ; $r = 1, 2, 3, 4$ for ungrouped and grouped data, effect of change of origin and scale.
- 4.3 Relations between central moments and raw moments, up to 4th order.
- 4.4 Concept of skewness of frequency distribution: Definition, type of skewness, measures of skewness;
 - i) Karl Pearson coefficient of skewness
 - ii) Pearsonian coefficient of skewness
 - iii) Bowley's coefficient of skewness
- 4.5 Bowley's coefficient of skewness lies between -1 to 1 (with proof) Interpretation using box plot.
- 4.6 Concept of kurtosis of frequency distribution: Definition, types of kurtosis, measure of kurtosis based on moments and partition values.
- 4.7 Examples and problem.

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.

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

Name of the Programme	: B.Sc. Statistics
Programme Code	: USSTA
Class	: F.Y.B.Sc.
Semester	: I
Course Type	: Major Mandatory (Theory)
Course Code	: STA-102-MJM
Course Title	: Discrete Probability and Probability Distributions – I
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Understand the concept of sample spaces, events, probability, conditional probability including Bayes' theorem and independence of events.
2. Learn the concepts of random variables and probability distributions.
3. Understand and apply the properties of probability distributions, such as the probability mass function (PMF), cumulative distribution function (CDF), and expected value.
4. Calculating and interpreting measures of central tendency (mean, median, mode) and dispersion (variance, standard deviation) for discrete random variables.
5. Computation of probabilities to solve real-world problems.
6. Develop problem-solving skills related to discrete probability distributions.
7. Communicate and present probability concepts and findings effectively through written reports and oral presentations.

Course Outcomes:

By the end of this course student will be able to:

- CO1.** understand the difference between random and non-random experiments.
- CO2.** understand the concepts of sample spaces, events and probability.
- CO3.** understand conditional probability, Bayes' theorem and independence of events.
- CO4.** understand and analyze discrete random variables, including their probability distributions and associated measures of central tendency and dispersion.
- CO5.** interpret and apply probability distribution properties, such as the probability mass function (PMF), cumulative distribution function (CDF), and expected value.

CO6. Demonstrate critical thinking and problem-solving skills by applying discrete probability and probability distribution concepts to various applied problems.

CO7. Communicate probability concepts and findings effectively through well-structured written reports and clear oral presentations.

Topics and Learning Points

Unit – 1 Sample space and Events: (5L)

- 1.1 Concepts of experiments, deterministic and non-deterministic experiments.
- 1.2 Definitions: Sample space, Types of sample space, Event, Types of Events: Elementary event, Complementary event, sure event, impossible event.
- 1.3 Concept of occurrence of an event, Equally-likely events
- 1.4 Algebra of events (Union, Intersection, Complementation).
- 1.5 Definitions of Mutually exclusive events, Exhaustive events.
- 1.6 Algebra of events and its representation of events in set theory notation:
Occurrence of the following events:
 - i) at least one of the given events
 - ii) none of the given events
 - iii) all of the given events
 - iv) mutually exclusive events
 - v) mutually exhaustive events
 - vi) exactly one event out of the given events.
- 1.7 Illustrative examples.

Unit – 2 Probability: (8L)

- 2.1 Concept of Permutations and Combinations
Equiprobable and non-equiprobable sample space, Classical definition of probability, examples. Probability model, probability of an event, examples.
The axiomatic approach of probability.
- 2.2 Important results and their proofs of the results:
 - i) $P(\Phi) = 0$,
 - ii) $P(A^c) = 1 - P(A)$,
 - iii) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ (Addition theorem of probability) and its generalization (Statement only).

iv) If $A \subset B$, $P(A) \leq P(B)$

v) $0 \leq P(A \cap B) \leq P(A) \leq P(A \cup B) \leq P(A) + P(B)$.

vi) $P(A \cup B) \leq P(A) + P(B)$ (Boole's Inequality) and its generalization (Statement only).

