Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Empowered Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus of Statistics Major for the T.Y.B.Sc. Semester- V (under NEP)

Program: B.Sc. STATISTICS

Program Code: RJSUSTA

(REVISED in 2025-2026 in alignment with the NEP2020 facilitating the inter-and multidisciplinary learning and multiple entry and exit of the students)

(CBCS 2025-2026)

T.Y.B.Sc. Semester V Statistics DSC Syllabus

Preamble

The National Education Policy 2020 aims at imparting skill-based learning and caters to the multiple entry and exit facility for the students thus empowering them to acquire knowledge at their pace. In the three-year UG program, the student has two exit options. Students also have the option of choosing the Honors program of four years study in a given discipline and later converting it to a five-year integrated PG degree program. As an undergraduate student, he/she learns the core subject (Major), subject complementing the core subject (Minor), a course from another discipline (OEC or GEC), Vocational and Skill Enhancement course from the Major (VSEC). The remaining verticals under NEP 2020 are IKS (Indian Knowledge System), AEC (Ability Enhancement Course), VEC (Value Enhancement Course) and with progressive three years of UG, student also completes at different levels OJT (On Job Training), FP (Field Projects), CEP (Community Engagement Program), RP (Research Project) which helps him/her in understanding their roots, application of the knowledge for the benefit of self and the society. Vertical CC (Co-curricular activities and activities related to yoga and human well-being) helps in preparing youth with good character and interpersonal relationships.

Credit Structure for B Sc Semester V as per NEP 2020 Implemented from the academic year 2025-2026
Course Code: RJDSCSTA

Semester V
Level 5.5 Major Statistics

Courses	Credits	Total Credits	Course Code
Discipline Specific Core -I Probability and Distribution Theory	4	12	RJDSCSTA351
Discipline Specific Core -II Theory of Estimation	4		RJDSCSTA352
Discipline Specific Core -III Practical on DSC-I and DSC-II	4		Practicals related to Theory I and II RJDSCSTAP351
Discipline Specific Elective-I Biostatistics	4	4	RJDSESTA351
Discipline Specific Elective-II Mathematical Economics			RJDSESTA352
Vocational Skill Course (VSC) Regression Analysis Using R software	2	2	RJVSCSTA351
Vocational Skill Course (VSC) Practical	2	2	RJVSCSTAP351
Field Project (FP)	2	2	RJFPSTA351
Total Credits	22	22	

*As per University Grid

DISTRIBUTION OF TOPICS AND CREDITS

T.Y.B.Sc. STATISTICS SEMESTER V

Vertical	Course Code	Nomenclature	Topics	Credits
DSC (12 credits)	RJDSCSTA351	Probability and Distribution Theory	Unit-I Probability-I Unit- II Probability-II Unit- III Joint Moment Generating Function, Trinomial and Multinomial Distribution Unit- IV Order Statistics	04
	RJDSCSTA352	Theory of Estimation	Unit-I Point Estimation and Properties of Estimator Unit-II Methods of Point Estimation Unit-III Bayesian Estimation and Confidence Interval Unit- IV Introduction to Linear Models	04
	RJDSCSTAP351	Practical	Statistics Practical	04

SEMESTER	:	V (CORE SUBJECT)
TITLE OF THE SUBJECT/COURSE	:	**Probability and Distribution Theory**
COURSE CODE	:	**RJDSCSTA351**
CREDITS	:	04
DURATION	:	60 HOURS

LEARNING OBJECTIVES
1. To strengthen the concepts in Mathematical Statistics.
2. To improve the skills of probability to use in the various fields.
3. To increase the ability to solve real life problems using probabilities.
4. To analyze the properties and applications of ordered random variables in statistical inference.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	understand the basics of probability and its application.	1,3,9	BT Level I , II and III remember, understand and apply
CO2	handle transformed random variables and derive associated distributions.	1,6	BT Level II , III understand and apply
CO3	learn the importance of multinomial distribution and its uses in solving real life problems.	1,3,4	BT Level I, II , III remember, understand and apply
CO4	learn about order statistics and its applications.	1,4,6,9	BT Level II , III understand and apply

