

Karmaveer Bhaurao Patil University, Satara

Syllabus For

B. Sc. III STATISTICS

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2026-2027

SYLLABUS FOR BACHELOR OF SCIENCE PART-III: STATISTICS

1. TITLE: **Statistics**

2. YEAR OF IMPLEMENTATION: From **2026-2027**

3. DURATION: **01 year**

4. PATTERN: **Semester**

5. MEDIUM OF INSTRUCTION: **English**

6. STRUCTURE OF COURSE: **As per NEP-2020 (2.0)**

Sem (Level)	Courses				VSC	SEC	AEC	FP	CEP	OJT	CC	Total
	Course I		Course II									
	T	P	T	P								
Sem V (5.5)	Major IX (2) Major X (2) Major XI (2)	Major P V (2)	Major XII (Elect.) (2)	Major P VI (Elect.) (2)	VSC III (Major Specific) (2) (P)	--	AEC III (2) (English)	--	CEP (2)	OJT (4)	--	22
Sem VI (5.5)	Major XIII (2) Major XIV (2) Major XV (2)	Major P VII (2)	Major XVI (Elect.) (2)	Major P VIII (Elect.) (2)	VSC IV (Major Specific) (2) (P)	SEC III (2) (P)	AEC IV (2) (English)	FP (2)	--	--	CC (2)	22

* Elective - 1 Course out of two for each semester.

7. COURSE TITLE

1) B.Sc. III (Statistics) Semester V

Level	Semester	Course	Course Code	Course Title	No. of Lectures/ Practical Per Week	Credits
5.5	V	Major IX	BST 351	Probability Distribution - I	2	2
		Major X	BST 352	Statistical Inference – I	2	2
		Major XI	BST 353	Operations Research	2	2
		Major XIX (Elective)	E-I BST 354	Sampling Theory	2	2
			E-II BST 355	Machine Learning Techniques		
		Major (P) V	BSP 356	Practical V	1	2
		Major (P) VI (Elective)	BSP 357	Practical VI	1	2
		VSC	BSPVSC III	Statistical Data Analysis Using Python- I	1	2
		OJT	BSPOJT	On Job Training in Statistics	2	4
		CEP	BSPCEP	Community Engagement Program	1	2
		AEC	AEC III	English	1	2
		Total				**22**

2) B.Sc. III (Statistics) Semester VI

Level	Semester	Course	Course Code	Course Title	No. of Lectures/ Practical Per Week	Credits
5.5	VI	Major XIII	BST 361	Probability Distribution – II	2	2
		Major XIV	BST 362	Statistical Inference – II	2	2
		Major XV	BST 363	Design of Experiments	2	2
		Major XVI (Elective)	E-I BST 364	Industrial Statistics	2	2
			E-II BST 365	Reliability Theory		
		Major (P) VII	BSP 366	Practical VII	1	2
		Major (P) VIII (Elective)	BSP 367	Practical VIII	1	2
		VSC	BSPVSC IV	Statistical Data Analysis Using Python- II	1	2
		SEC	BSPSEC III	Practical Approach to Relational Databases using MySQL Workbench	1	2
		FP	BSPFP I	Field Project in Statistics	1	2
		CC	BSPCC I	Co-curricular Course	1	2
		AEC	AEC IV	English	1	2
		Total				**22**

8. EVALUATION STRUCTURE:

- **B.Sc. III NEP 2.0**

Semester V (5.5)

Course	Course Category	Course Code	CCE	ESE	Total Marks	Credits
Major	T	BST 351	20	30	50	02
	T	BST 352	20	30	50	02
	T	BST 353	20	30	50	02
	P	BSP 356	20	30	50	02
Major (Elective) (1 Theory Paper Out of Two)	T	BST 354	20	30	50	02
	T	BST 355	20	30	50	02
	P	BSP 357	20	30	50	02
AEC	T	AEC III	20	30	50	02
VSC	P	BSPVSC-III	20	30	50	02
OJT	P	BSPOJT I	40	60	100	04
CEP	P	BSPCEP I	--	50	50	02
Total					**550**	**22**