2.3 Interpretation of probability in terms of odds ratio.

2.4 Illustrative examples.

Unit – 3 Conditional Probability and Independence of events: (8L)

3.1 Definition of the conditional probability of an event.

3.2 Multiplication theorem for two and three events.

3.3 Partition of sample space.

3.4 Idea of Posterior probability, Statement, and proof of Bayes' theorem, examples on Bayes' theorem.

3.5 Sensitivity and specificity

3.6 Concept of Independence of two events.

3.7 Proof of the result that if events A and B are independent then,

i) A and B^c ,

ii) A^c and B

iii) A^c and B^c are independent.

3.8 Pairwise and Mutual Independence for three events.

3.9 Illustrative examples.

Unit – 4 Univariate Probability Distributions (Finite Sample Space): (6L)

4.1 Definition of a discrete random variable.

4.2 Probability mass function (p.m.f.) and cumulative distribution function (c.d.f.) of a discrete random variable, Properties of c.d.f. (statement only).

4.3 Probability distribution of a function of a random variable.

4.4 Median and Mode of a univariate discrete probability distribution.

4.5 Illustrative examples.

Unit – 5 Mathematical expectation (Univariate random variable) (6L)

5.1 Definition of expectation of a random variable, the expectation of a function of a random variable.

5.2 Definition of variance, standard deviation (s.d.), Effect of change of origin and scale on mean, variance, and s.d. of random variable.

5.3 Definition of raw, central, and factorial moments of univariate probability distributions and their interrelations.

5.4 Definition of moment generating function (m.g.f.), deduction of moments from

m.g.f. and properties of m.g.f.: i) $M_x(0) = 1$ ii) Effect of change of origin and scale on m.g.f. iii) Additive property of m.g.f.

5.5 Definition of the cumulant generating function (c.g.f) deduction of cumulants from c.g.f. and properties of c.g.f.: ii) Effect of change of origin and scale on c.g.f. iii) Additive property of c.g.f.

5.6 Nature of probability distribution by using Pearsonian Coefficient of skewness and kurtosis.

5.7 Illustrative 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.
8. B. L. Agarwal : Programmed Statistics, New Age International Publishers, New Delhi.
9. Wayne W. Daniel : Biostatistics
10. Brase C. H. and Brase C. P., (2018), Understandable Statistics, Twelfth Edition, Cengage Learning.
11. Biston Moore D. S., Notz W. I., Flinger M. A., (2013), The Basic Practice of Statistics, Sixth Edition, Freeman and Company New York

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

Name of the Programme	: B.Sc. Statistics
Programme Code	: USSTA
Class	: F.Y.B.Sc.
Semester	: I
Course Type	: Major Mandatory (Practical)
Course Code	: STA-103-MJM
Course Title	: Statistics Practical – I
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

- 1) Students will develop a strong foundation to analyze and interpret data in various fields.
- 2) Compute various measures of central tendency and dispersion.
- 3) Summarize data using frequency distributions and graphical representations.
- 4) Acquire proficiency in calculating and interpreting various quantiles.
- 5) Understand the concept of sample spaces, events, probability, conditional probability including Bayes' theorem and independence of events.
- 6) Calculating and interpreting measures of central tendency (mean, median, mode) and dispersion (variance, standard deviation) for discrete random variables.
- 7) Computation of probabilities to solve real-world problems.

Course Outcome:

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

- CO1.** understand the fundamental concepts of descriptive statistics, including measures of central tendency and measures of dispersion.
- CO2.** utilize appropriate graphical representations and descriptive statistics measures to present and interpret data.
- CO3.** utilize probability and discrete probability distributions to solve practical problems.
- CO4.** utilize probability distributions to calculate probabilities of outcomes.
- CO5.** to perform data analysis, generate summary statistics, and visualize data by using R software.
- CO6.** apply critical thinking and problem-solving skills to real-world scenarios by

effectively applying descriptive statistics and probability concepts.

CO7. apply knowledge and skills gained from the course to solve practical problems and make informed decisions.

