Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T.Y B.Sc. STATISTICS

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Program Structure
Department of Mathematics & Statistics

Detail Syllabus of TYBSc Statistics as a Major Subject as per NEP-2020

Semester V

Course Code	Course Name	Teaching Hours		Credits Assigned			Marks		
		Theory	Practical	Theory	Practical	Total	Theory	Practical	Total
GNKUSSTAMJ1105/ GNKUSSTAMJ1P105	**Major 1:** Probability and Distribution Theory	45	30	3	1	4	75	25	100
GNKUSSTAMJ2105/ GNKUSSTAMJ2P105	**Major 2:** Theory of Estimation	45	30	3	1	4	75	25	100
GNKUSSTAMJ3105/ GNKUSSTAMJ3P105	**Major 3:** Biostatistics	45	30	3	1	4	75	25	100
GNKUSSTAEL1105/ GNKUSSTAEL1P105	**Elective 1:** Programming with Java and Oracle	45	30	3	1	4	75	25	100
GNKUSSTAEL2105/ GNKUSSTAEL2P105	**Elective 2:** Statistical Quality Control	45	30	3	1	4	75	25	100
GNKUSSTAVSC105	**Vocational Skill Enhancement course (VSEC):** Regression Analysis Using R Software		60		2	2	--	50	50
GNKUSSTAOJT105	**OJT** (On Job training)	120		4			--	100	100
Total Credits				22			300	250	550

Semester VI

Course Code	Course Name	Teaching Hours		Credits Assigned			Marks		
		Theory	Practical	Theory	Practical	Total	Theory	Practical	Total
GNKUSSTAMJ1106/ GNKUSSTAMJ1P106	**Major 1:** Distribution and Stochastic Models	**45**	**30**	**3**	**1**	**4**	**75**	**25**	**100**
GNKUSSTAMJ2106/ GNKUSSTAMJ2P106	**Major 2:** Testing of Hypothesis	**45**	**30**	**3**	**1**	**4**	**75**	**25**	**100**
GNKUSSTAMJ3106/ GNKUSSTAMJ3P106	**Major 3:** Actuarial Science	**45**	**30**	**3**	**1**	**4**	**75**	**25**	**100**
GNKUSSTAEL1106/ GNKUSSTAEL1P106	**Elective 1:** Data Analysis and Web Designing	**45**	**30**	**3**	**1**	**4**	**75**	**25**	**100**
GNKUSSTAEL2106/ GNKUSSTAEL2P106	**Elective 2:** Demography and Vital Statistics	**45**	**30**	**3**	**1**	**4**	**75**	**25**	**100**
GNKUSSTAMI1106/ GNKUSSTAMI1P106	**Minor:** Decision Theory and Game Models	**15**	**30**	**1**	**1**	**2**	**25**	**25**	**50**
GNKUSCC106	**CC** (Co-curricular Course Course)	**60**		**2**			**--**	**50**	**50**
GNKUSSTAFP106	**FP** (Field Project)	**60**		**2**			**--**	**50**	**50**
Total Credits				**22**			**300**	**250**	**550**

G N KHALSA COLLEGE OF ARTS, SCIENCE & COMMERCE(AUTONOMOUS), MATUNGA, MUMBAI-400019

MOTTO

Essence of Wisdom is Service to Humanity

VISION

To emerge as a Centre of Excellence in Higher Education.

MISSION

To create strong analytical minds with scientific temper, fostering global competencies through the spirit of humanism thereby bringing about holistic development of the students by remaining in sync with the teachings of Guru Nanak Dev Ji.

QUALITY POLICY

To attain excellence in all our endeavours namely teaching, research and continuing education; adopt self-evaluation as a measure for continuous improvement and ensure accountability.

Based on the provided motto, vision, mission, and quality policy, program outcomes for a science program of our college are:

Undergraduate Science Program Outcomes:

PO1	**Foundational Understanding:** Develop a foundational understanding of core scientific principles and theories across various disciplines of science.
PO2	**Analytical Skills:** Develop analytical and problem-solving skills to critically analyses scientific problems and apply scientific methodologies.
PO3	**Global Perspective:** Gain a global perspective by understanding diverse scientific issues and incorporating ethical considerations in scientific practices.
PO4	**Research Awareness:** Gain awareness of research methodologies and techniques, preparing for future research endeavors.
PO5	**Holistic Development:** Experience holistic development by embracing values of humanism, empathy, and social responsibility in scientific pursuits.
PO6	**Communication Skills:** Enhance communication skills to effectively convey scientific concepts to diverse audiences.
PO7	**Continuous Learning:** Develop a commitment to lifelong learning and staying updated with advancements in science.
PO8	**Ethical Practices:** Understand and adhere to ethical standards in scientific research and practice.

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Mathematics and Statistics

Programme: B.Sc. Statistics

Programme Specific Outcomes (PSOs) for B.Sc. in Statistics

Sr. No.	A student completing B.Sc. in Statistics will be able to:
PSO 1	Apply core statistical concepts and methods to solve real-world problems in various domains like biological, medical and pharmaceutical sciences.
PSO 2	Use statistical distributions and probability models to draw valid conclusions from data. To use statistical models to interpret real-world phenomena in life sciences.
PSO 3	Analyze data using statistical tools, software, and mathematical models.
PSO 4	Interpret statistical results and communicate findings effectively in both academic and applied contexts.

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. Statistics

Semester V

Major 1

Name of the paper: Probability and Distribution Theory

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Course: T.Y. B.Sc. STATISTICS Major 1
Semester-V
Course Title: Probability and Distribution Theory
Course Code: GNKUSSTAMJ1105
Credits: 3
No of lectures hours: 45
Marks: 75

Course Objectives:

The course aims at:

1. To develop a strong conceptual understanding of probability and explore its wide-ranging applications in depth.
2. To gain insight into the Laws of Large Numbers and various inequalities, emphasizing their practical applications.
3. To learn about the Joint Moment Generating Function, Trinomial, and Multinomial Distributions, along with their real-world applications.
4. To understand the concept of order statistics and examine its significance in the context of distribution theory.
5. To develop a strong conceptual understanding of probability and explore its wide-ranging applications in depth.

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs): On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Demonstrate a clear conceptual understanding of probability theory and apply it to solve real-life and theoretical problems involving randomness and uncertainty.	1,2,4	1,2	U and Ap
CO 2	Utilize the Joint Moment Generating Function to derive moments and analyze dependence structures; solve problems involving Trinomial and Multinomial distributions with relevant applications.	1,3,5	1,2,3	U, Ap & An
CO 3	Explain and apply the concept of order statistics in the development of distribution theory and its practical implications in statistical inference.	1,2,5	2,3,4	U and An

CO4	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

Major 1: Probability and Distribution Theory

Unit	Title	Lecture Hours	CO Mapping
1	**Probability**	**15**	
1.1	**Basic terminologies:** Random Experiment, Outcome, Event, Sample Space, Complementary, Mutually Exclusive, Exhaustive and Equally Likely Events. **Definition:** Mathematical, Statistical, Axiomatic and Subjective definition of probability. Addition Theorem for two and three events. **Conditional Probability:** Multiplication Theorem for two, three events. Bayes' theorem	05	CO1
1.2	Theorems on Probability of realization of (a) At least one event (b) Exactly m events and (c) At least m of N events A_1, A_2, A_3,…, A_N. Classical occupancy problems, Matching and Guessing problems.	05	CO1
1.3	**Inequalities and Law of Large Numbers** Markov Inequality, Chebyshev's Inequality, Boole's Inequality, Cauchy Schwartz's Inequality, Weak Law of Large Numbers.	05	CO1
II	**Order Statistics**	15	
2.1	Definition of Order Statistics based on a random sample. Derivation of: (a) Cumulative distribution function of r^{th} order statistic and (b) Probability density functions of the r^{th} order statistic.	05	CO3
2.2	Derivation of: (a) Joint Probability density function of the r^{th} and the s^{th} order statistic (r<s) and (b) Joint Probability density functions of all n ordered statistics.	05	CO3
2.3	Derivation of: (a) Distribution of Maximum observation (nth order statistic) and Minimum observation (first order statistic) in case of uniform and Exponential distribution and (b) Probability density function of the difference between r^{th} and s^{th} order statistic (r<s) in case of uniform and Exponential distribution.	05	CO3
III	**Joint Moment Generating Function, Trinomial Distribution and Multinomial Distribution**	**15**	
3.1	Moment Generating Function (MGF): Definition and properties of two random variables of discrete and continuous type. Necessary and Sufficient condition for independence of two random variables. Concept and definition of Bivariate MGF. Trinomial distribution: Definition of joint probability distribution of (X, Y). Joint moment generating function, moments μ_{rs} where r=0, 1, 2 and s=0, 1, 2. Marginal and Conditional distributions. Their Means & Variances.	05	CO2

3.2	Correlation coefficient between (X, Y). Distribution of (X+Y) Extension to Multinomial distribution with parameters (n, p_1, p_2,…, p_{k-1}) where $p_1+ p_2+…p_{k-1}+ p_k = 1$. Expression for joint MGF. Derivation of joint probability distribution of (X_i, X_j). Conditional probability distribution.	05	CO2
3.3	**Foundations of Statistical Thought in Indian Knowledge Systems** **1.1 Indian Knowledge Systems (IKS):** Understanding IKS as an interwoven part of Indian culture, philosophy, and practice. 1.2 Ancient Indian Texts and Data Collection i. Arthashastra (Kautilya): Economic and demographic data collection, quantitative methods in governance and taxation ii. Rigveda and Mahabharata: Early applications of probability and statistics in rituals and games of chance iii. Jain Mathematics: Permutations, combinations, and early probabilistic reasoning.	05	CO4

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited (1957).
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Sixth edition, Pearson Education (Singapore) Pvt. Ltd (2005).
3. Mood A. M., Graybill F. A. Boes D. C.: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series (1973).
4. V K Rohatgi: An Introduction to probability and Mathematical Statistics. (1976).
5. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments/ Class Participation, etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y. B.Sc. Statistics Major 1-Practical
Semester-V
Course Title: Practical: Probability and Distribution Theory
Course Code: GNKUSSTAMJ1P105
Credits: 01
No. of Practical Hours: 30
Marks: 25

Course Objectives

The course aims at:

1. To develop a strong conceptual understanding of probability and explore its wide-ranging applications in depth.
2. To gain insight into the Laws of Large Numbers and various inequalities, emphasizing their practical applications.
3. To learn about the Joint Moment Generating Function, Trinomial, and Multinomial Distributions, along with their real-world applications.
4. To understand the concept of order statistics and examine its significance in the context of distribution theory.
5. To develop a strong conceptual understanding of probability and explore its wide-ranging applications in depth.