Semester VI

Course	Course Category	Course Code	CCE	ESE	Total Marks	Credits
Major	T	BST 361	20	30	50	02
	T	BST 362	20	30	50	02
	T	BST 363	20	30	50	02
	P	BSP 366	20	30	50	02
Major (Elective) (1 Theory Paper Out of Two)	T	BST 364	20	30	50	02
	T	BST 365	20	30	50	02
	P	BSP 367	20	30	50	02
AEC	T	AEC IV	20	30	50	02
VSC	P	BSPVSC-IV	20	30	50	02
SEC	P	BSPSEC III	20	30	50	02
FP	P	BSPFP I	20	30	50	02
CC	P	BSPCC I	20	30	50	02
Total					**550**	**22**

DSC: Discipline Specific Course; DSE: Discipline Specific Elective; VSC: Vocational Skill Course; SEC: Skill Enhancement Course; OJT: On Job Training; CEP: Community Engagement Program; AEC: Ability Enhancement Course; FP: Field Project; CC: Co-curricular Course ; T: Theory; P: Practical

➢ CONTINOUS COMPRHENSIVE EVALUATION (CCE)STRUCTURE

- Continuous Comprehensive Evaluation (CCE) of theory papers shall carry a weightage of 40%.
- **Activity:** For the internal evaluation of theory papers following activities will be adopted for CCE I & CCE II: class test/ open book test/ online course/ Industrial review/ Industrial Visit/ e learning video creation/ assignment/seminar/ case study/ fieldwork/ project.
- CCE III shall consist of multiple-choice questions.
- Each CCE will carry 10 marks for 2-credit theory papers and 20 marks for 4-credit theory papers, and the best two scores will be considered for final score.
- Internal evaluation of practical papers shall carry a weightage of 40%.
- For practical examinations, internal evaluation will be based on student performance, attendance, journal records, and viva voce.

9. OTHER FEATURES:

A) LIBRARY:

Reference books, Textbooks, Journals, and Periodicals are available in Institute and Departmental Library. (Separate reference lists are attached along with the respective course syllabus)

B) EQUIPMENT:

1. Specific equipment's in laboratory:

   70 Computers, LCD Projector, Visualizer, 04 Smart board etc.

2. Laboratory Software's:

   1. R-Software. 2. SPSS 3. MATLAB
   4. MINITAB 5. Python

Bachelor of Science (B.Sc.) Part III

SEMESTER-V

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: Major	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: PROBABILITY DISTRIBUTION – I (BST 351)

Course Objectives: Students should…

1) Understand the concept of probability and probability distribution.
2) Differentiate between a univariate probability distribution and a truncated probability distribution.
3) Compute the distribution of the transformed random variable.
4) Apply a univariate continuous probability distribution to real-life data.

Course Outcomes: Students will be,

1) Understand the concepts and characteristics of Logistic distribution, Pareto distribution and the multinomial distribution.
2) Explain the different univariate probability distributions.
3) Understand the concepts of truncated distribution and solves the real-life problems.
4) Analyse the decomposition of the mixture c.d.f. into discrete and continuous c.d.f.' s.

Module	Title and Contents	Hrs.
Module-1:	**Continuous Univariate Distributions** 1.1 Laplace (Double Exponential) Distribution: P.d.f. with parameters (μ, λ), Nature of the probability curve, Distribution function, quartiles, m. g. f., mean, variance, moments, β_1, β_2, γ_1 and γ_2, Laplace distribution as the distribution of the difference of two i. i. d. Exponential variates with parameter θ, Real-life examples and problems. 1.2 Lognormal Distribution: P.d.f. with parameters (μ, σ^2), Nature of the probability curve, mean, variance, median, mode, moments, β_1, β_2, γ_1 and γ_2 coefficients, Relation with N(μ, σ^2), Real life examples and problems. 1.3 Cauchy Distribution: P.d.f. with parameters (μ, λ), nature of the probability curve, distribution function, quartiles, non-existence of moments, additive property for two independent Cauchy variates (statement only), relationship with Uniform and Student's 't' distribution, distribution of X/Y where X and Y are i.i.d. N(0,1), Real life examples and problems.	08
Module-2:	**Univariate Probability Distributions** 2.1 Logistic distribution: P.d.f. with parameters (μ, σ), c.d.f., mean, mode, variance, skewness using mode, applications. 2.2 Pareto distribution: P.d.f. with parameters (α, β), mean, variance, mode, skewness using mode, applications. 2.3 Power series distribution: P.m.f. mean, mode, variance. Particular cases:	08