Sr. No.	Title of Experiment
1	Use of Random Number Tables to Draw SRSWOR, SRSWR, Stratified Sample and Systematic Sample
2	Diagrammatic Representation of Statistical Data (Simple and Subdivided Bar Diagrams, Multiple Bar Diagram, Percentage Bar Diagram, Pie Diagram)
3	Graphical Representation of Statistical Data (Histogram, Frequency Curve and Ogive Curves, Determination of Mode and Median Graphically)
4	Measures of Central Tendency – I
5	Measures of Central Tendency – II
6	Measures of Dispersion – I
7	Measures of Dispersion – II
8	Moments, Skewness and Kurtosis
9	Probability, Conditional Probability
10	Application of Bayes' Theorem and Independence of Events
11	Univariate Discrete Probability Distribution – I
12	Univariate Discrete Probability Distribution – II
13	Project equivalent to 3 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.

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

Name of the Programme	: B.Sc. Statistics
Programme Code	: USSTA
Class	: F.Y.B.Sc.
Semester	: I
Course Type	: OE Theory
Course Code	: STA-116-OE
Course Title	: Commercial Statistics
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Inculcate awareness and appreciation for data and Statistics
2. Familiarize students with essential statistical terms and concepts.
3. Introduce various methods of collection and sampling techniques.
4. Develop skills in creating and interpreting data graphically.
5. Introduction of statistical measures for summarizing data.
6. Discuss different sampling methods and their implications.
7. To develop students' ability to think critically about data and statistical analyses.

Course Outcomes:

Students should be able to

- CO1.** demonstrate understanding of statistical concepts and utilize it in real life data analysis.
- CO2.** organize and summarize data using appropriate statistical measures.
- CO3.** create and interpret data graphically.
- CO4.** apply statistical concepts and techniques to real-world scenarios.
- CO5.** Familiarize with various sampling techniques, it's advantages, disadvantages, and applications.
- CO6.** understand the practical applications of statistics in various fields and be able to apply statistical methods to real-world problems.
- CO7.** cultivate critical thinking skills related to data analysis and interpretation.
- CO8.** use and communicate statistical information accurately and responsibly, recognizing the potential impact of statistical misinterpretation.

Topics and Learning Points

UNIT 1: Introduction to Statistics

(4L)

Definitions, need and importance, scope of Statistics.

UNIT 2: Data condensation and representation

(8L)

2.1 Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.

2.2 Classification of data, frequency distribution, cumulative frequency distribution

2.3 Graphical representations: Histogram, frequency polygon, frequency curve, ogive curves.

2.4 Diagrammatical representations: simple, multiple, subdivided bar diagrams, stem-leaf chart and pie diagram

2.5 Examples and problems.

UNIT 3: Population and Sample

(8L)

3.1 Concept of statistical population with illustrations, concept of sample with illustrations.

3.2 Census and sampling, Advantages of sampling over census.

3.3 Design of Questionnaire.

3.4 Methods of sampling: Probability Sampling Techniques: Simple Random Sampling and Stratified Random Sampling, Systematic, Cluster sampling and Non-Probability Sampling Techniques: Convenience sampling, Purposive sampling, Snowball sampling, Quota sampling.

3.5 Examples and problems.

UNIT 4: Measures of Central Tendency (Averages)

(10L)

4.1 Concept of central tendency, criteria for good measures of central tendency.

4.2 Arithmetic mean: Definition, computation for ungrouped and grouped data, combined mean, weighted mean, trimmed mean, merits and demerits.

4.3 Median: Definition, computation for ungrouped and grouped data, graphical method, merits and demerits.

4.4 Mode: Definition, computation for ungrouped and grouped data, graphical method, merits and demerits, empirical relation.

4.5 Examples and problems.

References:

1. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.
2. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.

3. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.
4. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentice Hall of India, New Delhi.
5. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.
6. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1996): Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

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

Name of the Programme	: B.Sc. Statistics
Programme Code	: USSTA
Class	: F.Y.B.Sc.
Semester	: I
Course Type	: OE Practical
Course Code	: STA-117-OE
Course Title	: Introduction to MS-Excel and Statistical Computing
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. Familiarize students with the Excel interface and basic functionalities.
3. Introduce the essential spreadsheet concepts and terminology and develop proficiency in creating and formatting worksheets.
4. Provide an understanding of data entry and manipulation techniques.
5. Introduce basic concepts, formulas, functions, and tools within Excel, enabling students to create, edit, format, and analyze data and perform calculations.
6. Effectively utilize Microsoft Excel for Data visualization using charts and graphs
7. Explore advanced features such as conditional formatting and filtering.
8. 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 of organizing and displaying raw data in structured format.
- CO4.** gain working knowledge of organizing and displaying raw data in structured format.
- CO5.** use and utilize functions and formulas in Excel.
- CO6.** summaries data using various statistical measures.
- CO7.** create charts and graphs can easily explain complex information or data.
- CO8.** explore advanced features such as conditional formatting and filtering.

CO9. manage and organize real datasets through hands-on exercises and projects.

Topics and Learning Points

UNIT 1: Introduction to Excel:

- 1.1 Introduction to importance of MS-Excel skills in various industries.
- 1.2 The Excel Environment: Cells, Rows, and Columns, Title Bar, Ribbon, Scroll Bars, Quick Access Toolbar, Formula Bar, Workbook View Buttons, Zoom Slider, Mini Toolbar, Keyboard Shortcuts, Formulas, Sheet Tabs, Page Margins, Page Orientation, Page Breaks and Printing.
- 1.3 Worksheets and Workbooks: Definition of Worksheets and Workbooks, creating and saving new worksheet, Naming of Worksheets, Adding and Deleting Worksheets, Hiding/ Unhiding Worksheets, Hiding Columns and Rows, Saving Workbooks, Saving an Existing File, Headers, and Footers, Inserting, Deleting, copy and Renaming of Worksheets. Conditional Formatting and cell styles, Basic file operations (open, save, rename, close)

UNIT 2: Data Entry and Manipulation

- 2.1 Import external data, Entering Data, create a table, Labels and Values, Copying Cells, Rows and Columns, Pasting Cells, Rows, and Columns, Paste an Item from the Clipboard
- 2.2 Inserting and Deleting Rows and Columns, Filling and Editing Cell Data, Find and Replace, Go to Cell Data, Locking Rows and Columns, Spell Check, AutoCorrect. Change Font Styles and Sizes, Adding Borders and Colors to Cells, change Column Width, change Row Height, Merge Cells, Applying Number Formats

UNIT 3: Inbuilt MS-Excel Functions

- 3.1 Basic mathematical operators: ABS, EXP, CEILING, FLOOR, INT, EVEN, ODD, COMBIN, COMBINA FACT, FACTDOUBLE, GCD, LCM, LN, LOG, LOG10, MOD, MULTINOMIAL, POWER PRODUCT, RAND, RANDARRAY, RANDBETWEEN, ROUND, SIGN, SORT, etc.
- 3.2 Logical: IF, AND, NOT, OR, LET, LAMBDA, TRUE, FALSE, SWITCH, etc. and Lookup: LOOKUP, HLOOKUP, VLOOKUP, XLOOKUP, etc.

Other functions: Date and Time Functions, Text functions, sort, duplicate, Pivot table, Pivot chart

UNIT 4: Data Analysis and Visualization

- 4.1 Creating charts and graphs: Titles, legend, data labels, creating a New Chart, Formatting the Chart, Types of charts, Using Chart Templates.
- 4.2 Simple bar diagram, subdivided bar diagram, multiple bar diagram, percentage bar diagram, pie diagram, rod or spike plot, histogram, frequency curve and ogive curves, Pareto chart.
- 4.3 Analyzing and interpreting case studies from different fields

List of Practicals:

Sr.No.	Title of Experiment	No. of Experiment
1.	Introduction to MS-Excel	3
2.	Basic mathematical functions	1
3.	Conditional logic functions and lookup function	2
4.	Statistical functions in excel analysis tool pack.	1
5.	Diagrammatic representation	1
6.	Graphical representation	2
7.	Pivot Chart	1
8.	Pivot Table	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: Quickstart 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.

