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

S.Y.B.Sc. (Statistics) Semester -III

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 2024-2025

Anekant Education Society's
Tuljaram Chaturchand College, Baramati
(Autonomous)
Board of Studies (BOS) in Statistics
From 2022-23 to 2024-25

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Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science & Commerce, Baramati.

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati is an autonomous & dynamic institute and has successfully implemented the National Education Policy-2020 since the academic year 2023-24. We are updating our academic policies as per local needs keeping in view the global perspectives. Accordingly, we have updated our program outcomes as per the graduate attributes defined in New Education Policy. In general, program outcomes are categorized into two categories as disciplinary & interdisciplinary outcomes and generic outcomes.

Program Outcomes for B.Sc.

1. **Comprehensive Knowledge and Understanding**: Graduates will possess a profound understanding of their field of study, including foundational theories, principles, methodologies, and key concepts, within a broader multidisciplinary context.
2. **Practical, Professional, and Procedural Knowledge**: Graduates will acquire practical skills and expertise essential for professional tasks within their field. This includes knowledge of industry standards, best practices, regulations, and ethical considerations, with the ability to apply this knowledge effectively in real-world scenarios.
3. **Entrepreneurial Mindset and Knowledge**: Graduates will cultivate an entrepreneurial mindset, identifying opportunities, fostering innovation, and understanding business principles, market dynamics, and risk management strategies.
4. **Specialized Skills and Competencies**: Graduates will demonstrate proficiency in technical skills, analytical abilities, problem-solving, effective communication, and leadership, relevant to their field of study. They will also adapt and innovate in response to changing circumstances.
5. **Capacity for Application, Problem-Solving, and Analytical Reasoning**: Graduates will possess the capacity to apply learned concepts in practical settings, solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn and take calculated risks.
6. **Communication Skills and Collaboration**: Graduates will effectively communicate complex information, both orally and in writing, using appropriate media and language. They will also collaborate effectively in diverse teams, demonstrating leadership qualities and facilitating cooperative efforts toward common goals.
7. **Research-related Skills**: Graduates will demonstrate observational and inquiry skills, formulate research questions, and utilize appropriate methodologies for data collection and analysis. They will also adhere to research ethics and effectively report research findings.
8. **Learning How to Learn Skills**: Graduates will acquire new knowledge and skills through self-directed learning, adapt to changing demands, and set and achieve goals independently.
9. **Digital and Technological Skills**: Graduates will demonstrate proficiency in using ICT, accessing information sources, and analyzing data using appropriate software.

10. **Multicultural Competence, Inclusive Spirit, and Empathy**: Graduates will engage effectively in multicultural settings, respecting diverse perspectives, leading diverse teams, and demonstrating empathy and understanding of others' perspectives and emotions.
11. **Value Inculcation and Environmental Awareness**: Graduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and take appropriate actions to promote sustainability and environmental conservation.
12. **Autonomy, Responsibility, and Accountability**: Graduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts.
13. **Community Engagement and Service**: Graduates will actively participate in community-engaged services and activities, promoting societal well-being.

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

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

Credit Distribution Structure for S.Y.B.Sc.-2024-2025 (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							
5.0	III	STA-201-MJM: Continuous Probability Distributions – I (T) STA-202-MJM: Statistical Techniques- I(T) STA-203-MJM: Applied Statistics-I(T) STA-204-MJM Statistics Practical-III (P) **Credits-2+2+2+2**	--	STA-211-MN: Foundations of Probability: Theory and Applications (T) STA-212-MN: Minor Statistics Practical – I (P) **Credit-2+2**	STA-216-OE: Applied Statistical Techniques (T) **Credit- 2**	STA-221-VSC: Quantitative Techniques (T) **Credit- 2**	MAR-231-AEC: भाषिक उपयोजन व लेखन कौशल्ये (T) **Or** HIN-231-AEC: हिंदी भाषा : सृजन कौशल (T) **Or** SAN-231-AEC: प्राथमिक संभाषणकौशल्यम् (T) GEN-245-IKS: Indian Knowledge System (Generic) (T) **Credit- 2+2**	STA-235-FP: Project YOG/PES/CUL/NSS/NCC-239-CC: (T) To be selected from the Basket **Credit- 2+2**	--	**UG Diploma 46**
	IV	STA-251-MJM Continuous Probability Distributions – II (T) STA-252-MJM Statistical Techniques- II (T) STA-253-MJM Applied Statistics-II (T) STA -254-MJM: Statistics Practical – IV(P) **Credits-2+2+2+2**	--	STA-261-MN: Probability Distributions and Applications (T) STA-262-MN: Minor Statistics Practical – II (P) **Credit-2+2**	STA-266-OE**:** Practical Based on Applied Statistical Techniques (P) **Credit- 2**	STA-276-SEC**:** Introduction to Tableau and Power BI (P) **Credit- 2**	MAR-231-AEC: लेखन निर्मिती व परीक्षण कौशल्ये (T) **Or** HIN-231-AEC: हिंदी भाषा: संप्रेषण कौशल (T) **Or** SAN-231-AEC: प्रगत संभाषणकौशल्यम् (T) **Credit- 2**	YOG/PES/CUL/NSS/NCC-289-CC: (T) To be selected from the Basket **Credit- 2**	STA-285-CEP: Community Engagement Project (P) **Credit-2**	
	Cum Cr.	16	--	8	4	4	6	6	2	

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

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

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

Sem	Course Type	Course Code	Course Name	Theory / Practical	Credits
III	Major Mandatory	STA-201-MJM	Continuous Probability Distributions – I	Theory	02
	Major Mandatory	STA-202-MJM	Statistical Techniques – I	Theory	02
	Major Mandatory	STA-203-MJM	Applied Statistics – I	Theory	02
	Major Mandatory	STA-204-MJM	Statistics Practical – III	Practical	02
	Minor	STA-211-MN	Foundations of Probability: Theory and Applications	Theory	02
	Minor	STA-212-MN	Minor Statistics Practical – I	Practical	02
	Open Elective (OE)	STA-216-OE	Applied Statistical Techniques	Theory	02
	Vocational Skill Course (VSC)	STA-221-VSC	Quantitative Techniques	Theory	02
	Ability Enhancement Course (AEC)	MAR-231-AEC HIN-231-AEC SAN-231-AEC	भाषिक उपयोजन व लेखन कौशल्ये हिंदी भाषा कौशल प्राथमिक संभाषणकौशल्यम्	Theory	02
	Field Project (FP)	STA-235-FP	Project	Practical	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-239-CC	To be selected from the Basket	Theory	02
	Generic IKS Course (IKS)	GEN-245-IKS	Indian Knowledge System (Generic)	Theory	02
				Total Credits Semester-II	**24**
IV	Major Mandatory	STA-251-MJM	Continuous Probability Distributions – II	Theory	02
	Major Mandatory	STA-252-MJM	Statistical Techniques – II	Theory	02
	Major Mandatory	STA-253-MJM	Applied Statistics – II	Theory	02
	Major Mandatory	STA-254-MJM	Statistics Practical – IV	Practical	02
	Minor	STA-261-MN	Probability Distributions and Applications	Theory	02
	Minor	STA-262-MN	Minor Statistics Practical – I	Practical	02
	Open Elective (OE)	STA-266-OE	Practical Based on Applied Statistical Techniques	Practical	02
	Skill Enhancement Course (SEC)	STA-276-SEC	Introduction to Tableau and Power BI	Practical	02
	Ability Enhancement Course (AEC)	MAR-281-AEC HIN-281-AEC SAN-281-AEC	लेखन निर्मिती व परीक्षण कौशल्ये हिंदी भाषा: संप्रेषण कौशल प्रगत संभाषणकौशल्यम्	Theory	02
	Community Engagement Project (CEP)	STA-285-CEP	Community Engagement Project	Practical	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-289-CC	To be selected from the Basket	Theory	02
				Total Credits Semester-IV	**22**
				Cumulative Credits Semester III + Semester IV	**46**

