

**Syllabus - Level 4.5 . F. Y. B.Sc.**

**Discipline: Statistics**

Semester	Course Type	Course Title	Course code	Credits	Hours	Periods (60 min)	Unit/ Module	Lectures (60minutes) per Unit/ module	Examination		
									Internal Marks	External Marks	Total Marks
<b>Discipline Specific Course (Core Course-Major)</b>											
I	DSC (Major)	Descriptive Statistics & Statistical Methods I	BH.USST. D- 101	3	45	3	3	3	25	50	75
II	DSC (Major)	Descriptive Statistics & Statistical Methods II	BH.USST. D- 201	3	45	3	3	3	25	50	75
I		Practical	BH.USST P.D.- 1	1	30	2	2	2	-	-	50
II		Practical	BH.USST P.D.- 2	1	30	2	2	2	-	-	50
<b>Discipline Specific Course (Core Course-Minor)</b>											
I	DSC (Minor)	Descriptive Statistics & Statistical Methods I	BH.USST M- 101	3	45	2	2	2	25	50	75
II	DSC (Minor)	Descriptive Statistics & Statistical Methods II	BH.USST M- 201	3	45	3	3	3	25	50	75
I		Practical	BH.USST P.M.- 1	1	30	2	2	2	-	-	50
II		Practical	BH.USST P.M.- 2	1	30	2	2	2	-	-	50

<b>Vocational /Skill Enhancement Course (vSEC)-Skill Enhancement Electives</b>											
I	vSEC	Statistical Analysis using Electronic Spreadsheets I	BH.USST. vSEC-101	3	45	3	3	3	25	50	75
II	vSEC	Statistical Analysis using Electronic Spreadsheets II	BH.USST. vSEC-201	3	45	3	3	3	25	50	75
I		Practical	BH.USST P.vSEC.- 1	1	30	2	2	2	-	-	50
II		Practical	BH.USST P.vSEC.- 2	1	30	2	2	2	-	-	50
<b>Generic Elective/Open Elective ( To be offered by the students of Commerce/Arts Faculty)</b>											
I	GE/OE	Simple Quantitative Techniques I	BH.USST OE-101	3	45	3	3	3	25	50	75
II	GE/OE	Simple Quantitative Techniques II	BH.USST OE-201	3	45	3	3	3	25	50	75
I		Tutorials	BH.USST P.OE-101	1	15	1	2	2	-	-	50
II		Tutorials	BH.USST P.OE-201	1	15	1	2	2	-	-	50
<b>Value Education Course</b>											
I	VEC	Data Presentation using Power BI I	BH.USST. VEC-101	2	30	2	2	2	20	30	50
II	VEC	Data Presentation using Power BI II	BH.USST. VEC-201	2	30	2	2	2	20	30	50

**Indian Knowledge System**

I	IKS	Indian Statistical Knowledge System	BH.USST. IKS-101	2	30	2	2	2	20	30	50
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**Resolution No.: BOS/100623/AC/260623**

**Bharatiya Vidya Bhavan's**

**M. M. College of Arts, N.M. Institute of Science, H.R.J. College of  
Commerce**

**(Bhavan's College) Autonomous**

**(Affiliated to University of Mumbai)**



**NEP Syllabus for: F.Y. B.Sc. Statistics**

**Program: B.Sc.**

**Program Code: BH. BSc**

**Course Code: (BH.USST.MAJ)**

**with effect from academic year 2023-24**

**PREAMBLE**

The world is undergoing rapid changes in the sphere of knowledge. With various scientific and technological advances, like increased automation, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly in the field of Statistics & Data Science will be in greater demand.

Statistics is the collection, presentation and analysis of observed data which evolves patterns over a period of time that plays an important role in health, agriculture, environment and industries. However, to provide more flexibility in the course curriculum and assigning credits based on the course contents and number of hours of teaching, Choice Based Credit System (CBCS) was introduced by the University of Mumbai on recommendations of the University Grants Commission (UGC) from the academic year 2016-2017.

The Choice Based Credit System (CBCS) curriculum for Statistics at the undergraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of University Grants Commission (UGC). LOCF aims to equip students with knowledge, skills, values, attitude, leadership and lifelong learning.

This National Education Policy 2020 is the first education policy of the 21st century and proposes the revision and refurbishing all aspects of the education structure, including its regulation and governance, to create a new system that is aligned with the aspirational goals of 21st century education.

The entire course of Bachelor of Science in Statistics is revamped according to the guidelines prescribed under the NEP-2020 and the process of restructuring the F.Y.B.Sc syllabus according to the NEP-2020 was initiated for its implementation from academic year 2023-24. The first-year curriculum involves discipline specific core [DSC] subjects that cover the fundamental aspects of Statistics and are all compulsory papers. Additionally, a Minor Subject course is designed to increase the expanse of the subject. Also, generic elective courses and skill-based courses would enable students to develop requisite skills in the areas of direct employability. The main aim behind designing this curriculum is to enable the students to select the courses of their choice depending on their interest.

**PROGRAM OUTCOMES**

A student opting this course will be able to: -

<b>SR NO</b>	<b>PROGRAM OUTCOMES</b>
PO 1	Understand the fundamental and applied concepts of Statistics and its allied areas
PO 2	Demonstrate expertise in requisite software skills and techniques that are required in various industries.
PO 3	Improve critical thinking & observation skills through diverse practicals involving varied aspects of statistics and their applications
PO 4	Inculcate the quality of team spirit by working cohesively in groups and demonstrate suitable scientific writing skills.

**PROGRAM SPECIFIC OUTCOMES**

After successful completion of this course, every learner will be able to: -

<b>SR NO</b>	<b>PROGRAM SPECIFIC OUTCOMES</b>	<b>MAPPING OF PSO</b>
PSO 1	use elementary tools using electronic spreadsheets in Descriptive Statistics and Statistical Methods, as the learner offers for the first time in his educational career, the subject Statistics as an Independent Subject.	vSEC OF SEM I & SEM II
PSO 2	have sound mathematical base for various Statistical Methods such as Standard Discrete & Continuous Probability Distributions, Exact Sampling Distributions, Sampling Techniques, ANOVA Techniques and further exploring applied nature of subject by receiving exposure to some optimization techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 3	Gain comfortable level of confidence in using statistical software.	VEC OF SEM I & II
PSO 4	have rigorous mathematical basis to various inferential statistical methods such as Estimation, Testing of Hypotheses, Distribution Theory & Stochastic Processes, Biostatistics and Operations Research techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 5	inculcate sound logical thinking due to exposure to advanced topics in Probability.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 6	make learner industry ready due to use R software/Python programming in theory papers/skill enhancement papers.	vSEC OF SEM I & SEM II

<b>Subject - STATISTICS</b>	<b>Theory → 3 &amp; Practical → 1 Total Credits = 4</b>	<b>SEMESTER I</b>
<b>Course Code BH.USST.MAJ101</b>	<b>Course Title—DESCRIPTIVE STATISTICS &amp; STATISTICAL METHODS I</b>	

**Course Objectives**

This course is designed to: -

1. To make aware of Statistics as a subject, the role of Statistics in the Indian/Global Scenario, data types, various methods of collection of data, classification of data.
2. To make aware of consistency of data, measures of association, applicability of various Measures of central Tendency.
3. To make aware of the concept of spread of data and the various measures of dispersion, representing the data in the form of box - plot, the nature of the data using the concept of skewness and kurtosis based on moments.
4. To learn basic properties of discrete random variable(s),
5. To identify practical situations where standard discrete probability distributions can be applied

**Course Outcomes**

After completing this course, the learner will be able to: -

1. Learner will be able to understand the importance of Statistics, different data types, how to prepare questionnaire, schedule.
2. Prepare contingency tables. Find the coefficient of association between attributes and its interpretation. Calculate various Measures of central Tendency, quantiles as per the data and its interpretation.
3. Learner will be able to calculate various Measures of dispersion, explain the use and limitations of these, based on shape of the curve conclude about the distribution. Represent the data using Box plot and interpret about shape of the distribution.
4. Learner will be able to identify situations where different discrete probability models can be applied.