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

Name of the Programme	: B.Sc. Statistics
Programme Code	: USSTA
Class	: F.Y.B.Sc.
Semester	: I
Course Type	: VSC Theory
Course Code	: STA-121-VSC
Course Title	: Introduction to R Programming Language
No. of Credits	: 02
No. of Teaching Hours	: 30

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:

The students will acquire knowledge about ;

- CO1.** statistical tools using R-software.
- 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

(12L)

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 case sensitivity.

1.2 Data types: Character, Numeric

a) Character Set: Alphabets, Numeric digits, Special Characters

b) Keywords

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:

(7L)

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` command.

2.3 Resident data sets: Accession and summary,

UNIT 3: Diagrams and Graphs

(11L)

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 `prob=T` option 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.

References:

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, Nirali Prakashan.

6. Garrett Golemund (2014). Hands-On Programming with R: Write Your Own Functions and Simulations.

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

Name of the Programme	: B.Sc. Statistics
Programme Code	: USSTA
Class	: F.Y.B.Sc.
Semester	: I
Course Type	: SEC Practical
Course Code	: STA-126-SEC
Course Title	: Statistical Computing using MS-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 Microsoft Excel for data analysis and management.
2. Introduce the essential spreadsheet concepts and terminology and develop proficiency in creating and formatting worksheets.
3. Introduce basic concepts, formulas, functions, and tools within Excel, enabling students to create, edit, format, and analyze data and perform calculations.
4. Use MS-Excel's statistical functions to compute descriptive statistics, such as mean, median, mode, standard deviation, and variance etc.
5. Create visually appealing charts and graphs to represent data effectively.
6. Introduce regression analysis techniques to analyze relationships between variables.
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.** use and utilize functions and formulas in Excel.
- CO4.** summaries data using various statistical measures.
- CO5.** create charts and graphs student can easily explain complex information or data.
- CO6.** apply regression analysis techniques to analyze relationships between variables.
- CO7.** manage and organize real datasets through hands-on exercises and projects

Topics and Learning Points

UNIT 1: Introduction to Excel:

- 1.1 Introduction to MS-Excel and its statistical capabilities.
- 1.2 Excel interface and navigation (Title Bar, Menu Bar, Ribbon, Formula Bar, Status Bar, Quick Access Bar)
- 1.3 Setting up Excel for statistical analysis.
- 1.4 Data entry and organization in Excel.
- 1.5 Creating and modifying tables
- 1.6 Inserting and deleting rows, columns, and cells
- 1.7 Entering and editing data, Copying, cutting, and pasting data
- 1.8 Using AutoFill and Flash
- 1.9 Fill to enter data series
- 1.10 Using find and replace, Basic mathematical operators
- 1.11 Common functions (SUM, AVERAGE, MAX, MIN, VLOOKUP, HLOOKUP etc.)
- 1.12 Other functions: Date and Time Functions, Text functions, sort, duplicate, Pivot table, Pivot chart

UNIT 2: Descriptive Statistics

- 2.1 Measures of central tendency: mean, median, and mode
- 2.2 Measures of Dispersion: standard deviation, variance, and range
- 2.3 Skewness and kurtosis
- 2.4 Computing descriptive statistics in Excel

UNIT 3: Data Visualization

- 3.1 Creating charts and graphs: Titles, legend, data labels, creating a New Chart, Formatting the Chart, Types of charts, Using Chart Templates.
Simple bar diagram, subdivided bar diagram, multiple bar diagram, percentage bar diagram, pie diagram, rod or spike plot, histogram, frequency curve and ogive curves, Pareto chart

UNIT 4: Correlation and Regression

- 4.1 Concept of correlation
- 4.2 Understanding regression analysis
- 4.3 Simple linear regression
Interpreting regression output in Excel

List of Practicals:

Sr. No.	Title of Experiment	No. of Experiment
1.	Introduction to MS-Excel	2
2.	Basic mathematical and statistical functions	1
3.	Diagrammatic representation	1
4.	Graphical representation	1
5.	Combinatorial Techniques, Probability distribution and Simulation	1
6.	Measures of central tendency	2
7.	Measures of Dispersion	2
8.	Correlation and regression	1
9.	Case Study	1

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

References:

1. M. L. Humphrey, Excel for Beginners
2. S. C. Gupta, V.K. Kapoor, Fundamental of Mathematical Statistics
3. William Fischer, Excel: Quickstart Guide for Beginner to Expert
4. Michkel Alexander, Dick Kusleika, John Walkenbeach, Microsoft Excel 2019 BIBLE The Comprehensive Tutorial Resource, Wiley Publication.
5. Frag Curtis (2013). Step by Step Microsoft Excel 2013, MS Press
6. Frye Curtis D. (2007). Step by step Microsoft Office Excel 2007, Microsoft Press
7. Salkind Neil J. and Frey Bruce B (2021). Statistics for people who (Think They) Hate Statistics, Using MS- Excel, Sage Publications.

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

Name of the Programme	: B.Sc. Statistics
Programme Code	: USSTA
Class	: F.Y.B.Sc.
Semester	: I
Course Type	: IKS Theory
Course Code	: STA-137-IKS
Course Title	: Evolution of Science and Statistics in India
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Creating awareness amongst the youths about the true history and rich culture of the country;
2. To learn about India's contributions from traditional to modern to the world of science and technology.
3. Promoting the youths to do research in the various fields of Bhāratīya knowledge tradition;
4. To learn about the torch bearers, ancient and modern, of Indian Knowledge System.
5. To understand the scientific value of the traditional knowledge of India.
6. To learn how Bharatiya wisdom translates to the applied aspect of the modern scientific paradigm.
7. To trace the evolution of Statistics as a subject in India.
8. To learn about renowned Indian Statisticians and their works.
9. To understand the working of various Statistical organizations in India.

Course Outcomes:

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

- CO1.** know the knowledge system was developed during the Vedic period, the Saraswatī-Sindhu Civilization, the Middle ages and practiced knowingly or unknowingly till date.
- CO2.** understand that, in Bhārata, a special attention was given to the reasons of ideas occurrence, and connection with the concept of material world, and religious, social, and cultural beliefs.
- CO3.** give awareness amongst the youths about the true history and rich culture of the country.
- CO4.** be self-motivated to do research in the various fields of Bhāratīya knowledge

tradition.

- CO5.** convert Bhāratīya wisdom into the applied aspect of the modern scientific paradigm.
- CO6.** competent enough to choose the IKS as career at the professional and business levels.
- CO7.** acknowledge, appreciate and value the rich heritage offered by India in areas of Science and Technology.
- CO8.** identify the erstwhile lesser known applications of Statistics since ancient times in India.
- CO9.** recognize the significance of contributions of Indian Statisticians.
- CO10.** Identify the role of Statistical organizations towards the progress and development of India.

Topics and Learning Points

UNIT 1: Bhāratīya Civilization and Development of Bhartiya Knowledge System

(5L) Genesis of the land, Antiquity of civilization, On the Trail of the Lost River, Discovery of the Saraswatī River, the Saraswatī-Sindhu Civilization, Traditional Knowledge System, The Vedas, Main Schools of Philosophy, Ancient Education System, the Takṣaśilā University, the Nālandā University, Alumni, Knowledge Export from Bhārata.

UNIT 2: Arts, Literature, and Scholars in Ancient Bharat (5L)

Art, Music, and Dance, Naṭarāja– A Master piece of Bhāratīya Art, Literature, Life and works of Agastya, Lopāmudrā, Ghōṣā, Vālmīki, Patañjali, Vedavyāsa, Yājñavalkya, Gārgī, Maitreyī, Bodhāyana, Caraka, Suśruta, Jīvaka, Nāgārjuna, Kaṇāda, Kauṭīlya, Pāṇini, Thiruvalluvar, Āryabhaṭa, Varāhamihira, ĀdiŚaṅkarācārya Bhāskarācārya, Mādhavācārya.