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

Name of the Programme : B.Sc. Statistics
Programme Code : USST
Class : S.Y.B.Sc.
Semester : III
Course Type : Major Mandatory (Theory)
Course Code : STA-201-MJM
Course Title : Continuous Probability Distributions – I
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1. The main objective of this course is to understand concept of continuous distributions with real life situations.
2. To identify the appropriate probability model that can be used.
3. To find various measures of r.v. and probabilities using its probability distributions.
4. To know the relations among the different distributions.
5. To understand the concept of transformation of univariate continuous random variables.
6. To understand the concept of transformation of bivariate continuous random variables.
7. To apply transformations to bivariate random variables and analyze their probability distributions using M.G.F. and related properties.

Course Outcomes:

Students should be able to:

CO1. define and understand the concept of continuous random variables.

CO2. understand continuous distributions with real life situations.

CO3. understand the statement and significance of the central limit theorem for continuous random variables.

CO4. learn uniform and Normal distributions.

CO5. learn Bivariate distributions.

CO6. learn the relations among the different distributions

CO7. learn the concept of transformation of continuous random variables which help to study derived distributions.

Topics and Learning Points

UNIT 1: Continuous Univariate Distributions (8L)

1.1 Definition of function, Continuous function, Monotonic function, One to one function, Onto function, Inverse function.

1.2 Continuous sample space: Definition, illustrations.

Continuous random variable: Definition, probability density function (p.d.f.), cumulative distribution function (c.d.f.), properties of c.d.f. (without proof), probabilities of events related to random variable.

1.3 Expectation of continuous r.v., expectation of function of r.v. E[g(X)], mean, variance, geometric mean, harmonic mean, raw and central moments, skewness, kurtosis.

1.4 Moment generating function (M.G.F.): Definition and properties, cumulant generating function (C. G. F.): definition**,** properties.

1.5 Mode, median, quartiles.

1.6 Probability distribution of function of r. v. : Y = g(X) using

i) Jacobian of transformation for g(.) monotonic function and one-to-one, on to functions,

ii) Distribution function for $Y = X^2$, Y = |X| etc.,

iii) M.G.F. of g(X).

UNIT 2: Continuous Bivariate Distributions: (10L)

2.1 Continuous bivariate random vector or variable (X, Y): Joint p. d. f. , joint c. d. f , properties (without proof), probabilities of events related to r.v. (events in terms of regions bounded by regular curves, circles, straight lines). Marginal and conditional distributions

2.2 Expectation of r.v., expectation of function of r.v. E[g(X, Y)], joint moments, Cov (X,Y), Corr (X, Y), conditional mean, conditional variance, E[E(X|Y = y)] = E(X), regression as a conditional expectation.

2.3 Independence of r. v. (X, Y) and its extension to k dimensional r. v. Theorems on expectation: i) E(X + Y) = E(X) + E(Y), (ii) E(XY) = E(X) E(Y), if X and Y are independent, generalization to k variables. E(aX + bY + c), Var (aX + bY + c).

2.4 M.G.F. : $M_{X,Y}(t_1, t_2)$, properties, M.G.F. of marginal distribution of r. v.s., properties,

i) $M_{X,Y}(t_1, t_2) = M_X(t_1,0)\, M_Y(0,t_2)$, if X and Y are independent r. v.s.

ii) $M_{X+Y}(t) = M_{X,Y}(t, t)$.

iii) $M_{X+Y}(t) = M_X(t)\, M_Y(t)$ if X and Y are independent r.v.s.

2.5 Probability distribution of transformation of bivariate r. v. $U = \phi_1(X, Y)$, $V = \phi_2(X, Y)$

UNIT 3: Uniform or Rectangular Distribution **(4L)**

3.1 Probability density function (p.d.f.) $f(x) = \begin{cases} \frac{1}{b-a} & ; a \le x \le b \\ 0 & ; \text{Otherwise} \end{cases}$

Notation : X ~ U[a, b], sketch of p. d. f., c. d. f., mean, variance, symmetry.

3.2 Distribution of i) $\frac{X-a}{b-a}$ ii) $\frac{b-X}{b-a}$ iii) Y=F(X), where F(X) is the c.d.f. of continuous r.v. X.

3.3 Application of the result to model sampling. (Distributions of X + Y, X – Y, XY and X/Y are not expected.)

UNIT 4: Normal Distribution **(8L)**

4.1 Probability density function (p. d. f.)

$$f(x) = \begin{cases} \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{1}{-2\sigma^2}(x-\mu)^2} & ; -\infty < x < \infty; -\infty < \mu < \infty; \sigma > 0 \\ 0 & ; \quad otherwise \end{cases}$$

p. d. f. curve, identification of scale and location parameters, nature of probability curve, mean, variance, M.G.F., C.G.F., central moments, cumulants, β_1, β_2, γ_1, γ_2, median, mode, quartiles, mean deviation, additive property, computations of normal probabilities using normal probability integral tables.

4.2 Probability distribution of : i) $\frac{X-\mu}{\sigma}$ standard normal variable (S.N.V.), ii) aX + b, iii) aX + bY + c, iv) X^2, where X and Y are independent normal variates.

4.3 Probability distribution of $\overline{X}$, the mean of n i.i.d. $N(\mu, \sigma^2)$ r.v.s.

4.4 Statement and proof of central limit theorem (CLT) for i.i.d. r.v.s with finite positive variance. (Proof should be using M.G.F.) Its illustration for Poisson and Binomial distributions.

References:

1. Mukhopadhya Parimal (1999), Applied Statistics, New Central Book Agency, Pvt. Ltd. Kolkata
2. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.

3. Gupta S. C. &Kapoor V.K.: (2002), Fundamentals of Mathematical Statistics. Sultan Chand & sons, New Delhi.
4. Gupta S. C. &Kapoor V.K.: Applied Statistics. Sultan Chand & sons, New Delhi.
5. Walpole R.E. & Mayer R.H.: Probability & Statistics. (Chapter 4, 5, 6, 8, 10) MacMillan Publishing Co. Inc, New York
6. Goon, A.M., Gupta M.K. and Dasgupta B: (1986), Fundamentals of Statistics Vol. I and Vol. II World Press, Calcutta.
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8. Mood, A. M., Graybill F. A. and Bose, F. A. (1974), Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI), McGraw - Hill Series G A 276
9. Ross, S. (2003), A first course in probability (Sixth Edition), Pearson Education publishers, Delhi, India.

COs and POs Mapping

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

PO1: Comprehensive Knowledge and Understanding:

All COs: Strongly Related (Weightage: 3)

Justification: The objectives directly contribute to the understanding of continuous random variables and their distributions, which are fundamental concepts in statistics. Therefore, they strongly align with the goal of comprehensive knowledge and understanding.

PO2: Practical, Professional, and Procedural Knowledge:

All COs: Strongly Related (Weightage: 3)

Justification: Understanding continuous random variables and their distributions (CO1 to CO7) is crucial for practical applications in various professional fields. Therefore, all objectives strongly contribute to practical, professional, and procedural knowledge.