SEMESTER V (THEORY)		L	Cr
Paper-I: Probability and Distribution Theory	**Paper Code: RJDSCSTA351**	60	4
UNIT I		15	
PROBABILITY-I			
1	Mathematical, Statistical, Axiomatic and Subjective probability.		
2	Sub populations and partitions. Derivation of (a) Ar,n : Number of distinguishable distributions of putting r indistinguishable balls in n cells; (b) Number of distinguishable distributions of putting r indistinguishable balls in n cells such that no cell is empty. Probabilities based on a) Maxwell Boltzmann, Bose Einstein and Fermi Dirac Statistics.		
3	Ordered samples and runs.		
4	Addition Theorem for (a) two (b) three events.(Only Statement)		
5	Theorems on Probability of realization of: (a) At least one (b) Exactly m (c) At least m of N events A_1, A_2, A_3…A_N. Matching and Guessing problems.		
UNIT II		15	
PROBABILITY II			
1	Conditional Probability: Multiplication Theorem for two, three events. Independence of two/three events - complete and pair wise, Bayes' theorem (Definition only).		
2	Chebyscheve's inequality and Markov's Inequality: Statement and proof. Illustrative Example.		

3	Convergence in probability.		
4	Weak Law of Large Numbers & Strong Law of Large Numbers: Statement and proof. Illustrative Example.		
UNIT III		15	
JOINT MOMENT GENERATING FUNCTION, TRINOMIAL AND MULTINOMIAL DISTRIBUTION			
1	Definition and properties of Moment Generating Function (MGF) of two random variables of discrete and continuous type. Necessary and Sufficient condition for independence of two random variables. Concept and definition of Multivariate MGF.		
2	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 & Conditional distributions. Their Means & Variances. Correlation coefficient between (X, Y). Distribution of the Sum X+Y.		
3	Extension to Multinomial distribution with parameters (n, p1, p2,…pk-1) where p1+ p2+…pk-1+ pk = 1. Expression for joint MGF. Derivation of joint probability distribution of (Xi, Xj). Conditional probability distribution of Xi given Xj =xj.		
UNIT IV		15	
ORDER STATISTICS			
1	Definition of Order Statistics based on a random sample.		
2	Derivation of: (a) Cumulative distribution function of rth order statistics. (b) Probability density function of the rth order statistics. (c) Joint Probability density function of the rth and the sth order statistics (r<s) (d) Joint Probability density function of all n ordered statistics.		

3	Probability density function of Median (in the case of odd sample sizes) and Range for Uniform and Exponential distributions.		

References:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited.
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Fifth edition, Pearson Education (Singapore) Pvt. Ltd.
3. Hogg R. V. and Tanis E.A. : Probability and Statistical Inference, Fourth edition, McMillan Publishing Company.
4. Hogg R.V., Craig A.T.: Introduction to Mathematical Statistics, Fourth Edition; Collier McMillan Publishers.
5. Hogg R.V., Tannis E. A.: Probability and Statistical Inference, Third Edition; Collier McMillan Publishers.
6. Hogg R.V. and Tanis E.A.: Probability and Statistical Inference, Third edition Delhi Pearson Education.
7. Mood A. M., Graybill F. A., Boes D. C.: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series.
8. A. Mood, F. Graybill and D. Boes: Introduction to theory of Statistics – McGraw Hill
9. Gupta S C & Kapoor V K: Fundamentals of Mathematical statistics, Eleventh edition, Sultan Chand & Sons.
10. Biswas S.: Topics in Statistical Methodology, First edition, Wiley Eastern Ltd.
11. Kapur J. N. & Saxena H. C.: Mathematical Statistics, Fifteenth edition, S. Chand and Company.
12. Chandra T.K. & Chatterjee D.: A First Course in Probability, Second Edition, Narosa Publishing House.

SEMESTER	:	V (CORE SUBJECT)
TITLE OF THE SUBJECT/COURSE	:	**Theory of Estimation**
COURSE CODE	:	**RJDSCSTA352**
CREDITS	:	04
DURATION	:	60 HOURS

LEARNING OBJECTIVES
1. Fundamental understanding of parametric models for developing relevant inferences on associated parameters.
2. Understanding point and interval estimation procedures and different methods of point estimation.
3. Calculate and interpret confidence intervals for parameters.
4. Describe the concept of risks in Bayes estimation and how to reduce it.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	understand the difference between the classical and Bayesian approach to estimation; describe the notions of estimator bias, variance, and efficiency; and describe the notion of sufficient statistics and its meaning in minimum variance unbiased (MVU) estimation.	1, 4, 6	BT Level II and III understand, apply
CO2	develop system models and parameter estimation problems and derive corresponding Cramer-Rao lower bounds and sufficient statistics. Prove optimality of estimators.	1, 2, 4	BT level II and III Understand and apply
CO3	apply appropriate estimators – including linear least squares, maximum likelihood and method of moments estimators – after considering estimation accuracy and complexity requirements.	1, 4, 6	BT level III and IV Apply and analyse
CO4	understand the concept of Bayesian Inference and apply it to estimate unknown population parameters.	1, 3, 4	BT level II & III Understand and apply