**COURSE CREDITS - 4**

**CATEGORY – DSC (MAJOR)**

**Course Title – DESCRIPTIVE STATISTICS & STATISTICAL METHODS I**

<b>COURSE CREDITS</b>			<b>No of Lectures</b>
<b>4</b>			
<b>THEORY UNIT</b>	<b>SUB - UNIT</b>	<b>TOPICS</b>	
<b>I</b>		<b>Data collection, Elementary Categorical Data Analysis and Measures of Central Tendency:</b>	<b>15L</b>
	<b>1.1</b>	Collection of Primary data: concept of a questionnaire and a schedule, Differences between the two, Secondary data - its major sources including some government publications. Different types of scales: nominal, ordinal, interval and ratio.	<b>3</b>
	<b>1.2</b>	Dichotomous classification- for two and three attributes, Verification for consistency · Association of attributes: Yule’s coefficient of association Q. Yule’s coefficient of Colligation Y, Relation between Q and Y (with proof).	<b>3</b>
	<b>1.3</b>	Concept of Measures of central tendency of data. Requirements of a good measure. Locational averages: Median, Mode, Empirical relation between mean, median and mode, and Partition Values:	<b>4</b>

		Quartiles, Deciles, and Percentiles.	
	<b>1.4</b>	Mathematical averages: Arithmetic mean (Simple, weighted mean, combined mean), Geometric mean, Harmonic mean, and the relationship between them. Merits and demerits of the different measures and their applicability.	<b>5</b>
<b>II</b>		<b>Measures of Dispersion, Skewness and Kurtosis:</b>	<b>15L</b>
	<b>2.1</b>	Concept of Measures of dispersion. Requirements of a good measure. Absolute and Relative measures of dispersion: Range, Quartile Deviation, Mean absolute deviation, Standard deviation, Variance, and properties of Standard deviation.	<b>9</b>
	<b>2.2</b>	Raw and Central Moments, their relationships up to fourth order. Skewness and Kurtosis: Concept of Skewness and Kurtosis. Various Measures of Skewness and Kurtosis.	<b>4</b>
	<b>2.3</b>	Box Plot.	<b>2</b>
<b>III</b>		<b>Probability, Discrete Random Variables, their Distributions, &amp; Properties:</b>	<b>15L</b>
	<b>3.1</b>	Elementary Probability Concepts: Definitions of Basic Terms, random experiment, outcome, sample space, an event, algebra of events, mutually exclusive, exhaustive events, complementary events. Mathematical & Statistical Definitions of Probability, Conditional Probability, Addition & Multiplication Theorems on Probability. Independence of two events, Mutual and Pairwise Independence of three events, Bayes' Theorem on Probability.	<b>6</b>
	<b>3.2</b>	Discrete Random Variable, its Definition, Probability Mass Function of a random variable, Cumulative Distribution Function, Expectation and Variance, their properties.	<b>3</b>
	<b>3.3</b>	Some Standard Discrete Distributions: One-point distribution (degenerate distribution), Bernoulli Distribution, Discrete Uniform Distribution, Binomial Distribution, Poisson Distribution, their mean, and variance. Poisson distribution as a limiting case of Binomial Distribution.	<b>6</b>
<b>PRACTICAL</b>	<b>1. List of practicals</b>		<b>30 HOURS</b>
		<b>Topic of the Practical</b>	<b>No. of Practical</b>
		Elementary Categorical Data Analysis	1
		Measures of central tendency	2
		Measures of dispersion	2
		Moments, Skewness and Kurtosis.	1
		Probability	2



	Discrete Random Variables	2	
	Discrete Uniform and Binomial Distribution	1	
	Poisson distribution	1	

**REFERENCE BOOKS**

1. Welling, Khandeparkar, Pawar, Naralkar: Descriptive Statistics: Manan Prakashan
2. Milan Gholba, Sudha Phatak: Descriptive Statistics: Vipul Prakashan
3. S.P. Gupta: Statistical Methods, Sultan Chand & Sons. First edition.
4. Gupta S.C., Kapoor V.K.: “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons
5. Gupta S.C., Kapoor V.K.: “Fundamentals of Applied Statistics”, Sultan Chand & Sons.
6. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.
7. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.
8. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi.
9. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York.
10. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.
11. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. McGraw Hill Book Company.
12. Ross S. (2002). A First Course in Probability, Sixth Edition, Pearson Education, Inc. & Dorling Kindersley Publishing, Inc.

<b>Subject - STATISTICS</b>	<b>Theory → 3 &amp; Practical → 1 Total Credits = 4</b>	<b>SEMESTER II</b>
<b>Course Code BH.USST.MAJ201</b>	<b>Course Title-DESCRIPTIVE STATISTICS &amp; STATISTICAL METHODS II</b>	

**Course Objectives**

This course is designed to: -

1. To express the relationship and to measure the extent of the correlation between two variables. To understand the concept of ranking of data and to find the correlation coefficient based on ranks. To understand the concept of Principle of least squares and to fit different types of curves to a given data set. To understand and calculate the regression between two variables and to learn their applications.
2. To learn basic properties of continuous random variable.
3. To identify practical situations where elementary standard continuous probability distributions can be applied.
4. To learn basics of Estimation and Testing of Hypotheses.

**Course Outcomes:**

1. The learner will be able to draw and interpret a bubble chart and scatter diagram. The learner will be able to do correlation and regression analysis along with the interpretation. Using the principle of least squares, the learner will be able to do curve fitting.
2. Learner will be able to solve simple examples on Probability based on continuous probability distributions.
3. Learner will be able to identify situations where simple continuous probability models can be applied.
4. Learner will be able to apply basic concepts of testing of hypotheses to solve examples on large sample tests.

**COURSE CREDITS - 4**

**CATEGORY – DSC(MAJOR)**

**Course Title – DESCRIPTIVE STATISTICS & STATISTICAL METHODS II**

<b>COURSE CREDITS</b>			<b>No of Lectures</b>
<b>4</b>			
<b>THEORY UNIT</b>	<b>SUB - UNIT</b>	<b>TOPICS</b>	
<b>I</b>		<b>Correlation and regression analysis:</b>	<b>15L</b>
	<b>1.1</b>	Visualizing relationship using Bubble chart, Scatter Diagram, Product moment correlation coefficient and its properties. Spearman’s Rank correlation (With and without ties).	<b>3</b>
	<b>1.2</b>	Concept of linear regression. Principle of least squares. Fitting a straightline by method of least squares.	<b>3</b>
	<b>1.3</b>	Relationship between regression coefficients and correlation coefficient, cause and effect relationship, Spurious correlation.	<b>3</b>
	<b>1.4</b>	Concept and use of coefficient of determination ( $R^2$ ). Fitting a quadratic curve by method of least squares,	<b>3</b>
	<b>1.5</b>	Fitting of curves reducible to linear form by transformation	<b>3</b>

		(Power curve, Exponential curve, Logarithmic curve).	
<b>II</b>		<b>Continuous Random Variable, its distribution, and properties:</b>	<b>15L</b>
	<b>2.1</b>	Definition of Probability Density Function, Cumulative Distribution Function, their properties & graphical representation. Mean, Median, Mode and Variance of a continuous variable. Raw and Central Moments and their uses.	<b>5</b>
	<b>2.2</b>	Rectangular Distribution, Exponential Distribution (one parameter and two parameter cases), their Mean, Median and Variance. Memory less property of Exponential Distribution.	<b>5</b>
	<b>2.3</b>	Normal Distribution, its Graphical Representation (Normal Curve), its properties without proof. Use of Normal Tables. Normal approximation to Binomial and Poisson Distributions (statements only)	<b>5</b>
<b>III</b>		<b>Basics of Estimation and Testing of Hypotheses:</b>	<b>15L</b>
	<b>3.1</b>	Population, Concept of a random sample, parameter, statistic, estimator, unbiased estimator, bias, sampling distribution. standard error of an estimator.	<b>3</b>
	<b>3.2</b>	Central Limit Theorem for Independently and Identically Distributed Random Variables (Statement only). Sampling Distribution of sample mean, and sample proportion based on large samples. Confidence Interval for population mean and population proportion based on large samples.	<b>4</b>
	<b>3.3</b>	Basics of testing of hypotheses, null and alternative, simple and composite hypotheses. Test of a statistical hypotheses. Critical Region, Probability of Type I and Type II errors, Level of Significance.	<b>4</b>
	<b>3.4</b>	Large sample tests for single population mean, single population proportion, difference in two population means and equality of two population proportions (procedures only).	<b>4</b>

<b>PRACTICAL</b>	List of practicals		<b>30 HOURS</b>
	<b>Topic of the Practical</b>	<b>No. of Practicals</b>	
	Correlation Analysis	1	
	Linear Regression Analysis	2	
	Curve Fitting	2	
	Continuous Random Variable	2	
	Rectangular & Exponential distributions	1	
	Normal Distribution	1	
	Testing of Hypotheses	1	
	Large Sample Tests	2	

<b>REFERENCE BOOKS</b>			
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|  | <ol style="list-style-type: none"><li>1. Welling, Khandeparkar, Pawar, Naralkar: Descriptive Statistics: Manan Prakashan</li><li>2. Milan Gholba, Sudha Phatak: Descriptive Statistics: Vipul Prakashan</li><li>3. S.P. Gupta: Statistical Methods, Sultan Chand &amp; Sons. First edition</li><li>4. Gupta S.C., Kapoor V.K.: “Fundamentals of Mathematical Statistics”, Sultan Chand &amp; Sons</li><li>5. Gupta S.C., Kapoor V.K.: “Fundamentals of Applied Statistics”, Sultan Chand &amp; Sons.</li><li>6. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.</li><li>7. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.</li><li>8. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi.</li><li>9. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York.</li><li>10. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.</li><li>11. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. McGraw Hill Book Company.</li><li>12. Ross S. (2002). A First Course in Probability, Sixth Edition, Pearson Education, Inc. &amp; Dorling Kindersley Publishing, Inc.</li></ol> |
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**Resolution No.: BOS/100623/AC/260623**

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**NEP Syllabus for: F.Y. B.Sc. Statistics**

**Program: B.Sc.**

**Program Code: BH. BSc**

**Course Code: (BH.USST.MIN)**

**with effect from academic year 2023-24**

**PREAMBLE**

The world is undergoing rapid changes in the sphere of knowledge. With various scientific and technological advances, like increased automation, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly in the field of Statistics & Data Science will be in greater demand.