PO3: Entrepreneurial Mindset and Knowledge:

All COs: Partially Related (Weightage: 1)

Justification: While an understanding of continuous random variables may indirectly contribute to problem-solving skills necessary for entrepreneurship, these objectives do not directly address entrepreneurial mindset or knowledge.

PO4: Specialized Skills and Competencies:

All COs: Strongly Related (Weightage: 3)

Justification: Mastery of continuous random variables and distributions (CO1 to CO7) requires specialized skills and competencies in statistical analysis, making them strongly related to this PO.

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

All COs: Strongly Related (Weightage: 3)

Justification: Understanding continuous random variables and distributions (CO1 to CO7) enhances problem-solving skills and analytical reasoning, directly contributing to the capacity for application in various contexts.

PO6: Communication Skills and Collaboration:

All COs: Partially Related (Weightage: 1)

Justification: While effective communication and collaboration may be necessary for discussing and applying concepts related to continuous random variables, these objectives do not directly address communication skills or collaboration.

PO7: Research-related Skills:

All COs: Strongly Related (Weightage: 3)

Justification: The objectives involve understanding and analyzing concepts related to continuous random variables, which are foundational for conducting research in statistics and related fields.

PO8: Learning How to Learn Skills:

All COs: Strongly Related (Weightage: 3)

Justification: Mastering concepts related to continuous random variables requires the ability to learn and adapt to new information effectively, making these objectives strongly related to learning how to learn skills.

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

Name of the Programme	**:** B.Sc. Statistics
Programme Code	**:** USST
Class	**:** S.Y.B.Sc.
Semester	**:** III
Course Type	**:** Major Mandatory (Theory)
Course Code	**:** STA-202-MJM
Course Title	**:** Statistical Techniques – I
No. of Credits	**:** 02
No. of Teaching Hours	**:** 30

Course Objectives:

1. The main objective of this course is to understand concept of some discrete distributions and truncated distribution with real life situations.
2. Know the relations among the different distributions.
3. To understand the p.m.f. of the NBD, multinomial distribution and its parameters.
4. To identify real-life situations where the negative binomial distribution is applicable.
5. Discuss truncated binomial and Poisson distributions.
6. To understand the methods of estimation of National Income and the challenges associated with each method.
7. To understand Chebyshev's Inequality for discrete and continuous distributions.

4. To fit the appropriate time series model that can be used.**Course Outcomes:**

Student will be able to:

CO1. understand discrete distributions with real life situations.

CO2. learn Negative binomial and multinomial distributions.

CO3. learn the concept of truncated distributions.

CO4. calculate the mean, variance, skewness, and kurtosis of the negative binomial and multinomial distributions.

CO5. Identify real-life situations where the negative binomial and multinomial distributions are applicable.

CO6. Define National Income according to Marshall, Pigou, and Fisher.

CO7. apply Chebyshev's Inequality to Binomial, Normal, and Exponential distributions.

Topics and Learning Points

Unit 1: Negative Binomial Distribution **(10L)**

1.1 Probability mass function (p.m.f.)

$$P(X = x) = \binom{x+k-1}{x} p^k q^x \quad ; x = 0, 1, 2, \ldots$$

$$; 0 < p < 1 ; q = 1 - p; k > 0$$

$$= 0 \quad ; \quad otherwise.$$

Notation: $X \sim NB(k, p)$.

1.2 Nature of probability curve, negative binomial distribution as a waiting time distribution,

1.3 Moment Generating Function (MGF), Cumulant Generating Function (CGF), mean, variance, skewness, kurtosis (recurrence relation between moments is not expected), additive property of NB(k, p).

1.4 Relation between Geometric Distribution and Negative Binomial Distribution. Poisson approximation to Negative Binomial Distribution.

1.5 Real life situations

Unit 2: Multinomial Distribution **(10L)**

2.1 Probability mass function (p.m.f.)

$$P(X_1 = x_1, X_2 = x_2, \ldots, X_k = x_k) = \frac{n!\, {p_1}^{x_1} {p_2}^{x_2} \ldots {p_k}^{x_k}}{x_1!\, x_2! \ldots x_k!} ; x_i = 0, 1, 2, \ldots, n - \sum_{1}^{i-1} x_r$$

$$; i = 1,2, \ldots, k$$

$$; x_1 + x_2 + \cdots + x_k = n$$

$$; 0 < p_i < 1; i = 1, 2, \ldots, k$$

$$; p_1 + p_2 + \cdots + p_k = 1$$

$$= 0 \quad ; otherwise$$

$Notation$: $(X_1, X_2, \ldots, X_k) \sim MD(n, p_1, p_2, \ldots, p_k)$, $\underline{X} \sim MD(n, \underline{p})$,

$where\ \underline{X} = (X_1, X_2, \ldots, X_k)$, $\underline{p} = (p_1, p_2, \ldots, p_k)$.

2.2 Joint MGF of $(X_1, X_2, \ldots, X_k)$, use of MGF to obtain means, variances, covariances, total correlation coefficients, variance – covariance matrix, rank of variance – covariance matrix and its interpretation.

2.3 Additive property of Multinomial Distribution, univariate marginal distribution, distribution of $Xi + Xj$, conditional distribution of Xi given $Xj = r$, conditional distribution of Xi given $Xi + Xj = r$.

2.4 Truncated Distributions: Concept of truncated distribution, truncation to the right, left and on both sides.

2.5 Binomial distribution left truncated at $X = 0$ (value zero is discarded), its p.m.f., mean and variance.

2.6 Poisson distribution left truncated at $X = 0$ (value zero is discarded), its p.m.f., mean and variance.

2.7 Real life situations and applications.

Unit 3: National Economy **(7L)**

3.1 Definition of National Income by

(a) Marshall

(b) Pigou

(c) Fisher.

3.2 Different concept of National Income

(a) Gross National Product (GNP)

(b) Net National Product (NNP)

3.3 Personal income, disposable income, per capita income, Gross Domestic Product (GDP), National Income at market price, National Income at factor cost, National Income at current prices, National Income at constant prices.

3.4 Methods of estimation of National Income and the difficulties in methods.

(a) output method

(b) income method

(c) expenditure method

3.5 Importance of National Income.

Unit 4: Chebychev's Inequality **(5L)**

4.1 For discrete and continuous distribution.

4.2 Examples and problems on Binomial, Normal and Exponential distributions.

References:

1. Brockwell P. J. and Davis R. A. (2003), Introduction to Time Series and Forecasting (Second Edition), Springer Texts in Statistics

2. Chatfield C. (2001), The Analysis of Time Series An Introduction, Chapman and Hall / CRC, Texts in Statistical Science .
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4. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
5. M. K. Jhingan : Macro Economic Theory : Vrinda Publications Pvt. Ltd. New Delhi.
6. R. D. Gupta : Keynes Post – Keynesian Economics : Kalyani Publishers, New Delhi.
7. M. L. Sheth : Macro Economics : Lakshmi-Narayan Agarwal education publishers, Agra 3.
8. H. L. Ahuja : Modern Economics : S. Chand publishers, New Delhi.

COs and POs Mapping:

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

PO1: Comprehensive Knowledge and Understanding:

CO1 to CO5: Strongly Related (Weightage: 3)

Justification: These objectives directly contribute to understanding discrete distributions and their real-life applications, which align with the goal of comprehensive knowledge and understanding.