	Binomial, Poisson, Geometric and Negative Binomial Distributions.	
Module -3:	**Truncated Distributions** 3.1 Truncated distribution as a conditional distribution, truncation to the right, left, and on both sides. 3.2 Binomial distribution B(n, p) left truncated at X = 0 (value zero not observable), its p.m.f., mean, variance. 3.3 Normal distribution N(μ,σ^2) truncated i. To the left, below a ii. To the right above b iii. To the left below a and to the right above b, its p.d.f. and mean. 3.4 Exponential distribution with parameter θ left truncated below a, its p.d.f. mean and variance. Real-life examples and problems.	08
Module -4:	**Mixture Distribution and Transformation** 4.1 Mixture of probability distributions, decomposition of mixture type c.d.f. into discrete and continuous c.d.f.'s. 4.2 Transformations of univariate random variables, Probability Integral transformation, Convolutions, Compound distributions.	06

Reference Books :-

1) Bhat B.R.: Modern Probability Theory. New Age International, 5th edition in 2023.
2) Cramer H., Mathematical Methods of Statistics, Asia Publishing House, Mumbai, 2005
3) Feller. W, An Introduction of Probability Theory and its Applications, Wiley Eastern Ltd. Mumbai, 1971.
4) Gupta S. C and Kapoor V. K., Sultan Chand and Sons, Fundamentals of Mathematical Statistics, 2020.
5) Hogg, R. V. and Craig A. T., Introduction to Mathematical Statistics (Third Edition), Macmillan Publishing Company, 2018.
6) Johnson N.L., Kotz S., Balakrishnan N. and Kemp A.W.: Continuous Univariate Distributions I and II; Univariate Discrete Distributions, Wiley 3rd Edition 2005.
7) Lindgren B.W, Statistical Theory (Third Edition), Collier Macmillan International Edition, Macmillan Publishing Co. Inc., New York, 2004.
8) Mood, A. M., Gray, bill K, Bose. D. C, Introduction to Theory of Statistics, Mc-Graw Hiil Series, 2005.
9) Rohatgi V. K., An Introduction to Probability Theory and Mathematical Statistics, Wiley, 2018.
10) Sanjay Arora and Bansi Lal, New Mathematical Statistics (First Edition), Satya Prakashan, New Market, New Delhi, 2024.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: Major	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: STATISTICAL INFERENCE – I (BST 352)

Course Objectives: Students should …

1) Understand the fundamental concepts of statistical inference, point estimation and interval estimation.
2) Analyze and evaluate the properties of estimators and criteria for efficient estimation.
3) Apply different methods of parameter estimation to statistical problems.
4) Construct and interpret confidence intervals for population parameters for statistical inference in practical applications.

Course Outcomes: Students will be able to:

1) Explain the concepts of point estimation, estimators, statistics and standard errors.
2) Evaluate the properties of estimators, including unbiasedness, sufficiency, consistency and efficiency.
3) Apply maximum likelihood, method of moments and minimum chi-square methods for parameter estimation,
4) Construct and interpret confidence intervals using pivotal quantities and assess the precision of interval estimates.