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**PROGRAM OUTCOMES**

A student opting this course will be able to: -

<b>SR NO</b>	<b>PROGRAM OUTCOMES</b>
PO 1	Understand the fundamental and applied concepts of Statistics and its allied areas
PO 2	Demonstrate expertise in requisite software skills and techniques that are required in various industries.
PO 3	Improve critical thinking & observation skills through diverse practicals involving varied aspects of statistics and their applications
PO 4	Inculcate the quality of team spirit by working cohesively in groups and demonstrate suitable scientific writing skills.

**PROGRAM SPECIFIC OUTCOMES**

After successful completion of this course, every learner will be able to: -

<b>SR NO</b>	<b>PROGRAM SPECIFIC OUTCOMES</b>	<b>MAPPING OF PSO</b>
PSO 1	use elementary tools using electronic spreadsheets in Descriptive Statistics and Statistical Methods, as the learner offers for the first time in his educational career, the subject Statistics as an Independent Subject.	vSEC OF SEM I & SEM II
PSO 2	have sound mathematical base for various Statistical Methods such as Standard Discrete & Continuous Probability Distributions, Exact Sampling Distributions, Sampling Techniques, ANOVA Techniques and further exploring applied nature of subject by receiving exposure to some optimization techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 3	Gain comfortable level of confidence in using statistical software.	VEC OF SEM I & II
PSO 4	have rigorous mathematical basis to various inferential statistical methods such as Estimation, Testing of Hypotheses, Distribution Theory & Stochastic Processes, Biostatistics and Operations Research techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 5	inculcate sound logical thinking due to exposure to advanced topics in Probability.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 6	make learner industry ready due to use R software/Python programming in theory papers/skill enhancement papers.	vSEC OF SEM I & SEM II

<b>Subject - STATISTICS</b>	<b>Theory → 3 &amp; Practical → 1 Total Credits = 4</b>	<b>SEMESTER I</b>
<b>Course Code BH.USST.MIN101</b>	<b>Course Title—DESCRIPTIVE STATISTICS &amp; STATISTICAL METHODS I</b>	

**Course Objectives**

This course is designed to: -

6. To make aware of Statistics as a subject, the role of Statistics in the Indian/Global Scenario, data types, various methods of collection of data, classification of data.
7. To make aware of consistency of data, measures of association, applicability of various Measures of central Tendency.
8. To make aware of the concept of spread of data and the various measures of dispersion, representing the data in the form of box - plot, the nature of the data using the concept of skewness and kurtosis based on moments.
9. To learn basic properties of discrete random variable(s),
10. To identify practical situations where standard discrete probability distributions can be applied

**Course Outcomes**

After completing this course, the learner will be able to: -

5. Learner will be able to understand the importance of Statistics, different data types, how to prepare questionnaire, schedule.
6. Prepare contingency tables. Find the coefficient of association between attributes and its interpretation. Calculate various Measures of central Tendency, quantiles as per the data and its interpretation.
7. Learner will be able to calculate various Measures of dispersion, explain the use and limitations of these, based on shape of the curve conclude about the distribution. Represent the data using Box plot and interpret about shape of the distribution.
8. Learner will be able to identify situations where different discrete probability models can be applied.

**COURSE CREDITS - 4**

**CATEGORY—DSC (MINOR)**

**Course Title – DESCRIPTIVE STATISTICS & STATISTICAL METHODS I**

<b>COURSE CREDITS</b>			<b>No of Lectures</b>
<b>4</b>			
<b>THEORY UNIT</b>	<b>SUB - UNIT</b>	<b>TOPICS</b>	
<b>I</b>		<b>Data collection, Elementary Categorical Data Analysis and Measures of Central Tendency:</b>	<b>15L</b>
	<b>1.1</b>	Collection of Primary data: concept of a questionnaire and a schedule, Differences between the two, Secondary data - its major sources including some government publications. Different types of scales: nominal, ordinal, interval and ratio.	<b>3</b>
	<b>1.2</b>	Dichotomous classification- for two and three attributes, Verification for consistency · Association of attributes: Yule’s coefficient of association Q. Yule’s coefficient of Colligation Y, Relation between Q and Y (with proof).	<b>3</b>
	<b>1.3</b>	Concept of Measures of central tendency of data. Requirements of a good measure. Locational averages: Median, Mode, Empirical relation between mean, median and mode, and Partition Values:	<b>4</b>



		Quartiles, Deciles, and Percentiles.	
	<b>1.4</b>	Mathematical averages: Arithmetic mean (Simple, weighted mean, combined mean), Geometric mean, Harmonic mean, and the relationship between them. Merits and demerits of the different measures and their applicability.	<b>5</b>
<b>II</b>		<b>Measures of Dispersion, Skewness and Kurtosis:</b>	<b>15L</b>
	<b>2.1</b>	Concept of Measures of dispersion. Requirements of a good measure. Absolute and Relative measures of dispersion: Range, Quartile Deviation, Mean absolute deviation, Standard deviation, Variance, and properties of Standard deviation.	<b>9</b>
	<b>2.2</b>	Raw and Central Moments, their relationships up to fourth order. Skewness and Kurtosis: Concept of Skewness and Kurtosis. Various Measures of Skewness and Kurtosis.	<b>4</b>
	<b>2.3</b>	Box Plot.	<b>2</b>
<b>III</b>		<b>Probability, Discrete Random Variables, their Distributions, &amp; Properties:</b>	<b>15L</b>
	<b>3.1</b>	Elementary Probability Concepts: Definitions of Basic Terms, random experiment, outcome, sample space, an event, algebra of events, mutually exclusive, exhaustive events, complementary events. Mathematical & Statistical Definitions of Probability, Conditional Probability, Addition & Multiplication Theorems on Probability. Independence of two events, Mutual and Pairwise Independence of three events, Bayes' Theorem on Probability.	<b>6</b>
	<b>3.2</b>	Discrete Random Variable, its Definition, Probability Mass Function of a random variable, Cumulative Distribution Function, Expectation and Variance, their properties.	<b>3</b>
	<b>3.3</b>	Some Standard Discrete Distributions: One-point distribution (degenerate distribution), Bernoulli Distribution, Discrete Uniform Distribution, Binomial Distribution, Poisson Distribution, their mean, and variance. Poisson distribution as a limiting case of Binomial Distribution.	<b>6</b>
<b>PRACTICAL</b>	<b>2. List of practicals</b>		<b>30 HOURS</b>
		<b>Topic of the Practical</b>	<b>No. of Practical</b>
		Elementary Categorical Data Analysis	1
		Measures of central tendency	2
		Measures of dispersion	2
		Moments, Skewness and Kurtosis.	1
		Probability	2

	Discrete Random Variables	2	
	Discrete Uniform and Binomial Distribution	1	
	Poisson distribution	1	

**REFERENCE BOOKS**

13. Welling, Khandeparkar, Pawar, Naralkar: Descriptive Statistics: Manan Prakashan
14. Milan Gholba, Sudha Phatak: Descriptive Statistics: Vipul Prakashan
15. S.P. Gupta: Statistical Methods, Sultan Chand & Sons. First edition.
16. Gupta S.C., Kapoor V.K.: “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons
17. Gupta S.C., Kapoor V.K.: “Fundamentals of Applied Statistics”, Sultan Chand & Sons.
18. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.
19. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.
20. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi.
21. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York.
22. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.
23. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. McGraw Hill Book Company.
24. Ross S. (2002). A First Course in Probability, Sixth Edition, Pearson Education, Inc. & Dorling Kindersley Publishing, Inc.

<b>Subject - STATISTICS</b>	<b>Theory → 3 &amp; Practical → 1</b>	<b>Total Credits = 4</b>	<b>SEMESTER II</b>
<b>Course Code BH.USST.MIN201</b>	<b>Course Title-DESCRIPTIVE STATISTICS &amp; STATISTICAL METHODS II</b>		

**Course Objectives**

This course is designed to: -

5. .To express the relationship and to measure the extent of the correlation between two variables. To understand the concept of ranking of data and to find the correlation coefficient based on ranks. To understand the concept of Principle of least squares and to fit different types of curves to a given data set. To understand and calculate the regression between two variables and to learn their applications.
6. To learn basic properties of continuous random variable.
7. To identify practical situations where elementary standard continuous probability distributions can be applied.
8. To learn basics of Estimation and Testing of Hypotheses.