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs): On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Demonstrate a clear conceptual understanding of probability theory and apply it to solve real-life and theoretical problems involving randomness and uncertainty.	1,2,4	1,2	U and Ap
CO 2	Utilize the Joint Moment Generating Function to derive moments and analyze dependence structures; solve problems involving Trinomial and Multinomial distributions with relevant applications.	1,3,5	1,2,3	U , Ap & An
CO 3	Explain and apply the concept of order statistics in the development of distribution theory and its practical implications in statistical inference.	1,2,5	2,3,4	U and An
CO4	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

List of Practical

1	Probability 1
2	Probability 2
3	Order statistics 1
4	Order statistics 2
5	Trinomial and Multinomial distribution
7	Statistical Methods in Arthashastra – Simulating Ancient Data Collection
8	Probability in Ancient Texts – Exploring Games and Rituals

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited (1957).
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Sixth edition, Pearson Education (Singapore) Pvt. Ltd (2005).
3. Mood A. M., Graybill F. A. Boes D. C.: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series (1973).
4. V K Rohatgi: An Introduction to probability and Mathematical Statistics. (1976).
5. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Practical Examination: 15M
- Journal & Viva: 5M + 5M

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. Statistics

Semester V

Major II

Name of the paper: Theory of Estimation

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Mathematics and Statistics

Course: T.Y. B.Sc. STATISTICS Major II
Semester-V
Course Title: Theory of Estimation
Course Code: GNKUSSTAMJ2105
Credits: 3
No of lectures hours: 45
Marks: 75

Course Objectives:

The course aims at:

1. To acquire fundamental knowledge of the theory of estimation, including different types of estimators and the construction of point and interval estimators.
2. To understand and analyse point estimation methods, focusing on the properties of estimators such as unbiasedness and mean square error, and identifying minimum variance unbiased estimators.
3. To explore various methods of estimation and apply them for deriving point estimators and constructing confidence intervals for parameters of different probability distributions.
4. To develop an understanding of Bayesian estimation and its applications in statistical inference

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Explain the fundamental concepts of statistical estimation and distinguish between different types of estimators, including point and interval estimators.	1,2	1,2	U, Ap
CO 2	Evaluate estimators based on properties such as unbiasedness, consistency, efficiency, and mean square error, and identify minimum variance unbiased estimators (MVUEs).	1,2,5	1,2	An, E
CO 3	Apply different methods of estimation—such as the method of moments, maximum likelihood, and least squares—to derive point estimators and construct confidence intervals.	1,2,3	1,2,3	Ap, An
CO 4	Demonstrate understanding of Bayesian estimation techniques and basic linear models and apply them in relevant statistical problems.	1,2,5	1,2,3	U, Ap, An

CO 5	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

Major II: Theory of Estimation

Unit	Title	Lecture Hours	CO Mapping
1	**Point Estimation and Properties of Estimators**	**15**	
1.1	Notion of Parameter and Parameter Space. Problems of Point estimation. Definitions: Statistic, Estimator and Estimate. Properties of a good estimator: **Unbiasedness:** Definition of an unbiased estimator, Illustrations. Proofs of the following results: (i) Two distinct unbiased estimators of U (θ) give rise to infinitely many unbiased estimators. (ii) If T is an unbiased estimator ofθ then U(T) is an unbiased estimator of U(θ) provided U(.) is a linear function.	04	CO 1
1.2	Consistency: Definition of Consistency. Sufficient condition for consistency, proof & Illustrations. Sufficiency: Concept and Definition of sufficient statistic. Neyman's Factorization theorem (without proof). Exponential family of probability distributions and sufficient statistics. Relative efficiency of an estimator and illustrative examples.	05	CO 1
1.3	Minimum Variance Unbiased Estimator (MVUE) and Cramer Rao Inequality Definition of MVUE, Uniqueness property of MVUE (proof). Fisher's information function, Regularity conditions. Statement and proof of Cramer-Rao inequality. Cramer-Rao Lower Bound (CRLB), Efficiency of an estimator using CRLB. Condition when equality attain in Cramer Rao Inequality and its use in finding MVUE.	06	CO1
II	**Methods of Point Estimation**	**15**	
2.1	Method of Maximum Likelihood Estimation (M.L.E.): Definition of likelihood as a function of unknown parameter for a random sample from discrete distribution and continuous distribution. Derivation of Maximum Likelihood Estimator (M.L.E.) for parameters of standard distributions (case of one and two unknown parameters). Properties of MLE (without proof).	06	CO2
2.2	Method of Moments: Derivation of Moments estimators for standard distributions (case of one and two unknown parameters) Illustrations of situations where MLE and Moments Estimators are distinct and their comparison using Mean Square Error.	06	CO2

2.3	**Method of Minimum Chi-square and Modified Minimum Chi-Square:** Concept and problems.	03	
III	**Bayesian Estimation and Interval Estimation Methods**	**15**	
3.1	**Bayes Estimation:** Definition Prior distribution, Posterior distribution, Loss function, Risk function, Types of Loss function: Squared Error Loss function (SELF), Absolute error Loss function (AELF) Bayes' risk. **Bayes' method of finding Point estimator (assuming SELF)** **Examples:** Binomial- Beta, Poisson- Gamma, Gamma-Gamma, Normal-Normal	05	CO 3
3.2	**Interval Estimation:** Concept of confidence interval and confidence limits. Definition of Pivotal quantity and its use in obtaining confidence limits. Derivation of 100(1- α) % confidence interval with equal tailed for: (a) the population mean: (population variance known/ unknown) (b) the population variance: (Normal distribution). Derivation of 100(1- α) % confidence interval for parameters of Binomial, Poisson and Exponential distributions by using asymptotic property of MLE.	05	CO 3
3.3	**Ethics in Ancient Indian Statistics** i. Role of data integrity in ancient census and economic surveys. **ii.** Ethical considerations in taxation records and trade assessments **Data Visualization and Sampling** i. Use of geometric techniques in astronomy and land surveys. ii. Influence of Vedic mathematics on early data tabulation iii. Sampling techniques in revenue collection and population estimation from Mauryan era.	05	CO 5

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited (1957).
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Sixth edition, Pearson Education (Singapore) Pvt. Ltd (2005).
3. Mood A. M., Graybill F. A. Boes D. C.: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series (1973).
4. V K Rohatgi: An Introduction to probability and Mathematical Statistics. (1976).
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6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments/ Class Participation, etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y. B.Sc. Statistics Major II Practical
Semester-V
Course Title: Practical: Theory of Estimation
Course Code: GNKUSSTAMJ2P105
Credits: 01
No. of Practical Hours: 30
Marks: 25

Course Objectives:

The course aims at:

1. To acquire fundamental knowledge of the theory of estimation, including different types of estimators and the construction of point and interval estimators.
2. To understand and analyse point estimation methods, focusing on the properties of estimators such as unbiasedness and mean square error, and identifying minimum variance unbiased estimators.
3. To explore various methods of estimation and apply them for deriving point estimators and constructing confidence intervals for parameters of different probability distributions.
4. To develop an understanding of Bayesian estimation and its applications in statistical inference

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Explain the fundamental concepts of statistical estimation and distinguish between different types of estimators, including point and interval estimators.	1,2	1,2	U, Ap
CO 2	Evaluate estimators based on properties such as unbiasedness, consistency, efficiency, and mean square error, and identify minimum variance unbiased estimators (MVUEs).	1,2,5	1,2	An, E
CO 3	Apply different methods of estimation—such as the method of moments, maximum likelihood, and least squares—to derive point estimators and construct confidence intervals.	1,2,3	1,2,3	Ap, An
CO 4	Demonstrate understanding of Bayesian estimation techniques and basic linear models and apply them in relevant statistical problems.	1,2,5	1,2,3	U, Ap, An
CO 5	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

List of Practical:

1. MVUE and MVBUE
2. Methods of Estimation-I
3. Methods of Estimation-II
4. Bayes' Estimation
5. Confidence Interval
6. Use of R Software
7. Estimating Population Using Sampling (Inspired by Mauryan Census Techniques
8. Land Revenue Estimation Using Vedic Geometry and Yield Sampling

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited (1957).
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Sixth edition, Pearson Education (Singapore) Pvt. Ltd (2005).
3. Mood A. M., Graybill F. A. Boes D. C.: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series (1973).
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7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Practical Examination: 15M
- Journal & Viva: 5M + 5M

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. Statistics

Semester V

Major III

Name of the paper: Biostatistics

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Mathematics and Statistics

Course: T.Y. B.Sc. STATISTICS Major III
Semester-V
Course Title: Biostatistics
Course Code: GNKUSSTAMJ3105
Credits: 3
No. of lectures hours: 45
Marks: 75

Course Objectives

The course aims at:

1. To develop a foundational understanding of the concepts and classifications of epidemics.
2. To apply basic deterministic and stochastic models for analysing epidemics and estimating associated parameters.
3. To understand the principles and types of bioassays used in biological and pharmaceutical studies.
4. To understand and apply statistical procedures used in the analysis of clinical trials.
5. To understand the concepts and analytical procedures involved in the design and analysis of bioequivalence trials.