Module	Title and Contents	Hrs.
Module -1:	**Point Estimation** 1.1 Notion of a parameter, parameter space 1.2 General problem of estimation, estimating an unknown parameter by point and interval estimation. 1.3 Point estimation: Definition of an estimator, statistic & its S.E. 1.4 Distinction between estimator and estimate 1.5 Illustrative examples	04
Module -2:	**Properties of Estimator** 2.1 Properties of estimators: Unbiased estimator, biased estimator, positive and negative bias, examples of unbiased and biased estimators. 2.2 Relative efficiency. 2.3 Minimum Variance Unbiased Estimator (MVUE) and Uniformly Minimum Variance Unbiased Estimator (UMVUE). 2.4 Sufficiency: Concept of sufficiency, sufficient statistic through (i) conditional distribution (ii) Neyman factorization criterion. 2.5 Pitman-Koopman form and sufficient statistic. 2.6 Fisher information function, 2.7 The concept of a minimal sufficient statistic. 2.8 Statement and proof of Cramer-Rao Inequality. Minimum Variance Bound Unbiased Estimator (MVBUE). 2.9 Concept of Consistency.	10

Module -3:	**Methods of Estimation** 3.1 Definition of likelihood function as a function of the parameter θ for a random sample from discrete and continuous distributions, Illustrative examples. 3.2 Method of maximum likelihood estimator, derivation of maximum likelihood estimators for parameters of standard distributions. 3.3 Use of iterative procedure to derive MLE of location parameter μ of Cauchy distribution, 3.4 Invariance property of MLE, relation between MLE and sufficient statistic. Illustrative examples. 3.5 Method of moments: Derivation of moment estimators for standard distributions. 3.6 Illustrations of situations where MLE and moment estimators are distinct and their comparison using mean square error (for uniform distribution), Illustrative examples. 3.7 Method of minimum chi-square: Definition, derivation of minimum chi-square estimator for the parameter. Illustrative examples.	08
Module -4:	**Interval Estimation** 4.1 The notion of interval estimation, the definition of a confidence interval, the length of a confidence interval and confidence bounds. 4.2 Definition of Pivotal quantity and its use in obtaining confidence intervals and bounds. 4.3 Illustrative examples.	08

Reference Books:-

1) Kale, B. K., A First Course on Parametric Inference, S. Chand & Company Ltd., New Delhi, 2004.
2) Rohatgi, V. K., Statistical Inference, Sultan Chand & Sons, New Delhi, 2001.
3) Rohatgi, V. K., An Introduction to Probability Theory and Mathematical Statistics, S. Chand & Company Ltd., New Delhi, 2008.
4) Saxena, H. C., & Surenderan, Statistical Inference, S. Chand & Company Ltd., New Delhi, 2011.
5) Kendall, M. G., & Stuart, A., The Advanced Theory of Statistics (Vol. 2), Charles Griffin & Company Ltd., London, 1977.
6) Lindgren, B. W., Statistical Theory (4th ed.), Chapman & Hall/CRC, Boca Raton, 2000.
7) Lehmann, E. L., & Casella, G., Theory of Point Estimation (2nd ed.), Springer, New York, 1998.
8) Rao, C. R., Linear Statistical Inference and Its Applications (2nd ed.), Wiley India Pvt. Ltd., New Delhi, 2004.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: Major	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: OPERATIONS RESEARCH (BST 353)

Course Objectives: Students should be,

1) Understand the concept of linear programming problem.
2) Describe the concept Assignment Problem and Transportation problem.
3) Demonstrate knowledge of CPM and PERT techniques used in project planning and scheduling.
4) Discuss the basic concepts and principles of Sequencing Problems.

Course Outcomes: Students will be…

1) Apply various methods to formulate and solve Linear Programming Problems and determine optimal solutions.
2) Apply appropriate techniques to solve Assignment and Transportation Problems and obtain optimal solutions.
3) Apply CPM and PERT techniques to plan, schedule, and analyze projects.
4) Analyze and solve sequencing problems using appropriate sequencing techniques to determine an optimal sequence of jobs.