UNIT 3: Nobel Laureates of Indian Origin/Relevance (3L)

Rabindranath Tagore, Sir C.V. Raman, Amartya Sen, Subrahmanyan Chandrasekhar, Har Govind Khorana,

UNIT 4: Inspiring Life of Indian Scientists and their Contributions (4L)

Sushruta, Bhaskara II (Bhaskaracharya), Aryabhata, Jagadish Chandra Bose, Acharya

Prafulla Chandra Ray, Birbal Sahni, P.C. Mahalanobis, Meghnad Saha, Satyendra Nath Bose, Salim Ali, Panchanan Maheshwari, Homi Jehangir Bhabha, Vikram Ambalal Sarabhai, Varghese Kurien, etc.

UNIT 5: Historical Perspective of Statistics in India (4L)

Statistics in ancient times, Probability in ancient India, Antiquity of the Mean, Statistics and Mathematics in ancient Indian poetry, Inferential Statistics and Statistical Economics before and during 4CE (Vishalaksha's contributions to inference and Kautilya's Arthashastra), Statistical System during British India, Statistical System in Independent India, Research Teaching and Training in Statistics,

UNIT 6: Statistical Heritage of India (4L)

Contributions of Calyampudi Radhakrishna Rao, Raghu Raj Bahadur, Pandurang Vasudeo Sukhatme, Debabrata Basu, Vasant Shankar Huzurbazar, Keshav Raghavan Nair, Vidyadhar Godambe,

UNIT 7 : Official Statistics in India (5L)

Historical perspective of Official Statistics in India, Overview of present Indian Statistical System: Statistical organizations and their functions.

References:

1. Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan, Under Publication (2021).
2. History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ram krishan Mission Institute of Culture, Kolkata (2014).
3. History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ram krishan Mission Institute of Culture, Kolkata (2014).
4. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).
5. Dutta A. K., The Concept of Arithmetic Mean in Ancient India, in 25 Years Gone By, ISIREA(2017):158-192.
6. Ghosh, J. K., Mitra, S. K., and Parthasarathy, K. R. (1992) Glimpses of India's Statistical Heritage, Wiley Eastern, New Delhi.

7. Ghosh, J. K, Maiti, P., Rao, T. J., and Sinha, B. K. (1999) Evolution of Statistics in India, *International Statistical Review*, 67, 13-34.
8. Glaz Sarah, Poetry Inspired by Mathematics: A Brief Journey through History, *J. of Mathematics and the Arts* 5, 171-183, 2011
9. Glaz Sarah, Mathematical Ideas in Ancient Indian Poetry, *Proceedings of Bridges Enschede*, July 2013
10. Indian Contributions to Science - Compiled by Vijnana Bharati.
11. Jarret, H. S. (1894) Translation of Ain-i-Akbari, Asiatic Society of Bengal, Vol. II, p. vii.
12. Mukhopadhyay, N. (1997) A conversation with Sujit Kumar Mitra, *Statistical Science*, 12, 61-75.
13. <https://pragyata.com/the-untold-foundations-of-modern-economics-did-adam-smith-plagiarise-kautilya/>
14. https://unstats.un.org/unsd/wsd/docs/India_wsd_history.pdf
15. Raju, C. K. 'Probability in Ancient India'. In *Handbook of Philosophy of Statistics*, edited by Paul Thagard and Dov M. Gabbay and John Woods, 7:1175–96. *Handbook of Philosophy of Science*. Elsevier, 2011.
16. Rangarajan L. N., *Kautilya - The Arthashastra*, Penguin Books India (P) Ltd.
17. Rao, Talluri. (2010). Official Statistics in India: The Past and the Present. *Journal of Official Statistics*. 26. 215-231.
18. Sihag Balbir S., *Kautilya's Arthashastra: The Origin of Statistical Economics During - 4CE*, JRSA, Vol. 2, No. 1, June-2013, pp 1-14

Examination Pattern / Evaluation Pattern

Teaching and Evaluation (for Major, Minor, AEC, VEC, IKS courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 / 60	2 / 4	50	20	30
3	45 / 90	4 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Teaching and Evaluation (for VSC, SEC & CC courses)

- Evaluation to be done by Internal & External Experts
 - No descriptive end semester written examination
 - Evaluation to be done at Department level preferably prior to commencement of Theory /Practical Examinations
- Evaluation to be done on the Skills gained by student