**Course Outcomes:**

5. The learner will be able to draw and interpret a bubble chart and scatter diagram. The learner will be able to do correlation and regression analysis along with the interpretation. Using the principle of least squares, the learner will be able to do curve fitting.
6. Learner will be able to solve simple examples on Probability based on continuous probability distributions.
7. Learner will be able to identify situations where simple continuous probability models can be applied.
8. Learner will be able to apply basic concepts of testing of hypotheses to solve examples on large sample tests.

**COURSE CREDITS - 4**

**CATEGORY – DSC(MINOR)**

**Course Title – DESCRIPTIVE STATISTICS & STATISTICAL METHODS II**

<b>COURSE CREDITS</b>			<b>No of Lectures</b>
<b>4</b>			
<b>THEORY UNIT</b>	<b>SUB - UNIT</b>	<b>TOPICS</b>	
<b>I</b>		<b>Correlation and regression analysis:</b>	<b>15L</b>
	<b>1.1</b>	Visualizing relationship using Bubble chart, Scatter Diagram, Product moment correlation coefficient and its properties. Spearman’s Rank correlation (With and without ties).	<b>3</b>
	<b>1.2</b>	Concept of linear regression. Principle of least squares. Fitting a straightline by method of least squares.	<b>3</b>
	<b>1.3</b>	Relationship between regression coefficients and correlation coefficient, cause and effect relationship, Spurious correlation.	<b>3</b>
	<b>1.4</b>	Concept and use of coefficient of determination ( $R^2$ ). Fitting a quadratic curve by method of least squares,	<b>3</b>
	<b>1.5</b>	Fitting of curves reducible to linear form by transformation	<b>3</b>

		(Power curve, Exponential curve, Logarithmic curve).	
<b>II</b>		<b>Continuous Random Variable, its distribution, and properties:</b>	<b>15L</b>
	<b>2.1</b>	Definition of Probability Density Function, Cumulative Distribution Function, their properties & graphical representation. Mean, Median, Mode and Variance of a continuous variable. Raw and Central Moments and their uses.	<b>5</b>
	<b>2.2</b>	Rectangular Distribution, Exponential Distribution (one parameter and two parameter cases), their Mean, Median and Variance. Memory less property of Exponential Distribution.	<b>5</b>
	<b>2.3</b>	Normal Distribution, its Graphical Representation (Normal Curve), its properties without proof. Use of Normal Tables. Normal approximation to Binomial and Poisson Distributions (statements only)	<b>5</b>
<b>III</b>		<b>Basics of Estimation and Testing of Hypotheses:</b>	<b>15L</b>
	<b>3.1</b>	Population, Concept of a random sample, parameter, statistic, estimator, unbiased estimator, bias, sampling distribution. standard error of an estimator.	<b>3</b>
	<b>3.2</b>	Central Limit Theorem for Independently and Identically Distributed Random Variables (Statement only). Sampling Distribution of sample mean, and sample proportion based on large samples. Confidence Interval for population mean and population proportion based on large samples.	<b>4</b>
	<b>3.3</b>	Basics of testing of hypotheses, null and alternative, simple and composite hypotheses. Test of a statistical hypotheses. Critical Region, Probability of Type I and Type II errors, Level of Significance.	<b>4</b>
	<b>3.4</b>	Large sample tests for single population mean, single population proportion, difference in two population means and equality of two population proportions (procedures only).	<b>4</b>

<b>PRACTICAL</b>	List of practicals		<b>30 HOURS</b>
	<b>Topic of the Practical</b>	<b>No. of Practicals</b>	
	Correlation Analysis	1	
	Linear Regression Analysis	2	
	Curve Fitting	2	
	Continuous Random Variable	2	
	Rectangular & Exponential distributions	1	
	Normal Distribution	1	
	Testing of Hypotheses	1	
	Large Sample Tests	2	

<b>REFERENCE BOOKS</b>
------------------------

- |  |   |
|--|---|
|  | <ol style="list-style-type: none"><li>13. Welling, Khandeparkar, Pawar, Naralkar: Descriptive Statistics: Manan Prakashan</li><li>14. Milan Gholba, Sudha Phatak: Descriptive Statistics: Vipul Prakashan</li><li>15. S.P. Gupta: Statistical Methods, Sultan Chand &amp; Sons. First edition</li><li>16. Gupta S.C., Kapoor V.K.: “Fundamentals of Mathematical Statistics”, Sultan Chand &amp; Sons</li><li>17. Gupta S.C., Kapoor V.K.: “Fundamentals of Applied Statistics”, Sultan Chand &amp; Sons.</li><li>18. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.</li><li>19. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.</li><li>20. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi.</li><li>21. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York.</li><li>22. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.</li><li>23. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. McGraw Hill Book Company.</li><li>24. Ross S. (2002). A First Course in Probability, Sixth Edition, Pearson Education, Inc. &amp; Dorling Kindersley Publishing, Inc.</li></ol> |
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Resolution No.: BOS/100623/AC/260623

## **Bharatiya Vidya Bhavan's**

**M. M. College of Arts, N.M. Institute of Science, H.R.J.  
College of Commerce  
(Bhavan's College) Autonomous**

**(Affiliated to University of Mumbai)**



**NEP Syllabus for: F.Y. B.Sc. Statistics**

**Program: B.Sc.**

**Program Code: BH. BSc**

**Course Code: (BH.USST.vSEC)**

**with effect from academic year 2023-24**

## **PREAMBLE**

The world is undergoing rapid changes in the sphere of knowledge. With various scientific and technological advances, like increased automation, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly in the field of Statistics & Data Science will be in greater demand.

Statistics is the collection, presentation and analysis of observed data which evolves patterns over a period of time that plays an important role in health, agriculture, environment and industries. However, to provide more flexibility in the course curriculum and assigning credits based on the course contents and number of hours of teaching, Choice Based Credit System (CBCS) was introduced by the University of Mumbai on recommendations of the University Grants Commission (UGC) from the academic year 2016-2017.

The Choice Based Credit System (CBCS) curriculum for Statistics at the undergraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of University Grants Commission (UGC). LOCF aims to equip students with knowledge, skills, values, attitude, leadership and lifelong learning.

This National Education Policy 2020 is the first education policy of the 21st century and proposes the revision and refurbishing all aspects of the education structure, including its regulation and governance, to create a new system that is aligned with the aspirational goals of 21st century education.

The entire course of Bachelor of Science in Statistics is revamped according to the guidelines prescribed under the NEP-2020 and the process of restructuring the F.Y.B.Sc syllabus according to the NEP-2020 was initiated for its implementation from academic year 2023-24. The first-year curriculum involves discipline specific core [DSC] subjects that cover the fundamental aspects of Statistics and are all compulsory papers. Additionally, a Minor Subject course is designed to increase the expanse of the subject. Also, generic elective courses and skill-based courses would enable students to develop requisite skills in the areas of direct employability. The main aim behind designing this curriculum is to enable the students to select the courses of their choice depending on their interest.

## **PROGRAM OUTCOMES**

A student opting this course will be able to: -

<b>SR NO</b>	<b>PROGRAM OUTCOMES</b>
PO 1	Understand the fundamental and applied concepts of Statistics and its allied areas
PO 2	Demonstrate expertise in requisite software skills and techniques that are required in various industries.
PO 3	Improve critical thinking & observation skills through diverse practicals involving varied aspects of statistics and their applications
PO 4	Inculcate the quality of team spirit by working cohesively in groups and demonstrate suitable scientific writing skills.