PO2: Practical, Professional, and Procedural Knowledge:

All COs: Strongly Related (Weightage: 3)

Justification: Understanding discrete distributions (CO1 to CO5) provides practical knowledge applicable in various professional fields, making them strongly related to this PO.

PO3: Entrepreneurial Mindset and Knowledge:

All COs: Partially Related (Weightage: 1)

Justification: While understanding distributions may indirectly contribute to problem-solving skills necessary for entrepreneurship, these objectives do not directly address entrepreneurial mindset or knowledge.

PO4: Specialized Skills and Competencies:

CO1 to CO5: Strongly Related (Weightage: 3)

Justification: Mastery of discrete distributions and their calculations (CO1 to CO5) requires specialized skills and competencies in statistical analysis, making them strongly related to this PO.

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

All COs: Strongly Related (Weightage: 3)

Justification: Understanding discrete distributions and their real-life applications (CO1 to CO5) enhances problem-solving skills and analytical reasoning, directly contributing to the capacity for application in various contexts.

PO6: Communication Skills and Collaboration:

All COs: Partially Related (Weightage: 1)

Justification: While effective communication and collaboration may be necessary for discussing and applying concepts related to discrete distributions, these objectives do not directly address communication skills or collaboration.

PO7: Research-related Skills:

All COs: Strongly Related (Weightage: 3)

Justification: The objectives involve understanding and analyzing concepts related to discrete distributions, which are foundational for conducting research in statistics and related fields.

PO8: Learning How to Learn Skills:

All COs: Strongly Related (Weightage: 3)

Justification: Mastering concepts related to discrete distributions requires the ability to learn and adapt to new information effectively, making these objectives strongly related to learning how to learn skills.

PO9: Digital and Technological Skills:

All COs: Partially Related (Weightage: 1)

Justification: While knowledge of discrete distributions may involve using statistical software, these objectives do not directly address digital or technological skills.

PO12: Autonomy, Responsibility, and Accountability:

All COs: Partially Related (Weightage: 1)

Justification: While understanding discrete distributions may require autonomy and responsibility in learning, these objectives do not directly address autonomy, responsibility, or accountability.

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

Name of the Programme	**:** B.Sc. Statistics
Programme Code	**:** USST
Class	**:** S.Y.B.Sc.
Semester	**:** III
Course Type	**:** Major Mandatory (Theory)
Course Code	**:** STA-203-MJM
Course Title	**:** Applied Statistics – I
No. of Credits	**:** 02
No. of Teaching Hours	**:** 30

Course Objectives:

1. To gain the knowledge about the econometrics.
2. To study the methodology of the econometrics
3. To introduce the meaning and significance of index number
4. To provide an understanding and application of the various types of index numbers
5. To fit the appropriate time series model that can be used in real life situations. Study of various index numbers and utilities with real life situations.
6. To develop the skills to interpret the results from time series analysis.
7. To develop critical thinking and problem-solving skills by applying the queuing models to obtain the optimum solutions.

Course Outcome:

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

CO1. applications of methodology of Econometrics effectively in finance.

CO2. understand the challenges and problems associated with the construction of various types of index numbers.

CO3. comprehend the concept of Consumer Price Index (CPI) and its relevance in measuring inflation & its impact on the economy.

CO4. identify and isolate the time series components from identifying patterns of time series.

CO5. acquire proficiency to provide the appropriate time series model for various real life situations.

CO6. identify the situations where queuing theory can be applied.

CO7. understand the challenges of applications of the queuing models in real life situations for optimum solutions.

Topics and Learning Points

UNIT – 1 Econometrics **(7L)**

1.1 Introduction to Econometrics

1.2 Econometrics: A Separate Discipline

1.3 Methodology of Econometrics: Statement of Theory or Hypothesis, Specification of the Mathematical Model of Consumption, Specification of the Econometric, Model of Consumption, Obtaining Data, Estimation of the Econometric Model, Hypothesis Testing, Forecasting or Prediction, Use of the Model for Control or Policy Purposes, Choosing among Competing Models, Types of Econometrics, Mathematical and Statistical Prerequisites, The Role of the Computer

UNIT – 2 Index Numbers **(8L)**

2.1 Introduction.

2.2 Definition and Meaning.

2.3 Problems/considerations in the construction of index numbers.

2.4 Simple and weighted price index numbers based on price relatives. (For practical only)

2.5 Simple and weighted price index numbers based on aggregates. (For practical only)

2.6 Laspeyre's, Paasche's and Fisher's Index numbers.

2.7 Test of adequacy for an Index Number (i) Time Reversal Test (ii) Factor Reversal Test

2.8 Consumer price index number: Considerations in its construction. Methods of construction of consumer price index number - (i) family budget method (ii) aggregate expenditure method.

2.9 Shifting of base, splicing, deflating, purchasing power.

2.10 Description of the BSE/NSE sensitivity and similar index numbers.

UNIT – 3 Time Series **(10L)**

3.1 Meaning and utility of time series, components of time series: trend, seasonal variations, cyclical variations, irregular (error) fluctuations.

3.2 Exploratory data analysis: Time series plot to (i) check any trend & seasonality in the time series (ii) capture trend.

3.3 Methods of trend estimation and smoothing: (i) moving average, (ii) curve fitting by least square principle , (iii) exponential smoothing.

3.4 Choosing parameters for smoothing and forecasting.

3.5 Forecasting based on exponential smoothing.

3.6 Measurement of seasonal variations: i) simple average method, ii) ratio to moving average method, iii) ratio to trend where trend is calculated by method of least squares. (For practical only)

3.7 Fitting of autoregressive model $AR\ (p)$, where $p\ =\ 1,2$.

3.8 Case studies of real life Time Series: Price index series, share price index series, economic time series: temperature and rainfall time series, wind speed time series, pollution levels.

UNIT – 4 Queuing Model **(5L)**

4.1 Introduction to queuing theory

4.2 Terms used in queuing model.

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

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

4.5 Examples and problems.

References:

1. Damodar N. Gujarati and Dawn C. Porter (2017) Basic Econometrics (Fifth Edition), McGraw-Hill Series Economics
2. Damodar N. Gujarati (2011), Econometrics by Example Damodar Gujarat, PALGRAVE MACMILLAN
3. Brockwell P. J. and Davis R. A. (2003), Introduction to Time Series and Forecasting (Second Edition), Springer Texts in Statistics
4. Chatfield C. (2001), The Analysis of Time Series An Introduction, Chapman and Hall / CRC, Texts in Statistical Science .

5. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
6. Gupta, S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
7. Mukhopadhya Parimal (1999), Applied Statistics, New Central Book Agency, Pvt. Ltd. Kolkata
8. Taha, H.A. (2007). Operation research: An Introduction, eighth edition, Prentice Hall of India, New Delhi.
9. Kapoor, V. K.(2006). Operations Research, S. Chand and Sons. New Delhi.

Cos and POs Mapping:

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

PO1: Comprehensive Knowledge and Understanding:

CO1: Applications of methodology of Econometrics effectively in finance. (3)

CO2: Understand the challenges and problems associated with the construction of various types of index numbers. (2)

CO3: Comprehend the concept of Consumer Price Index (CPI) and its relevance in measuring inflation & its impact on the economy. (3)

CO4: Identify and isolate the time series components from identifying patterns of time series. (3)

CO5: Acquire proficiency to provide the appropriate time series model for various real-life situations. (3)

CO6: Identify the situations where queuing theory can be applied. (1)

CO7: Understand the challenges of applications of the queuing models in real-life situations for optimum solutions. (1)

Justification: These outcomes are strongly related to PO1 as they involve gaining comprehensive knowledge and understanding of various economic concepts, statistical methods, and econometric techniques, particularly in the context of finance, inflation measurement, and time series analysis.