Module	Title and Contents	Hrs.
Module -1:	**Linear Programming Problem (LPP)** 1.1 Introduction, Structure of Linear Programming Model, General Mathematical Model of Linear Programming Problem 1.2 Formulation of Linear Programming Model 1.3 Basic concepts in Linear Programming Problem 1.4 Methods to obtain optimum solution to LPP 1.5 Method I: Graphical Method (Extreme Point Approach), Some Special Cases in Graphical Method 1.6 Reformulation of LPP: Canonical form of LPP, Standard form of LPP, 1.7 Method II: Simplex Method 1.8 Method III: Big –M Method (Method of Penalties) 1.9 Duality Theory Writing the dual of a primal problem, Some related theorems with proof: Dual of dual is Primal, If i^{th} constraint of primal is in standard form then i^{th} variable of dual is unrestricted in sign or vice versa. 1.10 Examples and problems.	10
Module -2:	**Transportation and Assignment Problems** A] Transportation Problem: 2.1 Introduction, Transportation Model, Transportation Table 2.2 Methods of finding Initial Basic Solution (IBFS): I. North – West corner Rule II. Row Minima method III. Column Minima Method	08

	IV. Matrix Minima Method V. Vogel's Approximation Method (VAM) 2.3 Test for Optimality: Basic Concept in optimum solution, MODI Method (Transportation Algorithm), Balance and unbalanced T.P, Degeneracy in Transportation problem B] Assignment Problem: 2.4 Introduction, Assignment Model, Basic Concepts and Definitions 2.5 The Assignment Algorithm, Unbalanced Assignment Problem 2.6 Difference between T.P. and A.P. 2.7 Examples and problems.	
Module -3:	**Network Analysis** 3.1 Introduction, Applications of CPM/PERT, Basic Network Terminology 3.2 Rules for Construction of Network 3.3 Critical Path in Network Analysis 3.4 Project Evaluation and Review Technique (PERT) 3.5 Probability of Meeting the Schedule Time 3.6 Difference between CPM and PERT 3.7 Examples and problems.	07
Module -4:	**Sequencing Problem** 4.1 Introduction 4.2 Sequencing of N jobs on Two machines 4.3 Sequencing of N jobs on M machines 4.4 Examples and problems.	05

Reference Books:

1) Gass, S. I., Linear Programming Method and Applications, 5th Edition, Dover Publications, 2011.
2) Taha, H. A., Operation Research –An Introduction, 10th Edition, Pearson, 2017.
3) Saceini, M., Yaspan, A. and Friedman, L., Operation Research: Methods and Problems, Literary Licensing, 2013.
4) Shrinath L.S., Linear Programming: Principles & Applications, Affiliated East-West Press Pvt. Ltd. New Delhi, 1982.
5) Phillips, D.T., Ravindra, A., Solberg, J., Operations Research Principles and Practice, 2nd Edition, John Wiley and Sons Inc.,1987.
6) Sharma J. K., Mathematical Models in Operations Research,5th Edition, MACIN, 2012.
7) Kapoor, V.K., Operation Research: Concepts, Problems and Solutions, Sultan Chand and Sons, New Delhi, 2012.
8) Gupta, P.K. and Hira, D.S., Operations Research, S. Chand and Company Ltd., New Delhi, 1976.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: Major (Elective)	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: SAMPLING THEORY (BST 354)

Course Objectives: Students should be,

1) Understand the basic concepts and terminology of sampling techniques.
2) Learn the concepts of simple random, systematic, stratified and cluster sampling.
3) Compare different sampling methods and select an appropriate method for a given situation.
4) Understand the principles of sample size determination for sample surveys.

Course Outcomes: Students will be,

1) Explain the basic terminology, concepts and principles of various sampling techniques.
2) Apply appropriate sampling methods for conducting real-life surveys.
3) Differentiate among simple random, systematic, stratified and cluster sampling methods based on their characteristics and applications.
4) Determine appropriate sample sizes and conduct sample surveys for primary data collection.