**PROGRAM SPECIFIC OUTCOMES**

After successful completion of this course, every student will be able to: -

SR NO	PROGRAM SPECIFIC OUTCOMES	MAPPING OF PSO
PSO 1	use elementary tools using electronic spreadsheets in Descriptive Statistics and Statistical Methods, as the learner offers for the first time in his educational career, the subject Statistics as an Independent Subject.	vSEC OF SEM I & SEM II
PSO 2	have sound mathematical base for various Statistical Methods such as Standard Discrete & Continuous Probability Distributions, Exact Sampling Distributions, Sampling Techniques, ANOVA Techniques and further exploring applied nature of subject by receiving exposure to some optimization techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 3	Gain comfortable level of confidence in using statistical software.	VEC OF SEM I & II
PSO 4	have rigorous mathematical basis to various inferential statistical methods such as Estimation, Testing of Hypotheses, Distribution Theory & Stochastic Processes, Biostatistics and Operations Research techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 5	inculcate sound logical thinking due to exposure to advanced topics in Probability.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 6	make learner industry ready due to use R software/Python programming in theory papers/skill enhancement papers.	vSEC OF SEM I & SEM II



<b>Subject - STATISTICS</b>		<b>Theory → 3 &amp; Practical → 1 Total Credits = 4</b>	<b>SEMESTER I</b>
<b>Course Code BH.USST.vSEC-101</b>		<b>Course Title – Statistical Analysis using Electronic Spreadsheets I</b>	
<b>Course Objectives</b> This course is designed to: - <ol style="list-style-type: none"> <li>To learn the basics of Microsoft Excel, data entry and formatting in excel.</li> <li>To draw charts using Excel.</li> <li>To prepare tables, pivot tables and pivot charts.</li> </ol>			
<b>Course Outcomes</b> After completing this course, the learner will be able to: - <ol style="list-style-type: none"> <li></li> </ol>			
<b>COURSE CREDITS - 4</b>		<b>CATEGORY - vSEC</b>	
<b>Course Title – STATISTICAL ANALYSIS USING ELECTRONIC SPREADSHEETS I</b>			
<b>COURSE CREDITS 4</b>			<b>No of Lectures</b>
<b>THEORY UNIT</b>	<b>SUB -UNIT</b>	<b>TOPICS</b>	
<b>I</b>		<b><u>Introduction to Spreadsheets</u></b>	<b>15L</b>
	<b>1.1</b>	<b><i>Reading Data into EXCEL:</i></b> Types of data, entering different types of data such as texts, numbers, dates, function. Different types of scales: nominal, ordinal, interval, and ratio.	<b>1</b>
	<b>1.2</b>	<b><i>Basic Data Manipulation:</i></b> Collection of Primary data: concept of a questionnaire and a schedule, Secondary data Quick ways to add data, AutoComplete, Auto Fill, Auto fit. Undo and Redo. Moving data, contiguous and non-contiguous selections. Selecting with keyboard, Cut-Copy paste. ADDING AND MOVING COLUMNS OR ROWS. Inserting columns and rows. Find and Replace values. Spell Check. Formatting cells, numbers, date, time, font, colors, borders, fills. Functions using Absolute and Relative references.	<b>7</b>
	<b>1.3</b>	<b><i>Multiple Worksheets/Spreadsheets</i></b> Adding, removing, hiding, and renaming worksheets. Add Headers/Footers to a workbook. Page breaks, preview. Creating formulas, inserting functions, cell references:	<b>7</b>

		Absolute, Relative and Mixed. Creating and Using templates, using predefined templates, Adding protection option. Creating and linking multiple spreadsheets.	
<b>II</b>		<b><u>Spreadsheet Functions to Present Data</u></b>	<b>15L</b>
	<b>2.1</b>	<b><i>Functions in Excel:</i></b> Date functions: TODAY, NOW, DATE, TIME, DAY, MONTH, YEAR, WEEKDAY, DAYS360 Statistical functions: COUNT, COUNTA, COUNTBLANK, CORREL, MAX, MIN, INT, MOD, SQRT, ABS, SUM, AVERAGE, ROUND, ROUNDUP, ROUNDDOWN, CEILING, FLOOR. Database functions: IF, Nested IF, LOOKUP, VLOOKUP, HLOOKUP	<b>7</b>
	<b>2.2</b>	<b><i>Graphical Representation of Data:</i></b> The graphical representation of data column, Scatter Diagram, Histogram, Ogives, Line, Pie, and Bar Charts, Multiple Bar Diagram.	<b>8</b>
<b>III</b>		<b><u>Exploratory Data Analysis - I:</u></b>	<b>15L</b>
	<b>3.1</b>	<b><i>Introduction to Filtering and Pivot Tables and Pivot Charts:</i></b> Filter with customized condition. Creating a Pivot table, Pivot table regions. Adding fields to Pivot table. Number formatting Contingency table making. Functions: Count, Max, Min, Avg, Sum	<b>7</b>
	<b>3.2</b>	<b><i>Arithmetic Manipulation in Excel:</i></b> Measures of Central Tendency: Locational Averages (Median, Mode, and Partition Values: Quartiles, Deciles and Percentiles, Ogives chart to locate Locational Averages). Mathematical Averages (Arithmetic Mean – Simple, Weighted and Combined Mean, Geometric Mean, Harmonic Mean) Measures of Dispersion: Absolute and relative measures of dispersion – Range, Quartile Deviation, Mean Absolute Deviation, Standard Deviation. Variance and Combined Variance. Concept of Skewness and Kurtosis.	<b>8</b>

		Box Plot. Stem & leaf plot	
<b>PRACT</b>	List of practicals		<b>30 HOURS</b>
<b>1. Reading Data into EXCEL</b> <b>2. Types of Data</b> <b>3. Data Manipulation in EXCEL</b> <b>4. Hands-on Worksheets</b> <b>5. EXCEL functions</b> <b>6. Statistical functions</b> <b>7. Database functions</b> <b>8. Graphical Representation of Data</b> <b>9. Pivot Tables and Pivot Charts</b> <b>10. Measures of Central Tendencies</b> <b>11. Measures of Dispersion</b> <b>12. Skewness and Kurtosis, Box Plot</b>			
	<b>REFERENCE BOOKS</b> <ol style="list-style-type: none"> <li>1. Microsoft Excel 2019 Data Analysis and Business Modelling, Sixth edition, Wayne L. Winston</li> <li>2. Data Analysis with EXCEL, Manisha Nigam eBook</li> <li>3. Microsoft Excel DATA ANALYSIS FOR DUMMIES, 3<sup>rd</sup> Edition, Stephen L. Nelson and Elizabeth C. Nelson</li> <li>4. EXCEL for Statistics, Thomas J. Quirk, Springer</li> <li>5. EXCEL Statistics, A Quick Guide, THIRD EDITION, Neil J. Salkind.</li> <li>6. Straightforward Statistics with EXCEL, 2<sup>nd</sup> EDITION, Chieh-Chen Bowen</li> </ol>		

<b>Subject - STATISTICS</b>		<b>Theory → 3 &amp; Practical → 1 Total Credits = 4</b>	<b>SEMESTER II</b>
<b>Course Code BH.USST.vSEC-201</b>		<b>Course Title – Statistical Analysis using Electronic Spreadsheets II</b>	
<b>Course Objectives</b> This course is designed to: - <ol style="list-style-type: none"> <li>1. To do basic data analysis using excel.</li> <li>2. To analyze data statistically.</li> <li>3. To apply various statistical functions in Excel.</li> </ol>			
<b>Course Outcomes</b> After completing this course, the learner will be able to: - <ol style="list-style-type: none"> <li>2.</li> </ol>			
<b>COURSE CREDITS - 4</b>		<b>CATEGORY - vSEC</b>	
<b>Course Title – STATISTICAL ANALYSIS USING ELECTRONIC SPREADSHEETS - II</b>			
<b>COURSE CREDITS 4</b>			<b>No of Lectures</b>
<b>THEORY UNIT</b>	<b>SUB -UNIT</b>	<b>TOPICS</b>	
<b>I</b>		<b><u>Exploratory Data Analysis – II:</u></b>	<b>15L</b>
	<b>1.1</b>	Use of dash board, Correlation: Scatter Diagram, Product Moment Correlation Coefficient, Spearman’s Rank Correlation Coefficient. (With and Without ties)	<b>7</b>
	<b>1.2</b>	Regression: Linear Regression, Method of Least Squares, Fitting a straight line by the method of least squares. Curve Fitting by Least Square Method.	<b>8</b>
<b>II</b>		<b><u>Probability Theory:</u></b>	<b>15L</b>
	<b>2.1</b>	<b><i>Probability:</i></b> Defining Probability, Calculating Probability, Understanding Conditional Probability	<b>7</b>
	<b>2.2</b>	<b><i>Distributions:</i></b> Organizing and graphing a distribution Graphing frequency polygons Properties of distributions Probability distributions	<b>8</b>
<b>III</b>		<b><u>Time Series:</u></b>	<b>15L</b>
	<b>3.1</b>	Definition of Time Series, its components, and models of time series. Estimation of Trend: (i) Free-Hand Curve Method, (ii)	<b>15</b>

	Method of Semi-Averages, (iii) Method of Moving Averages, (iv) Method of Least Squares. Forecasting using Least Squares Method.	
<b>PRACT</b>	List of practicals	<b>30 HOURS</b>
<b>1. Correlation Analysis</b> <b>2. Regression Analysis</b> <b>3. Curve Fitting</b> <b>4. Probability functions in EXCEL</b> <b>5. Graphing of Frequency Polygons</b> <b>6. Discrete Distributions</b> <b>7. Continuous Distributions</b> <b>8. Graphing a Distribution – I</b> <b>9. Graphing a Distribution – II</b> <b>10. Time Series – I</b> <b>11. Time Series – II</b> <b>12. Time Series – III</b>		
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Resolution No.: BOS/ 100623 /AC/260623

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**M. M. College of Arts, N.M. Institute of Science, H.R.J.  
College of Commerce  
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**NEP Syllabus for: F.Y. B.Sc. Statistics**

**Program: B.Sc.**

**Program Code: BH. BSc**

**Course Code: (BH.USST.VEC)**

**with effect from academic year 2023-24**

## **PREAMBLE**

The world is undergoing rapid changes in the sphere of knowledge. With various scientific and technological advances, like increased automation, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly in the field of Statistics & Data Science will be in greater demand.