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the fundamental concepts of epidemics and their classifications.	1	1	U
CO 2	Apply basic deterministic and stochastic epidemic models to estimate key parameters and interpret epidemic behavior.	1,2	1,2	Ap, An
CO 3	Describe the basic concepts, principles, and types of bioassay techniques used in biological testing.	1	1,2	U
CO 4	Apply statistical methods for estimating drug potency and analyzing related outcomes under various experimental conditions.	1,2,3	1,2,3	Ap, An
CO 5	Demonstrate an understanding of the structure and statistical analysis involved in clinical trial designs.	1,2,4,5	1,3	U, Ap, An
CO 6	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1,2	U

Major III: Biostatistics

Unit	Title	Lecture Hours	CO Mapping
1	**Epidemic Model**	**15**	
1.1	The features of Epidemic spread. Definitions of various terms involved. **Simple mathematical models for epidemics:** Deterministic model without removals for one and 'a' introduction. Carrier Model	04	CO1
1.2	Chain binomial models. Reed-Frost and Greenwood models.	05	CO2
1.3	Distribution of individual chains and total number of cases. Maximum likelihood estimator of `p' and its asymptotic variance for households of sizes up to 4.	06	CO1
II	**Bioassays**	**15**	
2.1	Meaning and scope of bioassays. Relative potency. Direct assays. Filler's theorem.	05	CO3
2.2	Indirect assays. Dose-response relationship. Conditions of similarity and monotony. Linearizing transformations. Parallel line assays: Symmetrical (2, 2) and (3, 3) parallel line assays. Validity tests using orthogonal contrasts.	05	CO2, CO3
2.3	Point Estimate and Interval Estimate of Relative potency. Quantal Response assays. Tolerance distribution. Median Effective Dose ED50 and LD50. Probit and Logit analysis.	05	CO2
III	**Clinical Trials and Bioequivalence**	**15**	
3.1	Introduction to clinical trials. The need and ethics of clinical trials. Common terminologies used in clinical trials. Overview of phases (I-IV). Introduction to ICH E9 guidelines, Study Protocol, Case record/ Report form, Blinding Single/ Double), Randomized controlled (Placebo/ Active controlled), Study Designs (Parallel, Cross Over). Types of Trials: Inferiority, Superiority and Equivalence, Multicentric Trial. Inclusion/ Exclusion Criteria. Sample size estimation.	05	CO5
3.2	**Definitions:** Generic Drug product, Bioavailability, Bioequivalence, Pharmacokinetic (PK) parameters (C_{max}, AUC_t, $AUC_{0-\infty}$, T_{max}, Kel, half-life). Estimation of PK parameters using `time vs. concentration' profiles. **Designs in Bioequivalence:** Parallel, Cross over (Concept only). Advantages of Crossover design over Parallel design. Analysis of Parallel design using logarithmic transformation (Summary statistics, ANOVA and 90% confidence interval). Confidence Interval approach to establish bioequivalence (80/125 rule).	05	CO5
3.3	**Descriptive Statistics** i. Measures of central tendency and dispersion used in Vedic land measurements and trade. ii. Concept of skewness and kurtosis in ancient economic planning **Healthcare & Ayurveda** i. Use of statistical inference in Ayurvedic formulations and Siddha medicine	05	CO6

	ii. Traditional public health surveys and their role in early epidemic control.		

References:

1. Bailey N.TJ.: The Mathematical theory of infectious diseases, Second edition, Charles Griffin and Co. London. (1975)
2. Finney D.J.: Statistical Methods in Biological Assays, First edition, Charles Griffin and Co. London. (1979)
3. Friedman L. M., Furburg C., Demets D. L.: Fundamentals of Clinical Trials, Third edition, Springer Verlag. (1998)
4. Shein-Chung-Chow: Design and Analysis of Bioavailability & Bioequivalence studies, Third Edition, Chapman & Hall/CRC Biostatistics series. (2009)
5. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments / Class Participation etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component

Course: T.Y. B.Sc. Statistics Major III Practical
Semester-V
Course Title: Practical: Biostatistics
Course Code: GNKUSSTAMJ3P105
Credits: 01
No. of Practical hours: 30
Marks: 25

Course Objectives

The course aims at:

1. To develop a foundational understanding of the concepts and classifications of epidemics.
2. To apply basic deterministic and stochastic models for analysing epidemics and estimating associated parameters.
3. To understand the principles and types of bioassays used in biological and pharmaceutical studies.
4. To understand and apply statistical procedures used in the analysis of clinical trials.
5. To understand the concepts and analytical procedures involved in the design and analysis of bioequivalence trials.

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the fundamental concepts of epidemics and their classifications.	1	1	U
CO 2	Apply basic deterministic and stochastic epidemic models to estimate key parameters and interpret epidemic behavior.	1,2	1,2	Ap, An
CO 3	Describe the basic concepts, principles, and types of bioassay techniques used in biological testing.	1	1,2	U
CO 4	Apply statistical methods for estimating drug potency and analyzing related outcomes under various experimental conditions.	1,2,3	1,2,3	Ap, An
CO 5	Demonstrate an understanding of the structure and statistical analysis involved in clinical trial designs.	1,2,4,5	1,3	U, Ap, An
CO 6	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1,2	U

List of Practical

1. Epidemic Models
2. Direct Assays
3. Parallel Line Assays

4. Quantal Response Assays
5. Clinical Trial
6. Bioequivalence
7. Biostatistical Analysis of Ayurvedic Treatment Outcomes
8. Traditional Public Health Survey and Epidemic Pattern Analysis

References:

1. Bailey N.TJ.: The Mathematical theory of infectious diseases, Second edition, Charles Griffin and Co. London. (1975)
2. Finney D.J.: Statistical Methods in Biological Assays, First edition, Charles Griffin and Co. London. (1979)
3. Friedman L. M., Furburg C., Demets D. L.: Fundamentals of Clinical Trials, Third edition, Springer Verlag. (1998)
4. Shein-Chung-Chow: Design and Analysis of Bioavailability & Bioequivalence studies, Third Edition, Chapman & Hall/CRC Biostatistics series. (2009)
5. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Practical Examination: 15M
- Journal & Viva: 5M + 5M

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T .Y B.Sc. Statistics

Semester V

Elective I

Name of the paper: Programming with Java and Oracle

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Mathematics and Statistics

Course: T.Y.B.Sc. Statistics Elective I
Semester: V
Course Title: Programming with Java and Oracle
Course Code: GNKUSSTAEL1105
Credits: 3
No. of lectures hours: 45
Marks: 75

Course Objectives:

1. To introduce basic OOP concept like abstraction, inheritance, polymorphism and to introduce basic database concept like entity, relation, objects etc.
2. To explain the role of Java and SQL in application development and how to use its various features in the development.
3. To apply Java and SQL to write the programs using its syntax and concepts.
4. To analyze the error occurring the program try and catch statements.
5. To create the complex applications with the help of Java and SQL

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Understand basic OOP concept like abstraction, polymorphism, inheritance and DBMS concept entity, relation and objects	1, 3, 6, 8	1, 2, 3, 4	R, Ap, An
CO 2	Apply Java and SQL to write the programs using its features, concepts and syntax.	1, 2, 6	1, 3, 5	Ap, R, C
CO 3	Analyze and control the error occurring in the program using try and catch features of Java.	1, 2, 7, 8	3, 5, 7	An, R, C
CO 4	Create the complex application with the help of Java and SQL.	2, 3, 4, 5	3, 5, 6, 8	C, An, Ap

Elective I: Programming with Java and Oracle

Unit	Title	Lecture Hours
1	**Java Programming**	**15**
1.1	Object-Oriented approach: Features of object-orientations: Abstraction, Inheritance, Encapsulation and Polymorphism. History of Java features, different types of Java programs, Java Virtual Machine. Java Basics: Variables and data types, declaring variables,	**8**

	literals numeric, Boolean, character and string literals, keywords, type conversion and casting. Standard default values. Java Operators, Loops and Controls	
1.2	Classes: Defining a class, creating instance and class members: creating object of a class, accessing instance variables of a class, creating method, naming method of a class, accessing method of a class, overloading method, 'this' keyword, constructor and Finalizer.	**3**
1.3	Basic Constructor, parameterized constructor, calling another constructor, finalize() method, overloading constructor. Arrays: one and two – dimensional array, declaring array variables, creating array objects, accessing array elements. Access control: public access, friendly access, protected access, private access.	**5**
II	**Inheritance, Exception Handling**	**15**
2.1	Inheritance: Various types so inheritance, super and sub classes, keywords 'extends', 'super', overriding method, final and abstract class: final variables and methods, final classes, abstract methods and classes. Concepts of interface.	**8**
2.2	Exception Handling and Packages: Need for Exception Handling, Exception Handling techniques: try and catch, multiple catch statements, finally block, us age of throw and throws. Concept of packages. Inter class method: parseInt().	**7**
III	**Relational Data Base Management System**	**15**
3.1	Introduction to Data base Concepts: Database, Overview of data base management system. Data base Languages- Data Definition Languages (DDL) and Data Manipulation Languages (DML).	**5**
3.2	Entity Relation Model: Entity, attributes, keys, relations, Designing ER diagram, integrity Constraints over relations, conversion of ER to relations with and without constrains.	**5**
3.3	SQL Commands and functions: Creating and altering tables, Handling data using SQL. Functions: Aggregate functions, Date functions. String functions, Numeric functions. Joining tables: Inner, outer and cross joins, union.	**5**

Reference:

1. Data base management system, Ram Krishnam, Gehrke, McGraw-Hill
2. SQL, PL/SQL–The Programming languages of Oracle, Ivan Bayross, B.P.B. Publications, 3rd Revised Edition.
3. ORACLE "The complete Reference", George Koch and Kevin Loney, Tata McGraw Hill, New Delhi.
4. Understanding SQL, Martin Gruber, B.P.B. Publications.
5. Oracle8i- A Beginner's Guide, Michael Abbey, Micheal. Corey, Ian Abramson, Tata McGraw- Hill.
6. Programming with Java: a Primer 4th Edition by E. Balagurusamy, Tata McGraw Hill.
7. Java the complete Reference, 8th Edition, Herbert Schildt, Tata McGraw Hill.

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments/ Class Participation, etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y.B.Sc. Statistics Elective I Practical
Semester: V
Course Title: Practical: Programming with Java and Oracle
Course Code: GNKUSSTAEL1P105
Credits: 1
No. of lectures hours: 30
Marks: 25

Course Objectives:

1. To introduce basic OOP concept like abstraction, inheritance, polymorphism and to introduce basic database concept like entity, relation, objects etc.
2. To explain the role of Java and SQL in application development and how to use its various features in the development.
3. To apply Java and SQL to write the programs using its syntax and concepts.
4. To analyze the error occurring the program try and catch statements.
5. To create the complex applications with the help of Java and SQL

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Understand basic OOP concept like abstraction, polymorphism, inheritance and DBMS concept entity, relation and objects	1, 3, 6, 8	1, 2, 3, 4	R, Ap, An
CO 2	Apply Java and SQL to write the programs using its features, concepts and syntax.	1, 2, 6	1, 3, 5	Ap, R, C
CO 3	Analyze and control the error occurring in the program using try and catch features of Java.	1, 2, 7, 8	3, 5, 7	An, R, C
CO 4	Create the complex application with the help of Java and SQL.	2, 3, 4, 5	3, 5, 6, 8	C, An, Ap

List of practical

1. Creating a single table with/without constraints and executing queries. Queries containing aggregate, string and date functions fired on a single table.
2. Updating tables, altering table structure and deleting table Creating and altering a single table and executing queries.
3. Joining tables and processing queries
4. Writing PL/SQL Blocks with basic programming constructs
5. Writing PL/SQL Blocks with control structures.
6. Write a Java program to create a Java class:(a) without instance variables and methods(b)with instance variables and without methods, (c) without instance variables and with methods. (d) with instance variables and methods.
7. Write a Java program that illustrates the concepts of one, two-dimension arrays.
8. Write a Java program that illustrates the concepts of Java class that includes(a)construct or with and without parameters (b) Over loading methods.
9. Write a Java program to demonstrate inheritance by creating suitable classes.
10. Write a program that illustrates the error handling using exception handling.