PO2: Practical, Professional, and Procedural Knowledge:

CO1: Applications of methodology of Econometrics effectively in finance. (3)

CO2: Understand the challenges and problems associated with the construction of various types of index numbers. (3)

CO3: Comprehend the concept of Consumer Price Index (CPI) and its relevance in measuring inflation & its impact on the economy. (3)

CO4: Identify and isolate the time series components from identifying patterns of time series. (2)

CO5: Acquire proficiency to provide the appropriate time series model for various real-life situations. (2)

CO6: Identify the situations where queuing theory can be applied. (2)

CO7: Understand the challenges of applications of the queuing models in real-life situations for optimum solutions. (2)

Justification: These outcomes are strongly related to PO2 as they involve the application of practical, professional, and procedural knowledge in various areas such as finance, inflation measurement, and time series analysis, which are essential for professionals working in related fields.

PO3: Entrepreneurial Mindset and Knowledge:

Justification: None of the specified course outcomes directly align with PO3, which focuses more on fostering entrepreneurial thinking and business acumen. However, understanding the challenges associated with index construction and time series analysis could indirectly support entrepreneurial endeavors by providing insights into market trends and consumer behavior.

PO4: Specialized Skills and Competencies:

CO1: Applications of methodology of Econometrics effectively in finance. (3)

CO4: Identify and isolate the time series components from identifying patterns of time series. (3)

CO5: Acquire proficiency to provide the appropriate time series model for various real-life situations. (3)

CO6: Identify the situations where queuing theory can be applied. (2)

CO7: Understand the challenges of applications of the queuing models in real-life situations for optimum solutions. (2)

Justification: These outcomes are strongly related to PO4 as they involve the development of specialized skills and competencies in econometrics, time series analysis, and queuing theory, which are highly relevant in specialized fields requiring expertise in these areas.

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

CO1: Applications of methodology of Econometrics effectively in finance. (3)

CO2: Understand the challenges and problems associated with the construction of various types of index numbers. (2)

CO3: Comprehend the concept of Consumer Price Index (CPI) and its relevance in measuring inflation & its impact on the economy. (3)

CO4: Identify and isolate the time series components from identifying patterns of time series. (3)

CO5: Acquire proficiency to provide the appropriate time series model for various real-life situations. (3)

CO6: Identify the situations where queuing theory can be applied. (3)

CO7: Understand the challenges of applications of the queuing models in real-life situations for optimum solutions. (3)

Justification: These outcomes are strongly related to PO5 as they require the application of statistical methods, analytical reasoning, and problem-solving skills to address practical challenges in finance, inflation measurement, time series analysis, and queuing theory.

PO7: Research-related Skills:

CO1: Applications of methodology of Econometrics effectively in finance. (2)

CO2: Understand the challenges and problems associated with the construction of various types of index numbers. (2)

CO3: Comprehend the concept of Consumer Price Index (CPI) and its relevance in measuring inflation & its impact on the economy. (2)

CO4: Identify and isolate the time series components from identifying patterns of time series. (3)

CO5: Acquire proficiency to provide the appropriate time series model for various real-life situations. (3)

CO6: Identify the situations where queuing theory can be applied. (3)

CO7: Understand the challenges of applications of the queuing models in real-life situations for optimum solutions. (3)

Justification: These outcomes are moderately related to PO7 as they involve research-related skills such as data analysis, interpretation, and modelling, particularly in the context of time series analysis and queuing theory.

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

Name of the Programme	**:** B.Sc. Statistics
Programme Code	**:** USST
Class	**:** S.Y.B.Sc.
Semester	**:** III
Course Type	**:** Major Mandatory (Practical)
Course Code	**:** STA-204-MJM
Course Title	**:** Statistics Practical – III
No. of Credits	**:** 02
No. of Teaching Hours	**:** 60

Course Objectives:

1. Understand the process of fitting a negative binomial and normal distributions to empirical data.
2. Understand how to model and solve practical problems using negative binomial and multinomial distributions.
3. Identify practical situations where the normal distribution is commonly used.
4. Learn how to generate random samples from a normal distribution using distribution functions and Box-Muller transformation.
5. Learn various methods of constructing index numbers.
6. Learn the basics of time series analysis, including trend estimation and forecasting.
7. Develop proficiency in using R software for computing probabilities of discrete probability distributions.

Course Outcome:

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

CO1. apply negative binomial, multinomial, and normal distributions to solve practical problems in various fields.

CO2. demonstrate proficiency in generating random samples from a normal distribution.

CO3. gain practical experience in fitting negative binomial and normal distributions using R software.

CO4. apply index numbers in measuring changes in prices, quantities, and other economic indicators.

CO5. develop skills in forecasting future values based on time series historical data.

CO6. identify trends, patterns, and seasonality in the time series data.

CO7. understand the syntax and usage of relevant R functions for computing probabilities.

Topics and Learning Points

Sr. No.	Title of Experiments
1	Fitting of Negative Binomial Distribution, plot of observed and expected frequencies
2	Fitting of Normal Distributions, plot of observed and expected frequencies
3	Applications of Negative Binomial and Multinomial Distributions
4	Applications of Normal Distributions
5	Model sampling from Normal distribution using Distribution Functions and Box-Muller transformation
6	Fitting of Negative Binomial, Normal using **R software**
7	Index Numbers – I
8	Index Numbers – II
9	Time series-I: Estimation and forecasting by Curve fitting using least least square Principle.
10	Time series-II: Estimation and forecasting of trend by fitting of AR (1) model, exponential smoothing, moving averages.
11	Time series-III: Estimation of Seasonal Indices by Ratio to Trend
12	Computations of probabilities of discrete probability distributions using **R Software**
13	Computations of probabilities of continuous distributions using **R Software**
14	Case Study on Index Number
15	Case Study on Time Series

Note:

1. Every practical is equivalent to four hours per batch per week
2. Practical batch should be of 12 students
3. For project, a group of maximum 12 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.

Cos and POs Mapping:

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

PO1: Comprehensive Knowledge and Understanding:

CO1: Apply negative binomial, multinomial, and normal distributions to solve practical problems in various fields. (3)

CO3: Gain practical experience in fitting negative binomial and normal distributions using R software. (3)

CO4: Apply index numbers in measuring changes in prices, quantities, and other economic indicators. (2)

CO5: Develop skills in forecasting future values based on time series historical data. (2)

CO6: Identify trends, patterns, and seasonality in the time series data. (2)

Justification: These outcomes are strongly related to PO1 as they require a comprehensive understanding of statistical distributions, econometric methods, and economic indicators. Mastery of these outcomes indicates a broad understanding of various statistical and econometric concepts applied across different fields.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Apply negative binomial, multinomial, and normal distributions to solve practical problems in various fields. (3)

CO2: Demonstrate proficiency in generating random samples from a normal distribution. (3)

CO3: Gain practical experience in fitting negative binomial and normal distributions using R software. (3)

CO4: Apply index numbers in measuring changes in prices, quantities, and other economic indicators. (2)

CO5: Develop skills in forecasting future values based on time series historical data. (2)

CO6: Identify trends, patterns, and seasonality in the time series data. (2)

CO7: Understand the syntax and usage of relevant R functions for computing probabilities. (2)

Justification: These outcomes are strongly related to PO2 as they involve the application of practical, professional, and procedural knowledge in statistical analysis, econometrics, and economic analysis, which are essential for professionals in various fields.