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## **PROGRAM OUTCOMES**

A student opting this course will be able to: -

<b>SR NO</b>	<b>PROGRAM OUTCOMES</b>
PO 1	Understand the fundamental and applied concepts of Statistics and its allied areas
PO 2	Demonstrate expertise in requisite software skills and techniques that are required in various industries.
PO 3	Improve critical thinking & observation skills through diverse practical involving varied aspects of Statistics and their applications
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**PROGRAM SPECIFIC OUTCOMES**

After successful completion of this course, every student will be able to: -

SR NO	PROGRAM SPECIFIC OUTCOMES	MAPPING OF PSO
PSO 1	use elementary tools using electronic spreadsheets in Descriptive Statistics and Statistical Methods, as the learner offers for the first time in his educational career, the subject Statistics as an Independent Subject.	vSEC OF SEM I & SEM II
PSO 2	have sound mathematical base for various Statistical Methods such as Standard Discrete & Continuous Probability Distributions, Exact Sampling Distributions, Sampling Techniques, ANOVA Techniques and further exploring applied nature of subject by receiving exposure to some optimization techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 3	Gain comfortable level of confidence in using statistical software.	VEC OF SEM I & II
PSO 4	have rigorous mathematical basis to various inferential statistical methods such as Estimation, Testing of Hypotheses, Distribution Theory & Stochastic Processes, Biostatistics and Operations Research techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 5	inculcate sound logical thinking due to exposure to advanced topics in Probability.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 6	make learner industry ready due to use R software/Python programming in theory papers/skill enhancement papers.	vSEC OF SEM I & SEM II



<b>Subject - STATISTICS</b>		<b>Theory → 2 &amp; Practical → -- Total Credits = 2</b>	<b>SEMESTER I</b>
<b>Course Code BH.USST.VEC-101</b>		<b>Course Title – Data Presentation using Power BI-I</b>	
<p><b>Course Objectives:</b>                  This course is designed to: -</p> <ol style="list-style-type: none"> <li>1. understand step by step the basics of Power BI installation, import, clean, transform and model data, data visualization concepts, and techniques for effective data presentation</li> <li>2. gain hands-on experience through practical exercises</li> </ol> <p><b>Course Outcomes:</b>                  After completing this course, the learner will be able to: -</p> <ol style="list-style-type: none"> <li>3. have a solid foundation in Power BI installation, data visualization, and data presentation techniques.</li> <li>4. create visually appealing and interactive reports using Power BI, enabling them to effectively communicate insights and findings through data.</li> </ol>			
<b>COURSE CREDITS - 2</b>		<b>CATEGORY - VEC</b>	
<b>Course Title – Data Presentation using Power BI-I</b>			
<b>COURSE CREDITS 2</b>			<b>No of Lectures</b>
<b>THEORY UNIT</b>	<b>SUB -UNIT</b>	<b>TOPICS</b>	<b>15 L</b>
I	1.1	<b>Introduction to Power BI:</b> Overview of Power BI and its features Understanding the Power BI ecosystem Installing Power BI Desktop Introduction to Power BI Service and Power BI Mobile	2
	1.2	<b>Connecting to Data:</b> Importing data into Power BI Connecting to various data sources (Excel, CSV, databases, etc.) Data preparation and transformation Overview of Power Query for data cleaning	3
	1.3	<b>Basics of Data Presentation:</b> Understanding the importance of data presentation Data visualization principles and best practices Selecting the right chart types for different data scenarios Using colors, fonts, and layouts effectively	3
	1.4	<b>Creating Visualizations in Power BI:</b> Overview of Power BI visuals and their types Building basic visuals (bar charts, line charts, pie charts, etc.) Formatting visuals (colors, labels, titles, etc.) Working with tables and matrices Using interactive filters and slicers Creating drill-through and drill-down experiences	5
	1.5	<b>Data Presentation Best Practices:</b>	2

		Effective use of color and contrast Using hierarchies and drill-down capabilities Designing for different screen sizes and devices Creating user-friendly navigation and interaction Accessibility considerations for data presentation	
<b>II</b>	Hands on Experience based on Unit I		<b>15 HOURS</b>
	<b>Topics of the Hands-on Experience</b>	<b>No. of Hours</b>	
	Introduction to Power BI	3	
	Connecting to Data	3	
	Basics of Data Presentation	3	
	Creating Visualizations in Power BI	3	
	Data Presentation Best Practices	3	
	<b>REFERENCES:</b> <ol style="list-style-type: none"> <li>1. <a href="https://radacad.com/online-book-power-bi-from-rookie-to-rockstar">https://radacad.com/online-book-power-bi-from-rookie-to-rockstar</a></li> <li>2. <a href="https://learn.microsoft.com/en-us/power-bi/consumer/end-user-basic-concepts">https://learn.microsoft.com/en-us/power-bi/consumer/end-user-basic-concepts</a></li> <li>3. YouTube channels</li> </ol>		

<b>Subject - STATISTICS</b>		<b>Theory → 2 &amp; Practical → -- Total Credits = 2</b>	<b>SEMESTER II</b>
<b>Course Code BH.USST.VEC-201</b>		<b>Course Title – Data Presentation and analysis using Power BI-II</b>	
<p><b>Course Objectives:</b>                  This course is designed to: -</p> <ol style="list-style-type: none"> <li>gain a deep understanding of Power BI's capabilities and learn how to leverage its features to analyze and visualize data effectively.</li> <li>equip them with the necessary skills to perform data analysis using the tool</li> </ol> <p><b>Course Outcomes :</b>                  After completing this course, the learner will be able to: -</p> <ol style="list-style-type: none"> <li>visualize and analyze data effectively using Power BI, thereby gaining valuable skills for data-driven decision making in various domains.</li> <li>have a strong foundation in Power BI and data analysis techniques</li> <li>create visually appealing and interactive reports and dashboards to communicate data effectively</li> </ol>			
<b>COURSE CREDITS - 2</b>		<b>CATEGORY - VEC</b>	
<b>Course Title – Data Presentation and analysis using Power BI-II</b>			
<b>COURSE CREDITS 2</b>			<b>No of Lectures</b>
<b>THEORY UNIT</b>	<b>SUB -UNIT</b>	<b>TOPICS</b>	<b>15 L</b>
I	1.1	<p><b>Advanced Visualization Techniques:</b>                      Advanced visualizations (tree-maps, scatter plots, maps, etc.)                      Adding custom visuals from Power BI market place                      Implementing custom formatting using themes                      Applying conditional formatting for data highlighting</p>	3
	1.2	<p><b>Advanced Power BI Features:</b>                      Power Query and data transformation                      Advanced DAX functions and calculations                      Creating calculated tables and advanced relationships                      Power BI data modeling best practices                      Performance optimization techniques</p>	3
	1.3	<p><b>Designing Interactive Dashboards:</b>                      Building interactive dashboards                      Utilizing bookmarks for navigation and storytelling                      Adding and configuring slicers for interactivity                      Introduction to bookmarks, buttons, and tooltips                      Using Q&amp;A feature for natural language queries                      Introduction to Power BI mobile reports</p>	6
	1.4	<b>Data Analysis Techniques:</b>	3

		Data exploration and filtering Aggregating and summarizing data Applying statistical functions Time intelligence calculations Analyzing trends and patterns in data Forecasting and predictive analytics	
<b>II</b>	Hands on Experience based on Unit I		<b>15 HOURS</b>
	<b>Topics of the Hands-on Experience</b>	<b>No. of Hours</b>	
	Advanced Visualization Techniques	4	
	Advanced Power BI Features	4	
	Designing Interactive Dashboards	4	
	Data Analysis Techniques	3	
	<b>REFERENCES:</b> 1. <a href="https://radacad.com/online-book-power-bi-from-rookie-to-rockstar">https://radacad.com/online-book-power-bi-from-rookie-to-rockstar</a> 2. <a href="https://learn.microsoft.com/en-us/power-bi/consumer/end-user-basic-concepts">https://learn.microsoft.com/en-us/power-bi/consumer/end-user-basic-concepts</a> 3. YouTube channels		

Resolution No.: BOS/100623/AC/260623

## **Bharatiya Vidya Bhavan's**

**M. M. College of Arts, N.M. Institute of Science, H.R.J.  
College of Commerce  
(Bhavan's College) Autonomous**

**(Affiliated to University of Mumbai)**



**NEP Syllabus for: F.Y. B.Sc. Statistics**

**Program: B.Sc.**

**Program Code: BH. BSc**

**Course Code: (BH.USST.OE)**

**with effect from academic year 2023-24**

## **PREAMBLE**

The world is undergoing rapid changes in the sphere of knowledge. With various scientific and technological advances, like increased automation, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly in the field of Statistics & Data Science will be in greater demand.