Reference:

1. Data base management system, Ram Krishnam, Gehrke, McGraw-Hill
2. SQL, PL/SQL–The Programming languages of Oracle, Ivan Bayross, B.P.B. Publications, 3rd Revised Edition.
3. ORACLE “The complete Reference”, George Koch and Kevin Loney, Tata McGraw Hill, New Delhi.
4. Understanding SQL, Martin Gruber, B.P.B. Publications.
5. Oracle8i- A Beginner’s Guide, Michael Abbey, Micheal. Corey, Ian Abramson, Tata McGraw- Hill.
6. Programming with Java: a Primer 4th Edition by E. Balagurusamy, Tata McGraw Hill.
7. Java the complete Reference, 8th Edition, Herbert Schildt, Tata McGraw Hill.

Examination:

- Practical Examination: 15M
- Journal & Viva: 5M + 5M

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T .Y B.Sc. STATISTICS

Semester V

Elective II

Name of the paper: Statistical Quality Control

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Mathematics and Statistics

Course: T.Y.B.Sc. Statistics Elective II
Semester: V
Course Title: Statistical Quality Control
Course Code: GNKUSSTAEL2105
Credits: 3
No of lectures (Hours): 45
Marks: 75

Course Objectives:

The course aims at:

1. To develop a sound conceptual understanding of the principles, methodology, and objectives of Six Sigma.
2. To build foundational skills in statistical data analysis relevant to quality improvement.
3. To learn how to define, analyze, and solve quality-related problems using Six Sigma tools and techniques.
4. To understand and apply statistical tools for quality control and continuous improvement.
5. To understand the concept and construction of control charts and their use in identifying assignable causes in process variation.

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the key principles and methodologies of Six Sigma and their role in quality management.	1,2	1	U, Ap
CO 2	Apply basic statistical tools to analyse data for quality improvement.	2,4	2	Ap, An
CO 3	Identify quality-related problems and propose solutions using Six Sigma tools like DMAIC and Pareto analysis.	2,5	3	An, E
CO 4	Construct and interpret various statistical control charts used in monitoring process behaviour.	1,2,6	2	Ap, An
CO 5	Evaluate process variation and suggest improvements using appropriate statistical techniques.	2,7,8	3	E, C

Elective-II Statistical Quality Control

Unit	Title	Lecture Hours	CO Mapping
I	**Six Sigma**	**15**	
1.1	History and concept, Basic Principles, Goals, six sigma v/s TQM, ISO 9000,Traditional Management, Quality defined, VOC and CTQ, Quality measurement to six sigma.	**05**	**CO 1**
1.2	Seven tools of quality and its application: 1)Histogram or Stem and Leaf display. 2) Check sheet. 3) Pareto Chart. 4)Cause and Effect diagram (Fish bone Diagram).5) Defect concentration diagram. 6) Scatter diagram. 7) Control charts (Only concept of control chart).	**07**	**CO 2**
1.3	DMAIC with case study, Introduction to Lean Six Sigma.	**03**	**CO 3**
II	**Control Charts I**	**15**	
2.1	Introduction, Chance and assignable causes, Statistical basis of the control chart: Basic principles of control chart (Shewhart control charts), Choice of control limits, Sample size and sampling frequency, Rational subgroups, Analysis of patterns on control charts,	**05**	**CO3 CO4**
2.2	Discussion of sensitizing rules for control chart. Introduction to the concept of attribute, Defect. P, np, c and u charts, their uses. p-chart with variable sample size. Operating-characteristics function,	**05**	**CO3 CO4**
2.3	Average run length. Applications of variable control charts.(In addition problems involving setting up standards for future use is also expected), Guidelines to implement control charts. (In addition problems involving setting up standards for future use is also expected).	**05**	**CO3 CO4**
III	**Control Charts II**	**15**	
3.1	Control chart for variables. X-Bar, R, S [sample standard deviation],(Construction, charts based on standard values, Interpretation), Operating-Characteristic function, Average run length. Applications of variable control charts.	**05**	**CO4**
3.2	Introduction to process capability concept, Specification limits, natural tolerance limits and their comparisons, estimate of percent defectives, Capability ratio and Capability indices(C_p).	**05**	**CO4**
3.3	Capability performance indices C_{pk} with respect to machine and process interpretation, relationship between (i) C_p and C_{pk} (ii)Defective parts per million an C_P	**05**	**CO4**

References:

1. Pyzdek, T., & Keller, P. (2014). The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels (4th ed.). McGraw-Hill Education.
2. Grant, E. L., & Leavenworth, R. S. (1996). *Statistical Quality Control* (7th ed.). Wiley.
3. Montgomery, D. C. (2012). *Introduction to Statistical Quality Control* (7th ed.). Wiley.

4. George, M. L. (2002). Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed. McGraw-Hill Education.
5. Duncan, A. J. (1986). *Quality Control and Industrial Statistics* (5th ed.). Richard D. Irwin, Inc.

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments/ Class Participation, etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y. B.Sc. Statistics Elective- II Practical
Semester: V
Course Title: Practical: Statistical Quality Control
Course Code: GNKUSSTAEL2P105
Credits: 01
No of Practical Hours: 30
Marks: 25

Course Objectives:

The course aims at:

1. To develop a sound conceptual understanding of the principles, methodology, and objectives of Six Sigma.
2. To build foundational skills in statistical data analysis relevant to quality improvement.
3. To learn how to define, analyze, and solve quality-related problems using Six Sigma tools and techniques.
4. To understand and apply statistical tools for quality control and continuous improvement.
5. To understand the concept and construction of control charts and their use in identifying assignable causes in process variation.

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the key principles and methodologies of Six Sigma and their role in quality management.	1,2	1	U, Ap
CO 2	Apply basic statistical tools to analyse data for quality improvement.	2,4	2	Ap, An
CO 3	Identify quality-related problems and propose solutions using Six Sigma tools like DMAIC and Pareto analysis.	2,5	3	An, E
CO 4	Construct and interpret various statistical control charts used in monitoring process behaviour.	1,2,6	2	Ap, An
CO 5	Evaluate process variation and suggest improvements using appropriate statistical techniques.	2,7,8	3	E, C

List of Practical

1. Quality Tool Application -I
2. Quality Tool Application -II
3. DMAIC Case Study
4. p-chart Construction (Attribute Control Chart)
5. X-Bar and R Chart for Variable Control
6. Process Capability Analysis (Cp & Cpk)

7 Pareto Analysis for Defects
8 Control Chart Rules and Pattern Recognition

References:

1. Pyzdek, T., & Keller, P. (2014). The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels (4th ed.). McGraw-Hill Education.
2. Grant, E. L., & Leavenworth, R. S. (1996). *Statistical Quality Control* (7th ed.). Wiley.
3. Montgomery, D. C. (2012). *Introduction to Statistical Quality Control* (7th ed.). Wiley.
4. George, M. L. (2002). Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed. McGraw-Hill Education.
5. Duncan, A. J. (1986). *Quality Control and Industrial Statistics* (5th ed.). Richard D. Irwin, Inc.

Examination:

- Practical Marks: 15 Marks
- Journal & Viva Marks: 5M + 5 M

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T.Y B.Sc. STATISTICS

Semester V

Vocational Skill Enhancement Course (VSEC)

Name of the paper: Regression Analysis Using R Software

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 – 2027

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Mathematics and Statistics

Course: T.Y.B.Sc. Statistics VSEC
Semester-V
Course Title: Regression Analysis Using R Software
Course Code: GNKUSSTAVSC105
Credits: 2
No of lectures Hours: 60
Marks: 50

Course Objectives:

The course aims at:

1. To gain foundational knowledge of R software, including its interface, data types, and basic commands.
2. To develop skills in data import, management, cleaning, and manipulation using R software.
3. To learn to implement and interpret simple and multiple linear regression models using R software and apply them to real-world datasets.

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Use R software effectively for basic statistical computing and visualization.	1,2	1	R, U
CO 2	Import, manage, and preprocess datasets in R for regression analysis	2,4	2	Ap, An
CO 3	Perform and interpret simple linear regression using R software	1,2,6	2	Ap, An
CO 4	Perform and interpret multiple linear regression analysis using R and validate model assumptions.	2,3,7	3	An, E
CO5	Perform Ridge regression	2,3,7	3	An, E, Ap

	List of Practical on Regression Analysis Using R Software	**Practical Hours**	**CO Mapping**
Practical 1	**Fundamental of R**		**CO1**
Content	Introduction to R, features of R, installation of R, starting and ending R session, getting help in R, Value assigning to variables. **Basic Operations:** +, -, *, ÷, ^, sqrt **Numerical**	05	

	functions: log 10, log, sort, max, unique, range, length, var, prod, sum, summary, dim, sort, five numeric. **Data Types:** Vector, list, matrices, array and data frame **Variable Type:** logical, numeric, integer, complex, character and factor.		
Practical 2	**Data Manipulation and Processing**		**CO1, CO2**
Content	**Data Manipulation:** Selecting random N rows, removing duplicate row(s), dropping a variable(s), Renaming variable(s), sub-setting data, creating a new variable(s), selecting of random fraction of row(s), appending of row(s) and column(s), simulation of variables. **Data Processing:** Data import and export, setting working directory. **Checking structure of Data:** Str(), Class(), Changing type of variable (for eg: as.factor, as.numeric)	05	
Practical 3	**Data Visualization**		**CO1, CO2**
Content	Simple bar diagram, subdivided bar diagram, multiple bar diagram pie diagram, Box plot for one and more variables, histogram, frequency polygon, scatter plot.	05	
Practical 4	**Data Visualization using ggplot**		**CO1**
Content	Simple bar diagram, subdivided bar diagram, multiple bar diagram pie diagram, Box plot for one and more variables, histogram, frequency polygon, scatter plot.	05	
Practical 5	**Simple Linear Regression: Fitting model**		**CO3**
Content	Assumptions of the model, Fitting of simple linear regression model, Computation and Interpretation of Coefficient of determination R^2 and adjusted R^2.	05	
Practical 6	**Simple Linear Regression: Diagnostic plots**		**CO3**
Content	Testing Overall significance of the models, testing of significance of individual coefficients, Confidence intervals for the regression coefficients, Detection and treatment of missing value(s)and outliers, Variable selection and Model building, Interpretation of output produced by lm command in R. Weighted Least Square Method.	05	
Practical 7	**Multiple Linear Regression: Fitting model**		**CO4**
Content	Fitting of multiple regression model, Coefficient of determination R^2 and adjusted R^2.		
Practical 8	**Multiple Linear Regression: Diagnostic plots**		**CO4**
Content	Testing Overall significance of the models, testing of significance of individual coefficients, Confidence intervals for the regression coefficients, Coefficient of determination R^2 and adjusted R^2.Standardized residuals, Studentized residuals, residual plots, Interpretation of four plots, Interpretation of outputs produced by plot() command in R and corrective measures such as transformation of response variable, testing normality of data.	05	