PO4: Specialized Skills and Competencies:

CO1: Apply negative binomial, multinomial, and normal distributions to solve practical problems in various fields. (3)

CO3: Gain practical experience in fitting negative binomial and normal distributions using R software. (3)

CO4: Apply index numbers in measuring changes in prices, quantities, and other economic indicators. (3)

CO5: Develop skills in forecasting future values based on time series historical data. (2)

CO6: Identify trends, patterns, and seasonality in the time series data. (2)

Justification: These outcomes are strongly related to PO4 as they involve the development of specialized skills and competencies in statistical analysis, econometrics, and economic analysis, which are highly relevant in fields requiring specialized knowledge and expertise.

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

CO1: Apply negative binomial, multinomial, and normal distributions to solve practical problems in various fields. (3)

CO4: Apply index numbers in measuring changes in prices, quantities, and other economic indicators. (2)

CO5: Develop skills in forecasting future values based on time series historical data. (3)

CO6: Identify trends, patterns, and seasonality in the time series data. (3)

CO7: Understand the syntax and usage of relevant R functions for computing probabilities. (2)

Justification: These outcomes are strongly related to PO5 as they require the application of statistical and econometric techniques to solve practical problems, analyse data, and make informed decisions. Mastery of these outcomes enhances one's capacity for problem-solving and analytical reasoning by providing tools and methods for data analysis and interpretation.

PO7: Research-related Skills:

CO3: Gain practical experience in fitting negative binomial and normal distributions using R software. (2)

CO5: Develop skills in forecasting future values based on time series historical data. (2)

CO6: Identify trends, patterns, and seasonality in the time series data. (2)

CO7: Understand the syntax and usage of relevant R functions for computing probabilities. (2)

Justification: These outcomes are moderately related to PO7 as they involve research-related skills such as data analysis, interpretation, and presentation, which are essential for conducting research and drawing meaningful conclusions from empirical data.

PO9: Digital and Technological Skills:

CO2: Demonstrate proficiency in generating random samples from a normal distribution. (2)

CO3: Gain practical experience in fitting negative binomial and normal distributions using R software. (3)

CO7: Understand the syntax and usage of relevant R functions for computing probabilities. (3)

Justification: These outcomes are strongly related to PO9 as they involve the acquisition and application of digital and technological skills, specifically proficiency in using R software for statistical analysis and data manipulation.

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

Name of the Programme : B.Sc. Statistics
Programme Code : USST
Class : S.Y. B. Sc.
Semester : III
Course Type : Minor Theory
Course Code : STA-211-MN
Course Title : Foundations of Probability: Theory and Applications
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

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

Course Outcomes:

The students will acquire knowledge about the,

CO1. random experiment, the difference between deterministic and nondeterministic experiments, sample space, an event, probability of an event, and the conditional probability of an event.

CO2. computation of probabilities in case of nondeterministic experiments.

CO3. various standard discrete probability distributions (finite sample space only) in different real-life situations.

CO4. univariate random variable, univariate discrete random variable and its probability distribution.

CO5. concepts of mean, median, and mode of a univariate discrete random variable

CO6. how to find the probabilities of various events.

CO7. obtain probability distribution of univariate discrete random variables.

Topics and Learning Points

Unit-1. Introduction to Probability (8L)

1.1 Concepts of experiments, deterministic and nondeterministic 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 Concept of Permutations and Combinations

1.7 Equiprobable sample space,

1.8 Classical definition of probability, examples.

1.9 Probability model, probability of an event, examples. Axiomatic approach of probability.

1.10 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)

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

Unit-2. Conditional Probability and Independence of events: (6L)

2.1 Definition of conditional probability of an event.

2.2 Multiplication theorem for two and three events.

2.3 Partition of sample space.

2.4 Bayes' theorem(Statement only), examples on Bayes' theorem.

2.5 Concept of Independence of two events.

2.6 Pairwise and Mutual Independence for three events.

2.7 Illustrative examples.

Unit-3. Discrete Univariate Probability Distributions (Finite Sample Space): (8L)

3.1 Definition of discrete random variable.

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

3.3 Probability distribution of function of random variable.

3.4 Median and Mode of a univariate discrete probability distribution.

3.5 Mathematical expectation

3.6 Variance and Standard Deviation

Unit-4. Some Standard Discrete Probability Distributions: (Finite Sample Space) (8L)

4.1 Degenerate Distribution: p.m.f., mean and variance.

4.2 Discrete Uniform Distribution: p.m.f., mean and variance.

4.3 Bernoulli Distribution: p.m.f., mean, variance

4.4 Binomial Distribution: p.m.f., mean, variance, Recurrence relation for successive probabilities, Computation of probabilities of different events, mode, Additive property of binomial variables.

4.5 Hypergeometric Distribution: p.m.f., mean, variance,

4.6 Real life situations.

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.
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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)
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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

Cos and POs Mapping:

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

PO1. Comprehensive Knowledge and Understanding:

CO1. Random experiment, the difference between deterministic and nondeterministic experiments, sample space, an event, probability of an event, and the conditional probability of an event. (Weightage: 3 - Strongly Related)

Justification: This CO directly aligns with PO1 as it covers foundational theories, principles, and key concepts within the broader field of probability and statistics, which are essential components of a profound understanding of the field of study.

PO2. Practical, Professional, and Procedural Knowledge:

CO2. Computation of probabilities in case of nondeterministic experiments. (Weightage: 3 - Strongly Related)

Justification: PO2 emphasizes practical skills and expertise essential for professional tasks within a field. Understanding how to compute probabilities in nondeterministic experiments is directly applicable to real-world scenarios, enabling graduates to apply their knowledge effectively in professional settings.

PO3. Entrepreneurial Mindset and Knowledge:

CO6. How to find the probabilities of various events. (Weightage: 2 - Moderately Related)

Justification: While understanding how to find probabilities of various events is not directly tied to entrepreneurial mindset, it can still be relevant in fostering innovation and identifying opportunities by assessing risks and potential outcomes in different scenarios.

PO4. Specialized Skills and Competencies:

CO5. Concepts of mean, median, and mode of a univariate discrete random variable. (Weightage: 2 - Moderately Related)

Justification: Understanding measures of central tendency such as mean, median, and mode is relevant to developing analytical abilities and problem-solving skills, which are key components of specialized skills and competencies within a field of study.

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

CO7. Obtain probability distribution of univariate discrete random variables. (Weightage: 3 - Strongly Related)

Justification: The capacity for application, problem-solving, and analytical reasoning involves being able to analyze data effectively and apply learned concepts in practical settings. Understanding how to obtain probability distributions of random variables contributes to this capacity by enabling graduates to analyze and interpret data in various real-world scenarios.

PO6. Communication Skills and Collaboration:

CO1. Random experiment, the difference between deterministic and nondeterministic experiments, sample space, an event, probability of an event, and the conditional probability of an event. (Weightage: 3 - Strongly Related)

Justification: Effective communication often involves conveying information about events, probabilities, and outcomes. Understanding the concepts related to random experiments, sample spaces, events, and probabilities, as outlined in CO1, is crucial for accurately communicating complex information related to probability and statistics, thereby enhancing communication skills.

PO7. Research-related Skills:

CO7. Obtain probability distribution of univariate discrete random variables. (Weightage: 2 - Moderately Related)

Justification: Research-related skills often involve data analysis, including the examination of probability distributions. Understanding how to obtain probability distributions of univariate discrete random variables, as outlined in CO7, contributes to the analytical skills required for research-related activities.