Statistics is the collection, presentation and analysis of observed data which evolves patterns over a period of time that plays an important role in health, agriculture, environment and industries. However, to provide more flexibility in the course curriculum and assigning credits based on the course contents and number of hours of teaching, Choice Based Credit System (CBCS) was introduced by the University of Mumbai on recommendations of the University Grants Commission (UGC) from the academic year 2016-2017.

The Choice Based Credit System (CBCS) curriculum for Statistics at the undergraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of University Grants Commission (UGC). LOCF aims to equip students with knowledge, skills, values, attitude, leadership and lifelong learning.

This National Education Policy 2020 is the first education policy of the 21st century and proposes the revision and refurbishing all aspects of the education structure, including its regulation and governance, to create a new system that is aligned with the aspirational goals of 21st century education.

The entire course of Bachelor of Science in Statistics is revamped according to the guidelines prescribed under the NEP-2020 and the process of restructuring the F.Y.B.Sc syllabus according to the NEP-2020 was initiated for its implementation from academic year 2023-24. The first-year curriculum involves discipline specific core [DSC] subjects that cover the fundamental aspects of Statistics and are all compulsory papers. Additionally, a Minor Subject course is designed to increase the expanse of the subject. Also, generic elective courses and skill-based courses would enable students to develop requisite skills in the areas of direct employability. The main aim behind designing this curriculum is to enable the students to select the courses of their choice depending on their interest.

## **PROGRAM OUTCOMES**

A student opting this course will be able to: -

<b>SR NO</b>	<b>PROGRAM OUTCOMES</b>
PO 1	Understand the fundamental and applied concepts of Statistics and its allied areas
PO 2	Demonstrate expertise in requisite software skills and techniques that are required in various industries.
PO 3	Improve critical thinking & observation skills through diverse practicals involving varied aspects of statistics and their applications
PO 4	Inculcate the quality of team spirit by working cohesively in groups and demonstrate suitable scientific writing skills.

**PROGRAM SPECIFIC OUTCOMES**

After successful completion of this course, every student will be able to: -

SR NO	PROGRAM SPECIFIC OUTCOMES	MAPPING OF PSO
PSO 1	use elementary tools using electronic spreadsheets in Descriptive Statistics and Statistical Methods, as the learner offers for the first time in his educational career, the subject Statistics as an Independent Subject.	vSEC OF SEM I & SEM II
PSO 2	have sound mathematical base for various Statistical Methods such as Standard Discrete & Continuous Probability Distributions, Exact Sampling Distributions, Sampling Techniques, ANOVA Techniques and further exploring applied nature of subject by receiving exposure to some optimization techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 3	Gain comfortable level of confidence in using statistical software.	VEC OF SEM I & II
PSO 4	have rigorous mathematical basis to various inferential statistical methods such as Estimation, Testing of Hypotheses, Distribution Theory & Stochastic Processes, Biostatistics and Operations Research techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 5	inculcate sound logical thinking due to exposure to advanced topics in Probability.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 6	make learner industry ready due to use R software/Python programming in theory papers/skill enhancement papers.	vSEC OF SEM I & SEM II

<b>Subject - STATISTICS</b>		<b>Theory → 3 &amp; Practical → 1 Total Credits = 4</b>	<b>SEMESTER I</b>
<b>Course Code BH.USST.OE101</b>		<b>Course Title –SIMPLE QUANTITATIVE TECHNIQUES I</b>	
<b>Course Objectives</b> This course is designed to: - <ol style="list-style-type: none"> <li>5. To introduce statistics to undergraduate students.</li> <li>6. To make aware of the concept of spread of data and the various measures of dispersion, measure of central tendency</li> <li>7. To enable students, use knowledge in industry to solve real life problem</li> </ol>			
<b>Course Outcomes</b> After completing this course, the learner will be able to: - <ol style="list-style-type: none"> <li>1. Use knowledge in industry to solve real life problem</li> </ol>			
<b>COURSE CREDITS - 4</b>		<b>CATEGORY – GE/OE</b>	
<b>Course Title – SIMPLE QUANTITATIVE TECHNIQUES I</b>			
<b>COURSE CREDITS 4</b>			<b>No of Lectures</b>
<b>THEORY UNIT</b>	<b>SUB -UNIT</b>	<b>TOPICS</b>	
<b>I</b>		<b>Classification and Tabulation</b>	<b>15L</b>
	<b>1.1</b>	<b>Tabulation:</b> Simple tables and Complex tables, two way and three-way tables.	<b>3</b>
	<b>1.2</b>	<b>Classification of Data:</b> Univariate frequency distribution of discrete and continuous variables. Cumulative frequency distribution, Bivariate frequency distribution of discrete and continuous variables, Marginal and conditional distributions.	<b>5</b>
	<b>1.3</b>	One- and two-dimensional diagrams, Bar diagrams, Line Graphs, pie chart, Histograms, Ogive Curves. Location of quantiles/mode from graphs.	<b>7</b>
<b>II</b>		<b>SUMMARISATION MEASURES</b>	<b>15L</b>
	<b>2.1</b>	<b>Measures of central Tendencies:</b> Concept of central tendencies For Grouped and Ungrouped data : Arithmetic mean, Geometric Mean, Harmonic Mean Median, Mode Quartiles, Deciles and Percentiles	<b>7</b>
	<b>2.2</b>	<b>Measures of Dispersions:</b> Concept of Dispersion For Grouped and Ungrouped data : Range, Quartile deviation, Mean deviation, Standard deviation, Variance, Combined variance.	<b>8</b>



<b>III</b>		<b>Decision Theory:</b>	<b>15L</b>
	<b>3.1</b>	Basic Concepts in probability	<b>3</b>
	<b>3.2</b>	Decision making situation, Decision maker Courses of Action, States of nature, Pay-off and Pay-off matrix	<b>2</b>
	<b>3.3</b>	Decision making under uncertainty: Maximin, Maximax, Minimax regret and Laplace criteria; simple examples to find optimum decision. Formulation of Payoff Matrix.	<b>5</b>
	<b>3.4</b>	Decision making under Risk, Expected Monetary Value (EMV); Simple Examples based on EMV. Expected Opportunity Loss (EOL), simple examples based on EOL, Decision Trees.	<b>5</b>
<b>TUTORIAL</b>	List of Topics for Tutorials 1. Tabulation & Classification 2. Univariate frequency distribution 3. Marginal and conditional distribution 4. Measure of central tendency – I 5. Measure of central tendency – II 6. Measure of Dispersion – I 7. Measure of Dispersion – II 8. Probability 9. Construction and formulation of pay off matrix 10. Decision making under uncertainty 11. Decision making under risk 12. Decision tree		<b>15 HOURS</b>
	<b>REFERENCE BOOKS</b>		
	7. Operations Research by Gupta and Kapoor 8. Statistical Methods - S.G. Gupta (S. Chand & Co. ) 9. Fundamentals of Statistics - D. N. Elhance. 10. An Introduction to probability and statistics- Vijay K Rohatgi, A.K.Md. Ehsanes 11. Gupta S.C., Kapoor V.K.: “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons 12. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, NewDelhi.		