Practical 9	**Detecting Heteroscedasticity and its remedial measures**		**CO1, CO3**
Content	Concept and detection using Breusch –Pagan-Godfrey Test, Interpretation of outputs produced by bp- test function in R.	05	
Practical 10	**Detecting Autocorrelation and its remedial measures**		**CO3, CO4**
Content	Concept and detection using Durbin Watson Test, Interpretation of outputs produced by DW-test function in R.	05	
Practical 11	**Detecting Multicollinearity and its remedial measures**		**CO3, CO4**
Content	Concept and detection using R^2 and t-ratios, pairwise correlation between regressors, Variance Inflation Factor (VIF), Interpretation of outputs produced by mc-test function in R,. Consequences of using OLS estimators in presence of Autocorrelation, Heteroscedasticity and Multicollinearity, Remedial measures.	05	
Practical 12	**Ridge Regression**		**CO5**
Content	Concept and case study using R.	05	

References:

1. Draper, N. R. and Smith, H. (1998), Applied Regression Analysis (John Wiley), Third Edition.
2. Crawley, M. J. (2006). Statistics - An introduction using R. John Wiley, London.
3. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003), Introduction to Linear Regression Analysis (Wiley).
4. Neter. J., W. Kutner, M. H.Nachtsheim, C.J. and Wasserman, W.(1996), Applied Linear Statistical Models, fourth edition, Irwin USA.
5. William Geene (1991), Econometrics Analysis, first edition, Mc Millan Publishing Company.
6. Purohit, S.G.Gore, S.D. and Deshmukh, S.R. (2015). Statistics using R, second edition. Narosa Publishing House, New Delhi.
7. Shahababa, B. (2011). Biostatistics with R, Springer, New York
8. Verzani, J. (2005). Using R for Introductory Statistics, Chapman and Hall /CRC Press, New York

Examination:

- Continuous Internal Assessment: 20 Marks
  - Journal & Viva Marks: 5M + 5 M
  - Case Study/ Assignment: 10 M
- External Practical Examination: 30 Marks

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. STATISTICS

Semester VI

Major I

Name of the paper: Distribution and Stochastic Models

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Mathematics and Statistics

Course: T.Y. B.Sc. Statistics Major I
Semester: VI
Course Title: Distribution and Stochastic Models
Course Code: GNKUSSTAMJ1106
Credits: 03
No of Lecture Hours: 45
Marks: 75

Course Objectives:

The course aims at:

1. To understand the concept of the **Bivariate Normal Distribution** and explore its applications in statistical modelling.
2. To derive and interpret the **Probability Generating Functions (PGFs)** of standard discrete probability distributions.
3. To gain foundational knowledge of **Stochastic Processes,** including their definitions, types, and real-life applications.

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the concept and properties of the Bivariate Normal Distribution and apply it to analyze jointly distributed random variables.	1,2,5	1,2	U, Ap, An
CO 2	Derive and apply Probability Generating Functions (PGFs) for standard discrete distributions to evaluate distributional characteristics.	1,2,3	1,2	Ap, An
CO 3	Describe the fundamental concepts of Stochastic Processes and identify their applications in various fields.	1,5	1,2	U, Ap
CO4	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

Major I – Distribution and Stochastic Models

Unit	Title	Lecture Hours	CO Mapping
1	**Bivariate Normal Distribution**	**15**	
1.1	Definition of joint probability distribution (X, Y). Joint Moment Generating function, moments $\mu_{rs}$where r=0, 1, 2 and s=0, 1, 2. Marginal and Conditional distributions,Means and Variances.	**05**	**CO1**
1.2	Correlation coefficient between bivariate random variables. Necessary and sufficient condition for the independence of X and Y. Distribution of aX + bY, where 'a' and 'b' are constants.	**05**	**CO1**
1.3	Distribution of sample correlation coefficient when $\rho = 0$. Testing the significance of a correlation coefficient. Fisher's z – transformation. Tests for:(i) H_0: $\rho = \rho_0$(ii) H_0: $\rho_1 = \rho_2$. Confidence interval for ρ.	**05**	**CO1**
II	**Probability Generating Functions and Reliability**	**15**	
2.1	Definitions of generating function and probability generating function. Expression for mean and variance in terms of generating functions. Definition of a convolution of two or more sequences. Generating function of convolution.	**04**	**CO2**
2.2	Generating functions of the standard discrete distributions. Relation in terms of convolution between : (i) Bernoulli and Binomial distributions(ii) Geometric and Negative Binomial distributions.	**04**	**CO2**
2.3	Concept of reliability, Hazard-rate. Bathtub curve. Failure time distributions: (i) Exponential, (ii) Gamma, (iii) Weibull, (iv) Gumbel, Definitions of increasing (decreasing) failure rate. System Reliability. Reliability of (i) series (ii) parallel system of independent components having exponential life distributions. Mean Time to Failure of a system (MTTF). Application of Reliability	**07**	**CO2**
III	**Stochastic Processes**	**15**	
3.1	Definition of stochastic process. Postulates and difference differential equations for: (i) Pure birth process and (ii)Poisson process with initially 'a' members, for a =0 and a >0, Derivation of $P_n(t)$, mean and variance.	**05**	**CO3**
3.2	Postulates and difference differential equations for: (i) Yule Furry process, (ii) Pure death process, (iii) Death process with $\mu_n=\mu$, (iv) Death process with $\mu_n= n\mu$, Derivation of $P_n(t)$, mean and variance. Postulates and difference differential equations for: (i) Birth and death process, (ii) Linear growth model. (iii) Derivation of mean and variance.	**05**	**CO3**
3.3	**Mathematical Contributions to Statistics** i. Aryabhata's early probability concepts in planetary motion models.	**05**	**CO4**

	ii. Bhaskaracharya's statistical insights in algebra and combinatorial mathematics. iii. Kerala School of Mathematics (Madhava): Contributions to series expansions and statistical applications.		

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited (1957).
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Sixth edition, Pearson Education (Singapore) Pvt. Ltd (2005).
3. Mood A. M., Graybill F. A. Boes D. C.: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series (1973).
4. V K Rohatgi: An Introduction to probability and Mathematical Statistics. (1976).
5. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments/ Class Participation, etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y. B.Sc. Statistics Major I Practical
Semester: VI
Course Title: Practical: Distribution and Stochastic Models
Course Code: GNKUSSTAMJ1P106
Credits: 01
No. of Practical hours: 30
Marks: 25

Course Objectives:

The course aims at:

1. To understand the concept of the **Bivariate Normal Distribution** and explore its applications in statistical modelling.
2. To derive and interpret the **Probability Generating Functions (PGFs)** of standard discrete probability distributions.
3. To gain foundational knowledge of **Stochastic Processes**, including their definitions, types, and real-life applications.

Course Outcomes (COs):

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the concept and properties of the Bivariate Normal Distribution and apply it to analyze jointly distributed random variables.	1,2,5	1,2	U, Ap, An
CO 2	Derive and apply Probability Generating Functions (PGFs) for standard discrete distributions to evaluate distributional characteristics.	1,2,3	1,2	Ap, An
CO 3	Describe the fundamental concepts of Stochastic Processes and identify their applications in various fields.	1,5	1,2	U, Ap
CO4	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

List of Practical

1. Bivariate Normal Distribution
2. Tests for Correlation and Interval Estimation
3. Generating Functions
4. Reliability
5. Stochastic Processes-I
6. Stochastic Processes-II
7 Aryabhata's Probability Concepts in Planetary Motion
8 Bhaskaracharya's Statistical/Combinatorial Insights in Probability

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited (1957).
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Sixth edition, Pearson Education (Singapore) Pvt. Ltd (2005).
3. Mood A. M., Graybill F. A. Boes D. C.: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series (1973).
4. V K Rohatgi: An Introduction to probability and Mathematical Statistics. (1976).
5. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Practical Examination: 15M
- Journal & Viva: 5M + 5M

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. Statistics

Semester VI

Major II

Name of the paper: Testing of Hypotheses

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027

Course: T.Y. B.Sc. Statistics Major II
Semester: VI
Course Title: Testing of Hypothesis
Course Code: GNKUSSTAMJ2106
Credits: 03
No of Lecture Hours: 45
Marks: 75

Course Objectives

The course aims at:

1. To acquire comprehensive knowledge of hypothesis testing, including types of hypotheses, statistical tests, types of errors, and the concepts of size, power, most powerful (MP) test and uniformly most powerful (UMP) test. .
2. To understand and apply the Neyman-Pearson Lemma in testing hypotheses related to different distributions, and to evaluate the power function of UMP tests and Likelihood Ratio Tests (LRT).
3. To develop a clear understanding of Sequential Probability Ratio Tests (SPRT) and their applications in sequential analysis.
4. To distinguish between parametric and non-parametric tests, understand their areas of application, and develop the ability to apply non-parametric tests such as the sign test, Wilcoxon rank test, and Mann–Whitney test effectively on real data.