PO8. Learning How to Learn Skills:

CO1. Random experiment, the difference between deterministic and nondeterministic experiments, sample space, an event, probability of an event, and the conditional probability of an event. (Weightage: 2 - Moderately Related)

Justification: Learning how to learn involves understanding fundamental concepts, such as the nature of experiments, sample spaces, events, and probabilities, which are covered in

CO1. This understanding helps graduates navigate through various learning materials and adapt to different learning environments effectively.

CO2. Computation of probabilities in case of nondeterministic experiments. (Weightage: 2 - Moderately Related)

Justification: Learning how to compute probabilities in nondeterministic experiments is an essential skill for graduates who aim to acquire new knowledge through self-directed learning. Understanding CO2 enables graduates to assess uncertainties and make informed decisions when exploring new topics or concepts independently.

PO9. Digital and Technological Skills:

CO3. Various standard discrete probability distributions (finite sample space only) in different real-life situations. (Weightage: 3 - Strongly Related)

Justification: Digital and technological skills often involve analyzing data using appropriate software, which includes understanding various probability distributions. Proficiency in digital skills, as emphasized in PO9, is directly related to CO3, as graduates need to apply probability distributions in real-life situations using technological tools.

CO4. Univariate random variable, univariate discrete random variable and its probability distribution. (Weightage: 3 - Strongly Related)

Justification: Understanding univariate random variables and their probability distributions is crucial for graduates to effectively analyze and interpret data in digital and technological contexts. CO4 directly supports the acquisition of digital and technological skills highlighted in PO9 by providing the necessary foundation in probability theory.

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

Name of the Programme : B.Sc. Statistics

Programme Code : USST

Class : S.Y.B.Sc.

Semester : III

Course Type : Minor Practical

Course Code : STA-212-MN

Course Title : Minor Statistics Practical – 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. To compute various measures of central tendency and dispersion.
3. To summarize data using frequency distributions and graphical representations.
4. To acquire proficiency in calculating and interpreting various quantiles.
5. To understand the concept of sample spaces, events, probability, conditional probability including Bayes' theorem and independence of events.
6. To calculating and interpreting measures of central tendency (mean, median, mode) and dispersion (variance, standard deviation) for discrete random variables.
7. To computation of probabilities to solve real-world problems.

Course Outcomes:

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

CO1. understand sampling techniques.

CO2. visual representation of data.

CO3. understand measures of central tendency and dispersion.

CO4. understand probability concepts.

CO5. understand univariate discrete probability distributions

CO6. apply binomial and hyper-geometric distributions in real life situations.

CO7. fit binomial distributions to observed data and use them to make predictions.

Topics and Learning Points

Sr. No.	Title of Experiments
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	Probability, Conditional Probability
9	Application of Bayes' Theorem and Independence of Events
10	Univariate Discrete Probability Distribution – I
11	Univariate Discrete Probability Distribution – II
12	Applications of Binomial and Hypergeometric Distribution
13	Fitting of Binomial Distribution
14	Model Sampling from Binomial Distribution
15	Case Study

Cos and POs Mapping:

Course Outcomes	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3					3						
CO2						2							
CO3													
CO4					4								
CO5													
CO6													
CO7													

PO1. Comprehensive Knowledge and Understanding:

CO3. Understand measures of central tendency and dispersion. (Weightage: 3 - Strongly Related)

Justification: Possessing a profound understanding of the field of study involves grasping fundamental statistical concepts such as measures of central tendency and dispersion, which are crucial for analyzing and interpreting data comprehensively.

PO2. Practical, Professional, and Procedural Knowledge:

CO1. Understand sampling techniques. (Weightage: 3 - Strongly Related)

Justification: Acquiring practical skills and expertise for professional tasks includes understanding sampling techniques, which are essential for collecting representative data in various real-world scenarios.

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

CO4. Understand probability concepts. (Weightage: 3 - Strongly Related)

Justification: The capacity for application, problem-solving, and analytical reasoning involves understanding probability concepts to solve complex problems and analyze data effectively in practical settings.

PO6. Communication Skills and Collaboration:

CO2. Visual representation of data. (Weightage: 2 - Moderately Related)

Justification: Effective communication often involves the visual representation of data to convey complex information more clearly and comprehensively. Graduates with strong communication skills, as emphasized in PO6, may utilize visual representations of data, such as charts, graphs, and diagrams, to enhance their communication of information.

PO7. Research-related Skills:

CO1. Understand sampling techniques. (Weightage: 3 - Strongly Related)

Justification: Research-related skills, as outlined in PO7, often involve data collection through various sampling techniques. Understanding sampling techniques, as specified in CO1, is crucial for graduates to effectively collect data for their research endeavors, demonstrating a strong relationship between the two.

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

Name of the Programme	**:** B.Sc. Statistics
Programme Code	**:** USST
Class	**:** S.Y.B.Sc.
Semester	: III
Course Type	**:** OE (Theory)
Course Code	**:** STA-216-OE
Course Title	**:** Applied Statistical Techniques
No. of Credits	**:** 02
No. of Teaching Hours	**:** 30

Course Objectives:

1. To understand the concept of index numbers and their applications in economics.
2. To construct price index numbers using different methodologies such as Laspeyre's, Paasche's, and Fisher's methods.
3. To understand the fundamental concepts of multiple linear regression.
4. To formulate and interpret the equation of the regression plane involving multiple predictor variables.
5. To apply multiple linear regression, multiple correlation, and partial correlation techniques to solve practical problems.
6. To analyze time series data to identify trends, seasonal variations, and irregularities.
7. To analyze mortality patterns using life table analysis.

Course Outcomes:

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

CO1. understand the challenges and problems associated with the construction of index numbers.

CO2. gain proficiency in constructing various price index numbers using methods such as Weighted Index, Laspeyre's, Paasche's, and Fisher's.

CO3. develop an understanding of inflation and its impact on the economy.

CO4. understand the concept and application of multiple linear regression in statistical modeling.

CO5. analyze real-world examples and solve problems related to time series data.

CO6. develop skills in interpreting results obtained from time series analysis.

CO7. develop proficiency in the construction of life tables.

Topics and Learning Points

UNIT 1: Multiple Linear regression (10L)

1.1 Introduction, Multiple Regression, Statement of equation of plane of regression of X_1 on X_2 and X_3 .

1.2 Multiple correlation: Concept, Definition and its formula, example and problems.

1.3 Partial correlation: Concept, Definition and its formula, example and problems.

1.4 Advantages and limitations of multiple correlation, standard error of estimate, partial correlation.

UNIT 2: Index numbers (8L)

2.1 Concept of index number, price index number, price relatives. Problems in construction of index number.

2.2 Construction of price index number: Weighted index Number, Laspeyre's, Paasche's and Fisher's method.

2.3 Cost of living /consumer price index number: Definition, Methods of construction of consumer price index number - (i) family budget method (ii) aggregate expenditure method.

2.4 Shifting of base, splicing, deflating, and purchasing power.

2.5 Description of the BSE sensitivity and similar index numbers.

UNIT 3 :Time Series (7 L)

3.1 Introduction, Definition, Components of Time Series: i) The Trend ii) Seasonal variation iii) Cyclical variation iv) Irregular variation,

3.2 Methods of estimating Trends, Moving averages (with periods 3, 4,5).

3.3 Fitting of autoregressive model AR(1).

3.4 Example and problems**.**

UNIT 4 : Life Table (5 L)

4.1 Introduction, Construction of life table, functions (l_x, d_x, p_x, q_x, L_x, T_x, e_x) and their interpretation, expectation of life.