SEMESTER V (THEORY)		**L**	**Cr**
Paper-II: Theory of Estimation	**Paper Code: RJDSCSTA352**	60	4
UNIT I		15	
POINT ESTIMATION AND PROPERTIES OF ESTIMATOR- I			
1	Unbiasedness: Definition of an unbiased estimator, biased estimator, positive and negative bias, illustrations and examples (these should include unbiased and biased estimators for the same parameters). Proofs of the following results regarding unbiased estimators. (a) Two distinct unbiased estimators of $\varphi(\theta)$ give rise to infinitely many unbiased estimators. (b) If T is an unbiased estimator of θ , then $\varphi(T)$ is an unbiased estimator of $\varphi(\theta)$ provided $\varphi(.)$ is a linear function. Ancillary Statistic and Illustrative examples.		
2	Consistency: Definition of Consistency Sufficient condition for consistency, proof & Illustrate.		
3	Sufficiency: Concept and definition of Sufficiency, Neyman Factorization Theorem (without proof). Exponential family of probability distributions and Sufficient statistics.		
4	Relative efficiency of an estimator. Illustrative example.		
5	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 is attained in Cramer Rao Inequality and its use in finding MV.		
UNIT II		15	

	METHODS OF POINT ESTIMATION		
1	Method of Maximum Likelihood Estimation (M.L.E.), Definition of likelihood as a function of unknown parameter, for a random sample from i) discrete distribution ii) continuous distribution. Distinction between likelihood function and joint p.d.f. / p.m.f. Derivation of Maximum Likelihood Estimator (M.L.E.) for parameters of standard distributions (case of one and two unknown parameters). Properties of M.L.E (without proof). Examples based on invariance property. Relation between Sufficiency and MLE.		
2	Method of Moments, Derivation of moment estimators for standard distributions (case of one and two unknown parameters). Illustrations of situations where M.L.E. and Moment Estimators are distinct and their comparison using Mean Square Error.		
3	Method of Minimum Chi-square and Modified Minimum Chi-square.		
	UNIT III	15	
	BAYESIAN ESTIMATION AND CONFIDENCE INTERVAL		
1	Definition: Decision function, Loss function, Risk function. Minimax Principle. Bayesian Estimation: Prior distribution, Posterior distribution. Types of Loss function : Squared error Loss function, Absolute error Loss function (AELF), Bayes' risk. Bayes' method of finding Point estimator (assuming SELF) Examples : (a) Binomial- Beta (b) Poisson- Gamma (c) Gamma-Gamma (d) Normal-Normal.		
2	Interval Estimation: Concept of confidence interval & confidence limits. Definition of Pivotal quantity and its use in obtaining confidence limits. Derivation of 100(1-α)% equal tailed confidence interval for : (a)The population mean : μ_1, $\mu_1-\mu_2$ (population variance known/ unknown). (b) the population variance: σ^2, $\frac{{\sigma_1}^2}{{\sigma_2}^2}$ (Normal distribution).		

3	Confidence interval for the parameters of Binomial, Poisson and Exponential distributions.		
UNIT IV			
INTRODUCTION TO LINEAR MODELS		15	
1	Explanation of General Linear Model of full rank with assumptions. Model Y= Xβ + e, e ~ $N(0, I\sigma^2)$		
2	Derivation of: 1) Least squares estimator of β 2) E(β) 3) V(β) .		
3	Gauss Markoff theorem for full rank Model: Y = Xβ + e.		
4	Derivation of: 1) E(l'β) 2) V(l'β)		
5	Confidence interval for l'β when σ^2 is known.		
6	Confidence interval of β when σ^2 is known.		