Course Outcomes

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the theory of hypothesis testing, distinguish between types of hypotheses, and evaluate the concepts of size, power, MP and UMP test.	1,2	1,2	U, An
CO 2	Apply the Neyman-Pearson Lemma to derive most powerful tests and compute power functions and likelihood ratio tests for various distributions.	1,2,4,8	1,2	Ap, An, E
CO 3	Differentiate between parametric and non-parametric tests and apply appropriate non-parametric tests to analyze real-life datasets.	2,3,5,6	2,3	Ap, An, E
CO4	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

Major-II –Testing of Hypotheses

Unit	Title	Lecture Hours	CO Mapping
I	**Most Powerful Tests and Uniformly Most Powerful Test**	**15**	
1.1	Problem of testing of hypothesis. **Definitions and illustrations:** Simple hypothesis, Composite hypothesis, Null Hypothesis, Alternative Hypothesis, Test statistic and Critical region Types of Errors: Type I and Type II errors. Level of significance, p-value	**05**	**CO1**
1.2	Size of the test, Power of the test, Power function of a test, Power curve. Most powerful test of size α for a simple hypothesis against a simple alternative hypothesis.	**05**	**CO**
1.3	Neyman-Pearson fundamental lemma **Uniformly Most Powerful Test:** Definition, Existence and Construction of Uniformly most powerful (UMP) test.	**05**	**CO2**
II	**Likelihood Ratio Tests and Sequential Probability Ratio Test**	**15**	
2.1	Likelihood Ratio Test: Likelihood ratio principle, Definition of test statistic and its asymptotic distribution (statement only).	**03**	**CO2**
2.2	Construction of LRT for the means of Normal distribution for (i) known σ^2 and Unknown σ^2 (two-sided alternatives) (ii) known μ and unknown μ (two-sided alternatives hypothesis)	**06**	**CO2**
2.3	Sequential test procedure for testing a simple null hypothesis against a simple alternative hypothesis. Its comparison with fixed sample size (Neyman-Pearson) test procedure. Definition of Wald's SPRT of strength (α, β). Graphical and Tabular procedure for carrying out SPRT Problems based on Bernoulli, Binomial, Poisson, Normal and Exponential distributions.	**06**	**CO2**
III	**Non-Parametric Tests**	**15**	
3.1	Need for non-parametric tests. Distinction between a parametric and a non-parametric test. Concept of a distribution free statistic. Single sample and two sample Non-parametric tests.	**06**	**CO3**
3.2	Sign test, Wilcoxon's signed rank test, Median test, Mann–Whitney test, Run test, Kruskal -Wallis test, Friedman test and Fisher exact test.	**06**	**CO3**
3.3	**Economic and Social Statistics** i. Statistical tools for studying caste, gender, and rural-urban disparities ii. Use of statistical surveys in ancient and medieval Indian economic planning.	**03**	**CO3**

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited (1957).
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Sixth edition, Pearson Education (Singapore) Pvt. Ltd (2005).
3. Lehmann, E. L. (2005). *Testing Statistical Hypotheses* (2nd ed.). Wiley-Interscience.
4. Daniel W.W.:Applied Non-Parametric Statistics, First edition Boston-Houghton Mifflin Company.
5. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.

7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments/ Class Participation, etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y. B.Sc. Statistics Major II Practical
Semester: VI
Course Title: Practical: Testing of Hypothesis
Course Code: GNKUSSTAMJ2P106
Credits: 01
No. of Lecture hours: 30
Marks: 25

Course Objectives

The course aims at:

1. To acquire comprehensive knowledge of hypothesis testing, including types of hypotheses, statistical tests, types of errors, and the concepts of size, power, most powerful (MP) test and uniformly most powerful (UMP) test. .
2. To understand and apply the Neyman-Pearson Lemma in testing hypotheses related to different distributions, and to evaluate the power function of UMP tests and Likelihood Ratio Tests (LRT).
3. To develop a clear understanding of Sequential Probability Ratio Tests (SPRT) and their applications in sequential analysis.
4. To distinguish between parametric and non-parametric tests, understand their areas of application, and develop the ability to apply non-parametric tests such as the sign test, Wilcoxon rank test, and Mann–Whitney test effectively on real data.

Course Outcomes

Sr. No.	**Course Outcomes (COs):**			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the theory of hypothesis testing, distinguish between types of hypotheses, and evaluate the concepts of size, power, MP and UMP test.	1,2	1,2	U, An
CO 2	Apply the Neyman-Pearson Lemma to derive most powerful tests and compute power functions and likelihood ratio tests for various distributions.	1,2,4,8	1,2	Ap, An, E
CO 3	Differentiate between parametric and non-parametric tests and apply appropriate non-parametric tests to analyze real-life datasets.	2,3,5,6	2,3	Ap, An, E
CO4	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

List of Practical

1. Testing of Hypothesis
2. Likelihood Ratio Test
3. Sequential Probability Ratio Test
4. Non-Parametric Test-I
5. Non-Parametric Test-II

6. Practical based on R software
7. Studying Rural-Urban Gender Disparity in School Attendance Using Mann–Whitney U Test
8. Analyzing Regional Tax Yield Estimates Using Kruskal–Wallis Test (Inspired by Arthashastra Methods)

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited (1957).
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Sixth edition, Pearson Education (Singapore) Pvt. Ltd (2005).
3. Lehmann, E. L. (2005). *Testing Statistical Hypotheses* (2nd ed.). Wiley-Interscience.
4. Daniel W.W.:Applied Non-Parametric Statistics, First edition Boston-Houghton Mifflin Company.
5. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
6. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
7. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Practical Examination: 15M
- Journal & Viva: 5M + 5M

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. STATISTICS

Semester VI

Major III

Name of the paper: Actuarial Science

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 – 2027

Course: T.Y. B.Sc. Statistics Major III
Semester: VI
Course Title: Actuarial Science
Course Code: GNKUSSTAMJ3106
Credits: 03
No of Lecture Hours: 45
Marks: 50

Course Objectives

The course aims at:

1. To understand and apply the fundamental principles and theories of actuarial science in the context of life insurance, general insurance, and superannuation.
2. To develop the ability to analyse actuarial data using advanced statistical tools and techniques.
3. To learn to compute key actuarial quantities such as insurance premiums, policy reserves, and superannuation contribution rates.
4. To cultivate analytical skills to solve both theoretical and real-world problems in the domains of insurance and superannuation.
5. To promote innovation and initiative in solving actuarial problems through the creative application of statistical and mathematical knowledge.

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain and apply core actuarial concepts in the fields of life insurance, general insurance, and superannuation.	1,2	1	U, Ap
CO 2	Analyze actuarial datasets using appropriate statistical and mathematical techniques	2,4	2	An, E
CO 3	Calculate insurance premiums, reserves, and superannuation contribution rates using actuarial methods	1,2,8	2,3	Ap, E
CO 4	Evaluate real-life and simulated problems in insurance and superannuation and recommend appropriate solutions.	2,3,5	3	An, E
CO 5.	Demonstrate creativity, initiative, and innovation in applying actuarial knowledge to solve complex problems.	2,4,6,7	3	C, E
CO6	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social,	1,2	1	U

	economic, and environmental patterns in a culturally contextualized manner.			

Major III: Actuarial Science

Unit	Title	Lecture Hours	CO Mapping
I	**Mortality Tables and Compound interest**	**15**	
1.1	Various mortality functions. Probabilities of living and dying. The force of mortality. Estimation of μ_x from the mortality table.	**05**	**CO1**
1.2	Central Mortality Rate. **Laws of mortality:** Gompertz's and Makeham's first law. Select Mortality table.	**05**	**CO1**
1.3	Accumulated value and present value, nominal and effective rates of interest. Varying rates of interest. Equation of value.	**05**	**CO1**
II	**Annuity and Life Annuity**	**15**	
2.1	**Annuity Certain:** Present and accumulated values of annuity certain (immediate and due) with and without deferment period. Present value for perpetuity (immediate and due) with and without deferment period.	**05**	**CO2**
2.2	Present and accumulated values of i. increasing annuity ii. increasing annuity when successive instalments form arithmetic progression iii. annuity with frequency different from that with which interest is convertible. Redemption of loan.	**05**	**CO2**
2.3	Present value in terms of commutation functions of Life annuities and Temporary life annuities (immediate and due) with and without deferment period. Present values of Variable, increasing life annuities and increasing Temporary life annuities (immediate and due).	**05**	**CO2, CO4**
III	**Assurance Benefits and Level Annual Premium**	**15**	
3.1	Present value of Assurance benefits in terms of commutation functions of: i. pure endowment assurance ii. temporary assurance iii. endowment assurance iv. whole life assurance v. double endowment assurance vi. special endowment assurance vii. deferred temporary assurance. **Net premiums:** Net level annual premiums (including limited period of payment) for various assurance plans. Natural and Office premiums.	**10**	**CO3, CO5**

3.2	**Agriculture & Environmental Statistics** i. Ancient rainfall prediction models and monsoon cycle calculations **ii.** Statistical analysis of crop yield and soil quality in traditional farming**.** **Modern Indian Statistical Systems** i. Evolution of census operations in India (1872–present) ii. Role of NSSO, RBI, and SEBI in contemporary Indian statistics	**05**	**CO6**

References:

1. Neill A.: Life Contingencies, First edition, Heineman educational books London
2. Dixit S.P., Modi C.S., Joshi R.V.: Mathematical Basis of Life Assurance, First edition Insurance Institute of India.
3. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
4. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
5. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments/ Class Participation, etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y. B.Sc. Statistics Major III Practical
Semester: VI
Course Title: Practical: Actuarial Science
Course Code: GNKUSSTAMJ3P106
Credits: 01
No. of Practical hours: 30
Marks: 25

Course Objectives

The course aims at:

1. To understand and apply the fundamental principles and theories of actuarial science in the context of life insurance, general insurance, and superannuation.
2. To develop the ability to analyse actuarial data using advanced statistical tools and techniques.
3. To learn to compute key actuarial quantities such as insurance premiums, policy reserves, and superannuation contribution rates.
4. To cultivate analytical skills to solve both theoretical and real-world problems in the domains of insurance and superannuation.
5. To promote innovation and initiative in solving actuarial problems through the creative application of statistical and mathematical knowledge.

Course Outcomes

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain and apply core actuarial concepts in the fields of life insurance, general insurance, and superannuation.	1,2	1	U, Ap
CO 2	Analyze actuarial datasets using appropriate statistical and mathematical techniques	2,4	2	An, E
CO 3	Calculate insurance premiums, reserves, and superannuation contribution rates using actuarial methods	1,2,8	2,3	Ap, E
CO 4	Evaluate real-life and simulated problems in insurance and superannuation and recommend appropriate solutions.	2,3,5	3	An, E
CO 5.	Demonstrate creativity, initiative, and innovation in applying actuarial knowledge to solve complex problems.	2,4,6,7	3	C, E
CO6	Demonstrate the ability to integrate traditional Indian knowledge and historical data practices with modern statistical tools to analyze social, economic, and environmental patterns in a culturally contextualized manner.	1,2	1	U

List of Practical

1. Mortality-I
2. Mortality-II

3. Annuities-I
4. Annuities-II
5. Life Annuities
6. Assurance Benefit
7. Discussion and Presentation on Environmental Statistics
8. Discussion and Presentation on Modern Indian Statistical System

References:

1. Neill A.: Life Contingencies, First edition, Heineman educational books London
2. Dixit S.P., Modi C.S., Joshi R.V.: Mathematical Basis of Life Assurance, First edition Insurance Institute of India.
3. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021).
4. Singh, A.K. & Kapoor, K. (2021). Indian Knowledge Systems - Vol 1 & 2.
5. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. (1999). Evolution of Statistics in India. International Statistical Review, ISI.