Module	Title and Contents	Hrs.
Module -1:	**Basic Terminology and Simple Random Sampling** 1.1 Basic Terminology: Population, Sample, sampling units, sampling frame, random sampling and non-random sampling. Concept of Probability and Non-Probability Sampling. Methods of Non-Probability Sampling. Advantages of sampling method over census method, objectives of a sample survey, Questionnaire, Characteristics of a good questionnaire, sampling and non-sampling errors. 1.2 Simple Random Sampling: with replacement (SRSWR) and without replacement (SRSWOR): Definitions, population mean and population total as parameters. Unbiased estimator and variance of the sample mean $\bar{y}_n$, derivation of its expectation, standard error. Sampling for attributes. Estimation of population proportion. Sample proportion(p), derivation of its expectation, standard error and estimator of standard error using SRSWOR. 1.3 Determination of the sample size. Determination of the sample size (n) for the given: Margin of error and confidence coefficient. Coefficient of variation of the estimate and confidence coefficient.	06
Module -2:	**Stratified Sampling** 2.1 Real-life situations where stratification can be used. Description of stratified sampling method. 2.2 Sample mean ($\bar{y}_{st}$), derivation of its expectation, standard error, and estimator of standard error. 2.3 Problem of allocation: Proportional allocation, Neyman's allocation, optimum allocation-I and optimum allocation-II; derivation of the expressions for the sample size of the above estimators when these allocations are used. Comparison amongst SRSWOR, stratification with proportional allocation, and stratification with optimum allocation.	08

Module -3:	**Systematic Sampling and Cluster Sampling** 3.1 Real-life situations where systematic sampling is appropriate. Technique of drawing a sample using systematic sampling. Estimation of population mean and population total, standard error of these estimators 3.2 Comparison of systematic sampling with SRSWOR and stratified sampling in the presence of a linear trend. Circular Systematic Sampling 3.3 a) Cluster Sampling: i. Real-life situations where cluster sampling is appropriate. Technique of drawing a sample using cluster sampling. ii. Estimation of population mean and population total (with equal-size clusters), standard error of these estimators. iii. Systematic sampling as a particular case of cluster sampling. b) Two-Stage and Multi-Stage Sampling	08
Module -4:	**Sampling Methods using Auxiliary Variables** 4.1 Ratio Method: i. Concept of auxiliary variable and its use in estimation ii. Situations where the Ratio method is appropriate. iii. Ratio estimators of the population mean and population total, and their standard errors (without derivations), and estimators of the standard errors. iv. Relative efficiency of ratio estimators with that of SRSWOR. 4.2 Regression Method: i. Situations where the Regression method is appropriate. ii. Regression estimators of the population mean and population total and their standard errors (without derivations), and estimators of these standard errors. iii. Comments regarding bias in estimation. iv. Relative efficiency of regression estimators with that of a) SSWOR b) Ratio estimator.	08

Reference Books:

1) Cochran, W. G. Sampling Techniques. New Delhi: Wiley Eastern Ltd., 2012.
2) Sukhatme, P. V., and Sukhatme, B. V. Sampling Theory of Surveys with Applications. New Delhi: Indian Society of Agricultural Statistics, 1989.
3) Des Raj. Sampling Theory. S. Chand Publishing, 2017.
4) Daroga Singh and Choudhary, F.S. Theory and Analysis of Sample Survey Designs. New Delhi: Wiley Eastern Ltd., 1986.
5) Murthy, M. N. Sampling Theory and Methods. Kolkata: Indian Statistical Institute, 1998.
6) Mukhopadhyay, Parimal. Theory and Methods of Survey Sampling. New Delhi: Prentice Hall of India Pvt. Ltd., 2003.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: Major (Elective)	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: MACHINE LEARNING TECHNIQUES (BST 355)

Course Objectives: Students should …

1) Understand supervised and unsupervised learning techniques for data analysis.
2) Apply classification and clustering algorithms to solve data mining problems.
3) Evaluate and improve machine learning models using appropriate validation and ensemble methods.
4) Analyze large datasets to discover patterns, associations and support data-driven decision-making.

Course Outcomes: Students will be able to…

1) Apply classification techniques such as KNN, Decision Tree, Naïve Bayes, Logistic Regression, Bayesian Networks and CART to predictive modelling.
2) Evaluate and compare classification models using performance metrics, cross-validation, ROC curves and statistical tests.
3) Improve predictive performance using ensemble methods, including Bagging, Boosting, AdaBoost and Random Forests.
4) Perform clustering and association rule mining using algorithms such as k-means, DBSCAN, CLARA, DENCLUE and Apriori to extract meaningful insights from data.