References:

1. Hogg R. V. and Tanis E.A. : Probability and Statistical Inference, Fourth edition, McMillan Publishing Company.
2. Hogg R.V., Craig A.T.: Introduction to Mathematical Statistics, Fourth Edition; Collier McMillan Publishers.
3. Hogg R.V. and Tanis E.A.: Probability and Statistical Inference, Third edition Delhi Pearson Education.
4. A. Mood, F. Graybill and D. Boes: Introduction to theory of Statistics – McGraw Hill.
5. Gupta S C & Kapoor V K: Fundamentals of Mathematical statistics, Eleventh edition, Sultan Chand & Sons.
6. Ulhas Jayram Dixit (2016) Examples in parametric inference with R (1st edition), Springer.
7. Cassela G. and Berger R .(2002) Statistical Inference (2nd edition), Duxbury Resource Centre.
8. Biswas S.: Topics in Statistical Methodology, First edition, Wiley Eastern Ltd.
9. Kapur J. N. & Saxena H. C.: Mathematical Statistics, Fifteenth edition, S. Chand and Company.
10. Chandra T.K. & Chatterjee D.: A First Course in Probability, Second Edition, Narosa

Publishing House.
11. V.K Rohatgi: An Introduction to probability and Mathematical Statistics
12. John E. Freund's Mathematical Statistics: I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.
13. Hoel P.G.: Introduction to Mathematical Statistics; Fourth Edition; John Wiley & Sons Inc.
14. Arora Sanjay and Bansi Lal : New Mathematical Statistics, Satya Prakashan, New Market, New Delhi, 1989
15. A.M.Kshirsagar , Linear Models
16. F.A. Graybill , An Introduction to Linear Mod
17. Theory and Methods of Survey Sampling: Parimal Mukhopadhyay, (1998), Prentice Hall Of India Pvt. Ltd.
18. Sampling Techniques: W.G. Cochran; 3rd Edition; Wiley(1978).

SEMESTER	:	V (CORE PRACTICAL COMPONENT)
TITLE OF THE SUBJECT/COURSE	:	**Statistics Practical**
COURSE CODE	:	**RJDSCSTAP351**
CREDITS	:	04
DURATION	:	120 HOURS

LEARNING OBJECTIVES	
1	To understand various estimation techniques.
2	To apply the concept of probability in solving real life problems.
3	Understand how trinomial distribution is used in solving real life problems.
4	Students will learn different types of estimation methods like MLE, MOM, MCS etc.
5	Students will understand how Bayesian Inference is used in solving problems of estimation.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	use the basic probability rules, including additive and multiplicative laws, using the terms, independent and mutually exclusive events.	1, 3	BT Level I, II Remember and Understand
CO2	translate real-world problems into probability models.	1,2,3	BT level II and III Understand, apply
CO3	identify the type of statistical situation to which different distributions can be applied.	1,4	BT level II and III, IV Understand, apply, analyze
CO4	draw conclusions about the whole population on the basis of a sample.	1,4,6	BT Level II, III IV Understand, apply and analyze
CO5	fit different models like regression, Anova etc using linear models.	1,2	BT level II and III, IV Understand, apply, analyze
CO6	estimate posterior probabilities on the basis of prior information using Bayesian inference.	1,4,6	BT level II and III, Understand, apply.

Semester V	
Statistics Practical	Paper Code: **RJDSCSTAP351**
Practicals based on DSC I (60 hours)	
1. Probability-1	
2. Probability-2	
3. Probability-3	
4. Multinomial distribution	
5. Order Statistics-1	
6. Order Statistics-2	
Practicals based on DSC II (60 hours)	
1. MVUE and MVBUE	
2. Method of Estimation -1	
3. Method of Estimation -2	
4. Bayes' Estimation	
5. Confidence Interval	
6. Linear model	

Scheme of Examinations

1. Evaluation will be for 100 marks based on both internal and external assessment for DSC I and DSC II.
2. Internal examination of 40 Marks for DSC I and DSC II based on MCQ/ True or false/ Short answers / Assignments / Projects / Seminar.
3. External examination (Semester End Examination) for DSC I and DSC II of 60 marks based on all units.
4. Minimum marks for passing the examination for DSC I and DSC II is 40 %.
5. Students must appear for at least one Internal to be eligible for the Semester End Examination.
6. Students must appear for the Semester End Examination to be able to complete total credits for a given Semester.
7. One combined Practical Examination DSC III (based on DSC I and DSC II) at the end of Semester consisting of 100 marks with minimum 40 marks for passing.
8. A candidate will be allowed to appear for the practical examinations if he/she submits a certified Journal of T.Y.B.Sc. Statistics or a certificate from the Head of the Department / Institute to the effect that the candidate has completed the practical course of T.Y.B.Sc. Statistics as per the minimum requirements.
9. In case of loss of journal, a candidate must produce a certificate from the Head of the Department /Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal (if any) will not be granted.
10. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

Evaluation and Assessment
(Based on the centralised guidelines given by EC under NEP 2020)

For DSC I and DSC II

Internal examination : 40 Marks

Internal examination consists of 2 types of assessments as follows:

Internal Assessment	Max Marks	Duration	Evaluation Particulars
1	20 /25	30 Minutes	MCQ / True or False / Short Answers
2	20/15	Based on set of rules	Projects / Assignments / Seminar

External examination : 60 Marks

Duration: 2 hours.