Examination:

- Practical Examination: 15 Marks
- Journal & Viva Marks: 5 + 5 Marks

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. STATISTICS

Semester VI

Elective I

Name of the paper: Data Analysis and Web Designing

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Course: T.Y.B.Sc. Statistics Elective 1
Semester: VI
Course Title: Data Analysis and Web designing
Course Code: GNKUSSTAEL1106
Credits: 3
No. of lectures hours: 45
Marks: 75

Course Objectives:

1. To Remember basic concept of JavaScript and its role in web development. To know basic design of dataframe and its various features.
2. To demonstrate skill in designing webpage using javascript and HTML.
3. To apply statistical tools for data visualization and analysis using Pandas.
4. To create web page using JavaScript and HTML.
5. To Analyze the data and draw conclusion from dataset using pandas.

Course Outcomes (COs):

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Recollect basic concept of JavaScript and its Pandas.	1,2, 3	1, 2, 4	R, U
CO 2	Demonstrate skill in designing webpage using JavaScript and HTML.	1, 2, 4, 6	1, 3, 6, 7	R, U, Ap
CO 3	Apply statistical tools for data visualization and analysis using Pandas.	1, 6, 7	1, 4, 5	R, Ap, An
CO 4	Create webpage using JavaScript and HTML.	1, 7, 8	1,4, 6	C, An Ap
CO 5	Analyze the data and create report from dataset using Pandas.	2, 4, 8	2, 4 ,5	C , An Ap

Elective- I Data Analysis with Python & Web designing

Unit	Title	Lecture Hours	CO Mapping
I	**Java Script and Graphics Programming**	**15**	
1.1	Introduction to JavaScript, Basic of HTML programming, basic program to create webpage, Difference between Java and JavaScript, Placing JavaScript in an HTML file, First JavaScript Program.	**04**	CO1
1.2	Comment in JavaScript, defining variables for JavaScript, Understanding Variable Types, using variables in Scripts, Structuring Functions, calling functions in your scripts	**06**	CO1
1.3	Event Handlers: Using an event handler in an HTML Element, Using an event Handler in the Script Code, Create a button, Learning the	**05**	CO2

	event handlers, Use events to send out Alerts, Creating Scripts Using Event Handlers		
II	**Basic of Data Analysis and Python**	**15**	
2.1	Basic of Python and introduction of machine learning: a) Data Analysis, its scope and limitations. b) MI: What is MI, its scope and limitations. c) Python Revision: What is Python, advantages of Python, declaring variable in Python, basic input/output function in python, conditional and iterative statements in Python, function, lambda function. d) List, tuples, dictionary, their attribute and various functions on it.	**05**	CO3
2.2	Basic of Panda Dataframe: a) Creation of dataframe using lists, panda series, dictionary, by reading csv file, excel file, Jason file. b) Dataframe attributes and functions on it. c) Data Manipulation: Working on indexes, columns, values of dataframe (adding/deleting/renaming/sorting).	**05**	CO3
2.3	Data Visualization: a) Generating report using slicing and indexing. Filtering records based on condition, handling missing values. b) Creation of bar diagrams, pie charts, histograms, density box, scatter plot etc using Matplotlib	**05**	CO4
III	**Statistical Analysis using Python:**	**15**	
3.1	Descriptive statistics and Probability Distribution: a) Measure of central tendency and dispersion. b) Standard Probability distribution (Binomial, Poisson, Normal, Uniform), random number generation using probability distribution.	**04**	CO4
3.2	Testing of Hypothesis: a) Z- test, One – sample t-test. b) Two-Sample t-test. c) Paired Sample t-test. d) Chi-Square Goodness of Fit Test. e) Analysis of Variance.	**06**	CO5
3.3	Linear Regression: a) Sample linear regression, Steps in building a Regression model. b) Building Simple Linear Regression Model. c) Creating Feature Set (X) and Outcome Variable (Y) d) Splitting the Dataset into Training and Validation Sets. e) Fitting the Model. f) Printing estimated parameters and interpreting them. g) Complete Code for Building Regression Model.	**05**	CO5

Examination:

- Internal Examination (15 Marks): 10 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 20 minutes. And 5 Marks for either Quiz/ Assignments/ Class Participation, etc.
- Semester End Examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2 hours.
- Combined passing of 40% with minimum 20% in Internal Component.

References:

1. Beginner's guide for JavaScript, 3rd Edition , John Pollock
2. Manaranjan Pradhan, U Dinesh Kumar, Machine learning using Python, Wily
3. Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython, Wes Mckinney, O'Reilly, Second edition
4. Python Data Science Handbook: Essential Tools for Working with Data, Jake VanderPlas, O'Reilly, First Edition.
5. Doing math with Python, Amit Saha

Software

http://continuum.io/downloads.Anaconda 3.x

TYBSc Semester VI: Statistics Elective I

Course Title: Practical: Data Analysis and Web designing
Paper Code: GNKUSSTAEL1P106
Credits: 01
No. of Practical hours: 30
Marks: 25

Course Objectives

1. To Remember basic concept of JavaScript and its role in web development. To know basic design of dataframe and its various features.
2. To demonstrate skill in designing webpage using javascript and HTML.
3. To apply statistical tools for data visualization and analysis using Pandas.
4. To create web page using JavaScript and HTML.
5. To Analyze the data and draw conclusion from dataset using pandas.

Course Outcomes

Sr. No.	On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Recollect basic concept of JavaScript and its Pandas.	1,2, 3	1, 2, 4	R, U
CO 2	Demonstrate skill in designing webpage using JavaScript and HTML.	1, 2, 4, 6	1, 3, 6, 7	R, U, Ap
CO 3	Apply statistical tools for data visualization and analysis using Pandas.	1, 6, 7	1, 4, 5	R, Ap, An
CO 4	Create webpage using JavaScript and HTML.	1, 7, 8	1,4, 6	C, An Ap
CO 5	Analyze the data and create report from dataset using Pandas.	2, 4, 8	2, 4 ,5	C , An Ap

List of Practical

1 Write a program to insert script into an HTML document.
2 Write a program to define and call function in JavaScript.
3 Write a program to illustrate use of different event handler in JavaScript.
4 Basic of Python and Pandas
5 Creation, manipulations and updating of data frame.
6 Descriptive statistics using data frame.
7 Data visualization using pandas.
8 Probability distribution using Pandas
9 Testing of Hypothesis using Pandas
10 Linear regression using Pandas

Total Marks: 25 Marks

- **Experiment Marks: 15 Marks**
- **Journal & Viva Marks: 5 + 5 Marks**

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. STATISTICS

Semester VI

Elective II

Name of the paper: Demography and Vital Statistics

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)
Department of Mathematics and Statistics

Course: T.Y.B.Sc. Statistics Elective II
Semester: VI
Course Title: Demography and Vital Statistics
Course Code: GNKUSSTAEL2106
Credits: 3
No of lectures hours: 45
Marks: 75

Course Objectives

The course aims at:

1. To develop a clear conceptual understanding of vital statistics, including the construction and interpretation of mortality tables.
2. To understand the applications of demographic data and methods in analyzing population trends for informed decision-making in public policy and business.
3. To explore the dynamics of population change by studying fertility, mortality, and migration and their influence on population size, composition, and structure.
4. To equip students with skills to compute and interpret demographic indicators and apply them to real-world data.

Course Outcomes

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO 1	Explain the fundamental concepts of vital statistics and construct mortality and life tables.	1,2	1	U, Ap
CO 2	Analyse demographic measures and interpret population trends using real-world data.	2,4	2	An, E
CO 3	Apply knowledge of fertility, mortality, and migration in evaluating population changes.	1,3,5	2	Ap, An
CO 4	Assess the importance of demography in planning, policy-making, and economic forecasting.	3,6	3	An, E

Elective-II Demography and Vital Statistics

Unit	Title	Lecture Hours	Co Mapping
I	**Introduction and Composition**	**15**	
1.1	Development of the subject, Present day concepts, Definitions, Origin and Scope of Demography, Components of population	04	CO1

	change: Fertility-Mortality-Migration - Sources of Demographic Data: Census-Vital Registration System-Population Register and Sample Surveys- Quality of Data – Smoothing techniques, Indices – Whipple‟s, Myer‟s, UN, Chandrasekhar and Deming method.		
1.2	Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events.	06	CO2
1.3	Population composition -Age, Sex – Population Pyramid - Religion, Caste, Education, Language and Income, dependency ratio. Models of population growth and their filling to population data.	05	CO3
II	**Components of population change and Reproduction**	15	
2.1	**Measurements of Fertility:** Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).	05	CO3
2.2	**Measurements of Mortality:** Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.	05	CO3
2.3	**Measurement of Population Growth and Reproduction:** Gross Reproduction Rate (GFR) and Net Reproductive Rate (NRR).	05	CO4
III	**Life tables**	15	
3.1	Stationary and Stable population, Central Mortality Rates and Force of Mortality.	04	CO1
3.2	Life (Mortality)Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.		CO1
3.3	Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method.	06	CO1

References:

1. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P)Ltd.
2. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
3. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
4. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag Newyork.

Examination:

- Internal Examination (25 Marks): 20 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 40 minutes. And 5 Marks for either Quiz/Assignments /Class Participation etc.
- End Semester theory examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours and 30mins
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y.B.Sc. Statistics Elective II Practical
Semester-VI
Course Title: Practical: Demography and Vital Statistics
Course Code: GNKUSSTAEL2P106
Credits: 1
No of Practical Hours: 30
Marks: 25

Course Objectives

The course aims at:

1. To develop a clear conceptual understanding of vital statistics, including the construction and interpretation of mortality tables.
2. To understand the applications of demographic data and methods in analyzing population trends for informed decision-making in public policy and business.
3. To explore the dynamics of population change by studying fertility, mortality, and migration and their influence on population size, composition, and structure.
4. To equip students with skills to compute and interpret demographic indicators and apply them to real-world data.