4.2 Example, and problems.

References:

1. Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
2. Gupta and Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
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4. Gupta S. C. and Kapoor V. K. (1987): Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
5. B. L. Agarwal : Programmed Statistics, New Age International Publishers, New Delhi.
6. Diewert, W. E., & Nakamura, A. (2009). Price and productivity measurement: Volume index number theory and applications. Cambridge University Press.
7. Gupta S. P.: Statistical Methods, Sultan Chand and Sons, 23, Daryaganj, New Delhi
8. Mukhopadhyay Parimal (1999): Applied Statistics, New Central Book Agency, Pvt. Ltd. Calcutta.
9. Brockwell, P. J., & Davis, R. A. (2016). Introduction to Time Series and Forecasting. Springer.
10. Chatfield, C. (2019). The Analysis of Time Series: An Introduction. CRC Press.
11. Preston, S. H., Heuveline, P., & Guillot, M. (2000). Demography: Measuring and modeling population processes. Wiley-Blackwell.
12. Caselli, G., Vallin, J., & Wunsch, G. (2005). Demography: Analysis and Synthesis. Elsevier Academic Press.

Cos and POs Mapping:

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

PO1. Comprehensive Knowledge and Understanding:

CO4. Define and understand the fundamental concepts and principles of Operations Research. (Weightage: 3 - Strongly Related)

Justification: Graduates possessing a profound understanding of their field of study should be familiar with fundamental concepts and principles such as those found in Operations Research, which forms a significant part of their knowledge base.

PO2. Practical, Professional, and Procedural Knowledge:

CO1. Learn optimization techniques to improve processes, maximize efficiency, minimize costs, and allocate resources effectively. (Weightage: 3 - Strongly Related)

Justification: Acquiring practical skills and expertise for professional tasks includes learning optimization techniques, which are essential for addressing real-world challenges effectively and efficiently within their field.

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

CO6. Identify situations where the Assignment Problem is applicable. (Weightage: 3 - Strongly Related)

Justification: The capacity for application, problem-solving, and analytical reasoning involves recognizing and identifying problem situations where specific techniques such as the Assignment Problem can be applied to solve real-world problems effectively.

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

Name of the Programme	**:** B.Sc. Statistics
Program Code	**:** USST
Class	**:** S.Y.B.Sc.
Semester	**:** III
Course Type	**:** VSC Theory
Course Code	**:** STA-221-VSC
Course Title	**:** Quantitative Techniques
No. of Credits	**:** 2 credits
No. of Teaching Hours	**:** 30

Course Objectives:

1. The main objective of paper is to understand the concept of optimal solutions.
2. To formulate Linear programming Problem, transportation problem, assignment problem and to obtain optimal solutions.
3. To recognize special cases such as degeneracy, multiple optimal Solutions.
4. To understand the foundational concepts and principles of Linear Programming and its applications in various real-world scenarios.
5. To understand the concept of Assignment Problems and their applications in matching tasks to optimize efficiency and resource utilization.
6. To Learn to formulate Assignment Problems and apply solution algorithms such as the Hungarian Method for finding optimal assignments.
7. To Analyze various types of games, including zero-sum and non-zero-sum games, and understand strategies such as dominance, Nash equilibrium, and mixed strategies.

Course Outcomes:

Student will be able to

CO 1. learn optimization techniques to improve processes, maximize efficiency, minimize costs, and allocate resources effectively.

CO 2. understand the features of Transportation Problem (TP) and Assignment Problem (AP).

CO 3. understand principles of zero-sum, two-person games.

CO 4. define and understand the fundamental concepts and principles of Operations Research.

CO 5. define the Assignment Problem and its applications in real-world scenarios.

CO 6. identify situations where the Assignment Problem is applicable.

CO 7. formulate the Transportation Problem using decision variables, objective function, and constraints.

Topics and Learning Points

UNIT-1 Linear Programming Problem (12L)

1.1 Statement of the linear Programming Problem (LPP), (minimization and maximization) Formulation of problem as LPP. Solution of L.P.P by Graphical method.

1.2 Definition of (i) A slack variable and (ii) Surplus Variable

1.3 Definition of (i) a solution (ii) basic and non-basic variables (iii) a feasible solution (iv) a basic feasible solution, (v) a degenerate and non–degenerate solution and (vi) an optimal solution.

1.4 Solution of L.P.P by Simplex Method: Obtaining Initial Basic Feasible Solution (IBFS), criteria for deciding whether obtained solution is optimal.

1.5 Duality Theory: Writing dual of a primal problem.

1.6 Examples and problems.

UNIT-2 Transportation Problem (7L)

2.1 Transportation problem (T.P.), statement of T.P, balanced and unbalanced T.P. minimization and maximization problem.

2.2 Obtaining basic feasible solution of T.P. by

(i) North-West Corner Method,

(ii) Least Cost Method

(iii) Vogel's Approximation Method (VAM).

2.3 Optimal solution using Modified Distribution MODI method.

2.4 Examples and problems.

UNIT-3 Assignment Problem (4L)

3.1 Statement of an Assignment Problem, Minimization and Maximization problem.

3.2 Balanced and Unbalanced Assignment Problem.

3.3 Relation with Transportation Problem.

3.4 Optimal solution using Hungarian method, Minimization and Maximization case.

3.5 Examples and problems.

UNIT-4 Game Theory (7L)

4.1 Introduction

4.2 Two-Person Zero-Sum games

4.3 Pure Strategies, Minimax and Maximin principles, pay off tables, Games with Saddle Point.

4.4 Examples and problems.

References:

1. Gass, S. L. (1997). Linear programming methods and applications, Narosa Publishing House, New Delhi.
2. Gupta, P. K. and Hira, D. S. (2008). Operation Research, 3rd edition S. Chand and company Ltd, New Delhi.
3. Kapoor, V. K. (2006). Operations Research, S. Chand and Sons. New Delhi.
4. Phillips, D. T. and Solberg, R. A. (1976). Operation Research principles and practice, John Willey and Sons Inc.
5. Saceini, M., Yaspan, A. and Friedman, L. (2013). Operation Research methods and problems,Willey International Edition.
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8. Taha, H. A. (2007). Operation research: An Introduction, eighth edition, Prentice Hall of India, New Delhi.

Cos and POs Mapping:

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

PO1. Comprehensive Knowledge and Understanding:

CO4. Define and understand the fundamental concepts and principles of Operations Research. (Weightage: 3 - Strongly Related)

Justification: Graduates need to possess a profound understanding of their field of study, which includes foundational theories and principles such as those found in Operations Research. Understanding these concepts is crucial for developing a comprehensive knowledge base.

PO2. Practical, Professional, and Procedural Knowledge:

CO1. Learn optimization techniques to improve processes, maximize efficiency, minimize costs, and allocate resources effectively. (Weightage: 3 - Strongly Related)

Justification: Acquiring practical skills and expertise for professional tasks involves learning optimization techniques, which directly contribute to improving processes and maximizing efficiency, aligning with the practical aspect of this PO.

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

CO6. Identify situations where the Assignment Problem is applicable. (Weightage: 3 - Strongly Related)

Justification: Graduates possessing the capacity for application, problem-solving, and analytical reasoning should be able to identify situations where specific techniques such as the Assignment Problem can be applied effectively to solve real-world problems.