Theory question paper pattern at the end of the semester for each course is as follows:

Question no.	Max Marks	Question based on
1	15 (with internal option)	Unit I
2	15 (with internal option)	Unit II
3	15 (with internal option)	Unit III
4	15 (with internal option)	Unit IV
Total	60	

Key to set effective Question paper:

Question	Knowledge	Understanding	Application and Analysis	Total marks- Per unit
Unit 1	06	05	04	15
Unit 2	06	05	04	15
Unit 3	06	04	05	15
Unit 4	06	04	05	15
-TOTAL- Per objective	24	18	18	**60**
% WEIGHTAGE	40%	30%	30%	**100%**

For DSC III

Practical examination : **100 marks**

Question no.	Max Marks	Question based on
1	40 (with internal option)	DSC I
2	40 (with internal option)	DSC II
Journal	10	-
Viva	10	-
Total	100	

T.Y.B.Sc. Semester V Statistics DSC Syllabus

Mapping of the course to Local/ Regional/National/International relevance

Class	Course Name	Course Code	Local relevance	Regional relevance	National relevance	International relevance
T Y B Sc Statistics DSC-I	Probability and Distribution Theory	RJDSCSTA351	Domain knowledge of Probability to solve local problems	Supports foundational learning in probability, aiding students in preparing for university exams, government jobs, and industry applications like banking and insurance.	Aligns with Indian higher education curricula, fostering skills in statistical modeling, data science, and AI, which are crucial for research, analytics, and policymaking	Provides a strong theoretical base applicable globally in fields like machine learning, finance, and scientific research, aligning with international standards in probability and statistics. SDG 4,8,9,11,13
T Y B Sc Statistics DSC-II	Theory of Estimation	RJDSCSTA352	Estimation Theory plays a significant role in various local applications, influencing decision-making in multiple fields.	In regional economics, estimation techniques aid in assessing economic growth, forecasting employment trends, and evaluating the impact of policies on industries. State governments and local authorities use these methods	The Reserve Bank of India (RBI) and financial institutions use these methods to set monetary policies, forecast market fluctuations, and ensure economic stability.	In global healthcare, estimation models are crucial for predicting the spread of diseases, planning international vaccination campaigns, and managing health crises. Organizations like the World Health Organization (WHO) use

				to allocate budgets, predict tax revenues, and optimize public expenditure.		estimation techniques to assess the impact of pandemics, allocate medical resources, and develop long-term health policies. For example, during the COVID-19 pandemic, estimation models played a vital role in predicting infection rates, hospital capacities, and vaccine distribution needs worldwide. SDG 4, 8
T Y B Sc Statistics DSC -III	Practical	RJDSCSTAP 351	1. Data collection analyzing and estimating unknown parameters of models. 2. Domain knowledge of various statistical functions and their application in Statistics	1. Data collection analyzing and estimating unknown parameters of models. 2. Domain knowledge of various statistical functions and their application in Statistics	1. Data collection analyzing and estimating unknown parameters of models. 2. Domain knowledge of developing models for forecasting in different government and non government organizations.	1. Data collection analyzing and estimating unknown parameters of models. SDG 3, 4, 5, 11

T.Y.B.Sc. Semester V Statistics DSC Syllabus

Mapping of the course to Employability/ Entrepreneurship/Skill development

The courses in Statistics have been designed to impart one or more skills to make students employable.

Class	Course Name	Course Code	Topic focussing on Employability/ Entrepreneurship/ skill development	Employability/Entrepreneurship/Skill development	Specific activity
TYBSC SEM V	Probability and Distribution Theory	RJDSCSTA351	Unit 1. Probability-I Unit 2. Probability-II	1. Employability in the field of sports, weather reports etc.	
	Theory of Estimation	RJDSCSTA352	Unit 1. Point estimation and Properties of estimator -1 Unit 2. Methods of point estimation Unit 4. Introduction to Linear models	1. Model building skills	

Integration of Cross cutting Issues

Class	Course Code	Cross Cutting Issues
T Y B Sc Statistics Major	RJDSCSTA351 RJDSCSTA352 RJDSCSTAP351	Equity and inclusion, Human values UNSDG 4, 5, 8