Course Outcomes

Sr. No.	Course Outcomes (COs): On completing the course, the student will be able to:	POs addressed	PSOs addressed	Cognitive Levels addressed
CO 1	Explain the fundamental concepts of vital statistics and construct mortality and life tables.	1,2	1	U, Ap
CO 2	Analyse demographic measures and interpret population trends using real-world data.	2,4	2	An, E
CO 3	Apply knowledge of fertility, mortality, and migration in evaluating population changes.	1,3,5	2	Ap, An
CO 4	Assess the importance of demography in planning, policy-making, and economic forecasting.	3,6	3	An, E

List of Practical

1. To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data
2. To calculate CDR and Age Specific death rate for a given set of data
3. To find Standardized death rate by:- (i) Direct method (ii) Indirect method
4. To calculate CBR, GFR, SFR, TFR for a given set of data
5. Calculate GRR and NRR for a given set of data and compare them
6. To construct a complete life table
7. To fill in the missing entries in a life table
8. To calculate probabilities of death at pivotal ages and use it construct abridged life table

References:

1. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P)Ltd.
2. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
3. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
4. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag Newyork.

Examination:

- Practical Examination: 15 Marks
- Journal & Viva Marks: 5 + 5 Marks

Shiromani Gurudwara Prabandhak Committee's

Guru Nanak Khalsa College of Arts, Science and Commerce (Autonomous)

Matunga, Mumbai – 400 019, Maharashtra

Program: Bachelor of Science

Syllabus

Course: T. Y. B.Sc. Statistics

Semester VI

Minor

Name of the paper: Decision Theory and Game Models

(As per NEP guidelines-DSC model)

With effect from Academic Year 2026 - 2027)

Course: T.Y.B.Sc. Statistics Minor
Semester: VI
Course Title: Decision Theory and Game Models
Course Code: GNKUSSTAMI1106
Credits: 1
No. of lectures hours: 30
Marks: 25

Course Objectives

The course aims at:

1. Understand the fundamental principles of decision theory under various conditions such as certainty, risk, and uncertainty.
2. Develop skills to construct decision-making models and apply decision rules in different decision environments.
3. Learn the structure and classification of games, including two-person zero-sum, non-zero-sum, cooperative and non-cooperative games.
4 Apply mathematical tools like saddle points, dominance principles, and mixed strategies to solve decision problems and games.

Course Outcomes

Sr. No.	Course Outcomes (COs):			
	On completing the course, the student will be able to:	**POs addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO1	Explain the concepts and principles of decision theory and its application in decision-making processes.	1	1	R, U
CO2	Classify decision-making environments and apply appropriate decision rules under conditions of certainty, risk, and uncertainty.	2	2	Ap, An
CO3	Describe and analyze different types of games and strategic interactions.	1,2	1,2	U, An
CO4	Solve two-person zero-sum games using saddle point, dominance, and mixed strategy approaches.	2	2	Ap, An
CO5	Interpret and analyze real-world decision-making problems using appropriate mathematical decision models.	3,4,5	3	An,E,C

Minor: Decision Theory and Game Models

Unit	Title	Lecture Hours	CO Mapping
I	**Decision Theory**	15	
1.1	Decision making under certainty: Introduction and its application Decision making under uncertainty: Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwitz criterion, Minimax Regret criterion.	05	CO1
1.2	Decision making under risk: Expected Monetary Value criterion, Expected Opportunity Loss criterion, Expected Payoff from Perfect Information, Expected Value of Perfect Information.	05	CO1, CO2
1.3	Decision tree analysis. Introduction to decision-making under risk and uncertainty using decision trees. Construction of decision tree diagrams to represent sequential decisions and possible outcomes, with associated probabilities and payoffs. Evaluation of decision alternatives using expected monetary value (EMV).	05	CO2,
II	**Game Theory**	15	
2.1	Decision making under conflict Definitions of Two persons Zero Sum Game, Saddle Point, Value of the Game, Pure and Mixed strategy, Optimal solution of twopersons zero sum games.	05	CO3
2.2	**Dominance property:** • Dominance among rows (strategies for Player A) • Dominance among columns (strategies for Player B) • Elimination of dominated strategies **Algebraic solution for (2×2) games without saddle point** • Formulation of algebraic expressions to determine mixed strategies for both players • Use of expected payoff equations for equilibrium • Calculation of value of the game (V)	05	CO3
2.3	**Graphical solution of (2xn) and (mx2) games:** Introduction to graphical methods for solving two-person zero-sum games of type (2×n) and (m×2) without a saddle point. Plotting expected payoff functions for different strategies on a graph, determining the lower (or upper) envelope to find optimal mixed strategies and the value of the game. Application of graphical solutions in strategic decision-making problems.	05	CO4, CO5

References:

- Vora N. D.: Quantitative Techniques in Management, Third edition, McGraw Hill Companies.
- Kantiswarup, P.K. Gupta, Manmohan: Operations Research, Twelfth edition, Sultan Chandand sons.
- Sharma S. D.: Operations Research, Eighth edition, Kedarnath Ramnath & Co.
- Sharma S. D.: Operations Research, Eighth edition, Kedarnath Ramnath & Co.

Examination:

- Internal Examination (25 Marks): 20 Marks exam (MCQ and short answer question) with 20% completed syllabus. Duration of exam: 40 minutes. And 5 Marks for either Quiz/Assignments /Class Participation etc.
- End Semester theory examination (60 Marks): Weightage of each unit will be proportional to the number of lecture hours as mentioned in the syllabus. Duration of exam: 2hours and 30mins
- Combined passing of 40% with minimum 20% in Internal Component.

Course: T.Y.B.Sc. Statistics Minor Practical
Semester: VI
Course Title: Practical: Decision Theory and Game Models
Course Code: GNKUSSTAMI1P106
Credits: 1
No of Practical Hours: 30
Marks: 25

Course Objectives

The course aims at:

1. Understand the fundamental principles of decision theory under various conditions such as certainty, risk, and uncertainty.
2. Develop skills to construct decision-making models and apply decision rules in different decision environments.
3. Learn the structure and classification of games, including two-person zero-sum, non-zero-sum, cooperative and non-cooperative games.
4 Apply mathematical tools like saddle points, dominance principles, and mixed strategies to solve decision problems and games.

Course Outcomes

Sr. No.	Course Outcomes (Cos):			
	On completing the course, the student will be able to:	**Pos addressed**	**PSOs addressed**	**Cognitive Levels addressed**
CO1	Explain the concepts and principles of decision theory and its application in decision-making processes.	1	1	R, U
CO2	Classify decision-making environments and apply appropriate decision rules under conditions of certainty, risk, and uncertainty.	2	2	Ap, An
CO3	Describe and analyze different types of games and strategic interactions.	1,2	1,2	U, An
CO4	Solve two-person zero-sum games using saddle point, dominance, and mixed strategy approaches.	2	2	Ap, An
CO5	Apply linear programming techniques to solve game theory and decision problems.	2	2	Ap,An
CO6	Interpret and analyze real-world decision-making problems using appropriate mathematical decision models.	3,4,5	3	An,E,C

List of Practical

1. Decision Making Under Certainty and Uncertainty
2. Decision Making Under Risk-I
3. Decision Making Under Risk-II
4. Decision Tree
5. Game Theory (with saddle point)
6. Game Theory: Algebraic method
7. Game Theory: Dominance Property
8. Game Theory: Graphical method

References:

1. Vora N. D.: Quantitative Techniques in Management, Third edition, McGraw Hill Companies.
2. Kantiswarup, P.K. Gupta, Manmohan: Operations Research, Twelfth edition, Sultan Chandand sons.
3. Sharma S. D.: Operations Research, Eighth edition, Kedarnath Ramnath & Co.
4. Sharma S. D.: Operations Research, Eighth edition, Kedarnath Ramnath & Co.

Examination:

- Practical Examination: 15 Marks
- Journal & Viva Marks: 5 + 5 Marks

Course Outcomes

Bloom's Taxonomy categorizes educational objectives into six cognitive levels, listed from the simplest to the most complex.

The course outcomes (CO) are mapped to the revised Bloom's Taxonomy using the following Cognitive levels along with abbreviations: **Remembering-R, Understanding-U, Applying-Ap, Analyzing-An, Evaluating-E, Creating-C.**

R-Remembering: This level involves recalling facts, terms, basic concepts, and answers without necessarily understanding the meaning or implications.

U-Understanding: Understanding involves explaining ideas or concepts and interpreting them in one's own words to demonstrate comprehension.

Ap-Applying: Applying knowledge involves using acquired knowledge in new situations or applying it in different ways.

An-Analyzing: Analyzing involves breaking down information into parts to understand its organizational structure, recognizing patterns, and identifying relationships between components.

E-Evaluating: Evaluating involves making judgments based on criteria and standards, assessing the value of theories, presentations, or materials.

C-Creating: Creating involves putting elements together to form a coherent or functional whole, reorganizing elements into a new pattern or structure.

Use the following action verbs for Blooms taxonomy levels to prepare Course outcomes:

No	Levels	Action verbs
1	**Remember**	Choose, Describe, Define, Label List, Locate,, Match, Memorize, Name, Omit, Recite, Select, State, Count, Draw, Outline, Point, Quote, Recall, Recognize, Repeat, Reproduce, Recall, Arrange, Duplicate, Tabulate.
2	**Understand**	Restate ,Discuss, Clarify, Locate, Recognise, Classify, Translate, Explain, Express, Review, Interpret, Select, Summarise, Contrast, Predict, Associate, Estimate, Extend
3	**Apply**	Demonstrate, Schedule, Operate, Dramatize, Apply, Employ, Use, Practise, Illustrate, Choose, Solve, Write, Calculate, Complete, Show, Examine, Modify, Relate, Classify, Experiment.
4	**Analyse**	Distinguish, Differentiate, Investigate, Categorise, Appraise, Inspect, Test, Debate, Compare, Contrast, Question
5	**Evaluate**	Judge, Score, Select, Evaluate, Choose, Rate, Assess, Compare, Estimate, Value, Measure, Discriminate, Argue, Defend, Support, Conclude, Summarize, Appraise, Revise.
6	**Create**	Compose, Assemble, Organise, Plan, Collect, Propose, Construct, Design, Create, Formulate, Arrange, Devise, Modify, Derive, Develop, Integrate, Rearrange, Substitute, Invent, Generalise.