<b>Subject - STATISTICS</b>		<b>Theory → 3 &amp; Practical → 1 Total Credits = 4</b>	<b>SEMESTER II</b>
<b>Course Code BH.USST.OE201</b>		<b>Course Title –SIMPLE QUANTITATIVE TECHNIQUES II</b>	
<b>Course Objectives</b> This course is designed to: - 4. To introduce concept of correlation and regression. 5. To learn concept of Time series and Index Numbers <b>Course Outcomes</b> After completing this course, the learner will be able to: - 8.			
<b>COURSE CREDITS - 4</b>		<b>CATEGORY – GE/OE</b>	
<b>Course Title – SIMPLE QUANTITATIVE TECHNIQUES II</b>			
<b>COURSE CREDITS</b> 4			<b>No of Lectures</b>
<b>THEORY UNIT</b>	<b>SUB - UNIT</b>	<b>TOPICS</b>	
<b>I</b>		<b>Bivariate Linear Correlation and Regression</b>	<b>15L</b>
	<b>1.1</b>	<b>Correlation Analysis:</b> Meaning, Types of Correlation, Determination of Correlation: Scatter diagram, Karl Pearson’s method of Correlation, Spearman’s Rank Correlation Coefficient	<b>7</b>
	<b>1.2</b>	<b>Regression Analysis</b> Meaning, Concept of Regression equations Slope of the Regression Line, and its interpretation. Regression Coefficients (excluding Bivariate Frequency Distribution Table), Relationship between Coefficient of Correlation and Regression Coefficients, Finding the equations of Regression lines by method of Least Squares.	<b>8</b>
<b>II</b>		<b>Index Numbers &amp; Time Series</b>	<b>15L</b>
	<b>2.1</b>	<b>Time Series:</b> Definition of time series uses of time series, Its components, Models of time series	<b>1</b>
	<b>2.2</b>	<b>Estimation of trend using:</b> Freehand curve method, Method of semi averages, Method of Moving averages, Method of least squares (linear trend only).	<b>4</b>
	<b>2.3</b>	<b>Index Numbers:</b> Concept and usage of Index numbers, Types of Index number	<b>2</b>

	2.4	Aggregate and Relative Index Numbers Lasperye's, Paasche's, Dorbisch-Bowley's, Marshall-Edgeworth and Fisher's ideal index numbers.	4
	2.5	Chain Base Index Nos. Shifting of Base year, Cost of Living Index Numbers, Concept of Real Income, Concept of Wholesale Price Index Number.	4
<b>III</b>		<b>Linear Programing Problem</b>	<b>15L</b>
	3.1	<b>Introduction to LPP, Mathematical Formulation:</b> Maximization and Minimization type problems	5
	3.2	<b>Concept of Solution:</b> Feasible solution, Basic Feasible Solution, Optimal Solution	5
	3.3	Graphical solution for problems with two variables. Simplex method for two variables.	5
<b>Tutorials</b>		<p>List of Tutorials</p> <ol style="list-style-type: none"> <li>1. Correlation analysis</li> <li>2. Regression analysis</li> <li>3. Regression line and its equations</li> <li>4. Spearman's Rank correlation</li> <li>5. Aggregative and relative Index numbers</li> <li>6. Types of Index number</li> <li>7. Chain base index numbers, Shifting of base year</li> <li>8. Cost of living index number, Real income and wholesale price Index</li> <li>9. Method of Semi and Moving Average, Least Square</li> <li>10. Formulation of LPP</li> <li>11. Graphical Method</li> <li>12. Simplex Method</li> </ol>	<b>15 HOURS</b>
		<b>REFERENCE BOOKS</b>	
		<ol style="list-style-type: none"> <li>1. S.P. Gupta: Statistical Methods, Sultan Chand &amp; Sons. First edition</li> <li>2. Gupta S.C., Kapoor V.K.: "Fundamentals of Mathematical Statistics", Sultan Chand &amp; Sons</li> <li>3. Gupta S.C., Kapoor V.K.: "Fundamentals of Applied Statistics", Sultan Chand &amp; Sons</li> <li>4. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, NewDelhi.</li> <li>5. .Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.</li> <li>6. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, NewDelhi.</li> </ol>	

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|  | 7. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentce Hall of India, NewDelhi. Snedecor G. W. and Cochran W. G.(1989). Statistical Methods, Eighth Ed. East-WestPress. |
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**Resolution No.: BOS/100623/AC/260623**

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**NEP Syllabus for: F.Y. B.Sc. Statistics**

**Program: B.Sc.**

**Program Code: BH. BSc**

**Course Code: (BH.USST.IKS)**

**with effect from academic year 2023-24**

### **PREAMBLE**

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**PROGRAM OUTCOMES**

A student opting this course will be able to: -

<b>SR NO</b>	<b>PROGRAM OUTCOMES</b>
PO 1	Understand the fundamental and applied concepts of Statistics and its allied areas
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PO 3	Improve critical thinking & observation skills through diverse practical involving varied aspects of Statistics and their applications
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**PROGRAM SPECIFIC OUTCOMES**

After successful completion of this course, every student will be able to: -

<b>SR NO</b>	<b>PROGRAM SPECIFIC OUTCOMES</b>	<b>MAPPING OF PSO</b>
PSO 1	use elementary tools using electronic spreadsheets in Descriptive Statistics and Statistical Methods, as the learner offers for the first time in his educational career, the subject Statistics as an Independent Subject.	vSEC OF SEM I & SEM II
PSO 2	have sound mathematical base for various Statistical Methods such as Standard Discrete & Continuous Probability Distributions, Exact Sampling Distributions, Sampling Techniques, ANOVA Techniques and further exploring applied nature of subject by receiving exposure to some optimization techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 3	Gain comfortable level of confidence in using statistical software.	VEC OF SEM I & II
PSO 4	have rigorous mathematical basis to various inferential statistical methods such as Estimation, Testing of Hypotheses, Distribution Theory & Stochastic Processes, Biostatistics and Operations Research techniques.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 5	inculcate sound logical thinking due to exposure to advanced topics in Probability.	PAPER OF DSC & MAJOR OF SEM I & II
PSO 6	make learner industry ready due to use R software/Python programming in theory papers/skill enhancement papers.	vSEC OF SEM I & SEM II

<b>Subject - STATISTICS</b>		<b>Theory → 2</b>	<b>Total Credits = 2</b>	<b>SEMESTER I</b>
<b>Course Code BH.USST.IKS.101</b>		<b>Course Title – Indian Statistical Knowledge System</b>		
<p><b>Course Objectives:</b> This course is designed to: -</p> <ol style="list-style-type: none"> <li>1. Make students aware about IKS</li> <li>2. Understand evolution of Statistics with its holistic development using ancient religious text.</li> </ol> <p><b>Course Outcomes:</b> After completing this course, the learner will be able to: -</p> <ol style="list-style-type: none"> <li>1. Gain knowledge about IKS</li> <li>2. Understand evolution of Statistics</li> </ol>				
<b>COURSE CREDITS - 2</b>		<b>CATEGORY - IKS</b>		
<b>Course Title – INDIAN STATISTICAL KNOWLEDGE SYSTEM</b>				
<b>COURSE CREDITS</b> 2				<b>No of Lectures</b>
<b>THEORY UNIT</b>	<b>SUB - UNIT</b>	<b>TOPICS</b>		<b>15 L</b>
I	1.1	<p><b>Overview of IKS:</b> Survey of IKS Domains: A Broad overview of disciplines included in the IKS and historical developments.</p>		3
	1.2	<p>Sources of IKS knowledge, classification of IKS texts and secondary resources materials. Differences between sutra, bhashya, karika, vartika texts. Fourteen/eighteen vidasthanas, tantrayukti.</p>		4
	1.3	<p><b>Vocabulary of IKS:</b> Introduction to Panchamahabhutas, Concept of a sutra, introduction to the concepts of non-translatable (Ex. Dhanna, punya, aatma, karma, yagna, shakti, vama, jaati, moksha, loka, daana, itihaasa, purana etc.) and importance of using the proper terminology. Terms such as praja, Janata, loktantra, prajatantra, Ganatantra swarajya, Suraiya rashtra desh.</p>		8
				<b>15 L</b>
II	2.1	<p><b>Evolution of Statistics:</b> Statistical system in British India, Statistical system after</p>		8



		Independence, National Sample Survey Office(NSSO), Central Statistical organization(CSO), National Sample survey, Indian Statistical Institute, Institute of Agricultural Research Statistics (IARS), National Statistical Commission, Gap in theory and practice.	
	2.2	<b>Probability in Ancient India:</b> Mathematical Pre-requisites, Precise fractions, a game of dice in India, The hymn on dice in the Rugveda, The notion of a fair game and the frequentist interpretation of Probability, Probabilities of singular events.	4
	2.3	<b>Weighted Arithmetic Mean in Ancient India:</b> Introduction, Mean measures in Excavation Problem, Computations on the purity of gold in Alligation Problems.	3
<p><b>REFERENCES:</b></p> <ol style="list-style-type: none"> <li>1. Indian Knowledge Systems - Vol 1 &amp; 2, Avadhesh K. Singh, Kapil Kapoor (2021)</li> <li>2. Computing Science in Ancient India, T.R.N. Rao &amp; Subhash Kak</li> <li>3. Wisdom of the Ancient Seers Mantras of the Rig Veda, David Frawley</li> <li>4. Evolution of Statistics in India. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. Journal International Statistic Review 1999, ISI</li> <li>5. Official Statistics in India: The past and the present. T.J. Rao. Journal of Official Statistics vol. 26, no.2,2010.</li> <li>6. Probability in Ancient India. C. K. Raju, Handbook of Philosophy of Statistics, edited by Paul Thagard Dov M. Gabbay and John Woods, handbook of Philosophy of Science, Elsevier, 2011.</li> <li>7. Weighted Arithmetic Mean in Ancient India by Amartya Kumar Dutta, Bhavana Oct., 2017.</li> <li>8. The book on Games of Chance: The 16<sup>th</sup> century Treatise on Probability, Gerolamo Cardano, Translated by Sydney Henry Gould, Dover Publications, Mineola, New York.</li> </ol>			