Module	Title and Contents	Hrs.
Module -1:	**Data understanding and data cleaning** 1.1 Concept of supervised and unsupervised learning. 1.2 Problem of classification, classification techniques: k-nearest neighbour, decision tree, Naïve Bayesian, classification based on logistic regression, Bayesian belief Network, CART (classification and regression trees)	10
Module -2:	**Model evaluation and selection** 2.1 Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Cross-Validation, Bootstrap. 2.2 Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost–Benefit and ROC Curves	08
Module -3:	**Techniques to Improve Classification Accuracy** 3.1 Introduction to Ensemble Methods, Bagging, Boosting, and AdaBoost, Random Forests. 3.2 Improving Classification Accuracy of Class-Imbalanced Data.	06

Module -4:	**Unsupervised learning** 4.1 Clustering: k-means, CLARA, DENCLUE, DBSCAN, Probabilistic model-based clustering. 4.2 Market Basket Analysis: Association rules and prediction, Apriori Algorithm, data attributes, applications to electronic commerce.	06

Reference Books :-

1) Berson and S. J. Smith, Data warehousing, Data Mining, and OLAP, McGraw-Hill, 1997.
2) J.H. Breiman, R.A. Friedman, Olshen, and C.J. Stone, Classification and Regression Trees, Wadsworth and Brooks / Cole, 1984.
3) Jiawei Han, Micheline Kamber, and Jian Pei, Data Mining: Concepts and Techniques, Elsevier, 3rd Edition, 2012.
4) T. M. Mitchell, Machine Learning, McGraw-Hill, 1997.
5) B. D. Ripley, Pattern Recognition and Neural Networks, Cambridge University Press,1996.
6) V. N. Vapnik, The nature of Statistical learning theory, Springer, 2000.
7) Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Jonathan Taylor, An Introduction to Statistical Learning, Springer, 2013.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: Major Practical	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: PRACTICAL PAPER V (BSP 356)

Practical Batch: 12 Students / Batch

Course Objectives: Students should …

1) Develop practical skills in simulating, fitting and analyzing discrete and continuous probability distributions.
2) Apply probability distribution models to solve statistical problems and interpret probabilistic phenomena.
3) Apply statistical inference techniques to estimate unknown population parameters using standard estimation methods.
4) Construct and interpret confidence intervals for population parameters to support statistical decision-making.

Course Outcomes: Students will be able to…

1) Simulate random samples and fit standard discrete and continuous probability distributions.
2) Analyze and interpret probability models and their applications using statistical software.
3) Estimate unknown parameters using the Method of Moments, Maximum Likelihood and Minimum Chi-square methods.
4) Construct and interpret confidence intervals for population means, variances and proportions.

List of Experiments	**Hrs.**
1) Model sampling from Laplace and Cauchy and Pareto distributions 2) Model sampling from truncated Binomial and truncated Poisson distributions. 3) Model sampling from truncated normal and truncated exponential distributions. 4) Fitting of lognormal and Weibull distribution. 5) Fitting of truncated Binomial and truncated Poisson distribution. 6) Decomposition of mixture type c.d.f. into discrete and continuous c.d.f.'s. 7) Applications of Weibull, Laplace, Pareto, Logistic and Power series distribution. 8) Point estimation by method of moments for discrete distributions. 9) Point estimation by method of moment for continuous distributions. 10) Point estimation by method of maximum likelihood (one parameter). 11) Point estimation by method of maximum likelihood (two parameters) 12) Point estimation by method of minimum chi-square. 13) Interval estimation of location and scale parameters of normal distribution (single sample). 14) Interval estimation of difference of location and ratio of scale parameters of normal distribution (two samples). 15) Interval estimation for population proportion and difference between two population proportions.	60

Reference Books:

1) Mood, A. M., Gray bill K, Bose. D. C, Introduction to Theory of Statistic, Mc-Graw Hiil Series, 2005.
2) Lindgren B.W, Statistical Theory (Third Edition), Collier Macmillan International Edition, Macmillan Publishing Co. Inc. New York, 2004.
3) Hogg, R. V. and Craig A. T., Introduction to Mathematical Statistics (Third Edition), Macmillan Publishing Company, 2000.
4) Gupta S. C and Kapoor V. K., Sultan Chand and Sons, Fundamentals of Mathematical Statistics, 2020.
5) Rohatgi V. K., An Introduction to Probability Theory and Mathematical Statistics, Wiley, 2018.
6) Kale, B.K., A First Course on Parametric Inference, S. Chand, New Delhi, 2004.
7) Rohatgi, V. K., An Introduction to Probability Theory and Mathematical Statistics, S. Chand, New Delhi, 2008.
8) Saxena H. C. and Surenderan Statistical Inference, 2011.
9) Rao, C. R., Linear Statistical Inference, S. Chand, New Delhi,2004
10) Casella G. and Berger Robert L. Statistical Inference. 2nd Edition, Duxbury Advanced series, 2002.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: Major (Elective) Practical	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: PRACTICAL PAPER VI (BSP 357) (E-I)

(Practical Batch: 12 Students / Batch)

Course Objectives: Students should …

1) Explain the concepts of Linear Programming Problems and various methods used for obtaining optimal solutions.
2) Describe the concepts and applications of Assignment, Sequencing, CPM and PERT techniques in Operations Research.
3) Explain the basic concepts and procedures of Simple Random Sampling for variables and attributes.
4) Describe the concepts and procedures of Stratified, Systematic and Cluster Sampling Techniques.

Course Outcomes: Students will be …

1) Apply Simplex, Big M, and Duality Methods to solve Linear Programming Problems and determine optimal solutions.
2) Solve Assignment and Sequencing Problems and apply CPM and PERT techniques for effective project planning and management.
3) Apply Simple Random Sampling methods for variables and attributes in appropriate sampling situations.
4) Differentiate among Stratified, Systematic and Cluster Sampling Techniques and select an appropriate sampling method for conducting surveys.

List of Experiments	**Hrs.**
1) L.P.P. by Simplex Method I (Slack variable). 2) L.P.P. by Simplex Method II (Big M method). 3) Transportation Problem I. 4) Transportation Problem II (Degeneracy). 5) Assignment Problem. 6) Sequencing Problem. 7) Construction of CPM and PERT-I 8) Construction of CPM and PERT-II 9) Simple Random Sampling for Variables and Attributes. 10) Determination of Sample Size in SRS for Variables and Attributes. 11) Stratified Random Sampling. 12) Ratio Method of Estimation. 13) Regression Method of Estimation. 14) Systematic Sampling. 15) Cluster Sampling.	60

Reference Books:

1) Gass, S. I. Linear Programming Methods and Applications. 5th Edition. Mineola, New York: Dover Publications, 2011.
2) Taha, H. A. Operations Research: An Introduction. 10th Edition. Pearson Education, 2017.
3) Sharma, J. K. Mathematical Models in Operations Research. 5th Edition. New Delhi: Macmillan India Ltd., 2012.
4) Kapoor, V. K. Operations Research: Concepts, Problems and Solutions. New Delhi: Sultan Chand & Sons, 2012.
5) Shrinath, L. S. Linear Programming: Principles and Applications. New Delhi: Affiliated East-West Press Pvt. Ltd., 1982.
6) Sasieni, M., Yaspan, A., and Friedman, L. Operations Research: Methods and Problems. Literary Licensing, 2013.
7) Cochran, W. G. Sampling Techniques. New Delhi: Wiley Eastern Ltd., 2012.
8) Sukhatme, P. V., and Sukhatme, B. V. Sampling Theory of Surveys with Applications. New Delhi: Indian Society of Agricultural Statistics, 1989.
9) Des Raj. Sampling Theory. S. Chand Publishing, 2017.
10) Mukhopadhyay, Parimal. Theory and Methods of Survey Sampling. New Delhi: Prentice Hall of India Pvt. Ltd., 2003.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: Major (Elective) Practical	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: PRACTICAL PAPER VI (BSP 357) (E-II)

(Practical Batch: 12 Students / Batch)

Course Objectives: Students should …

1) Develop an understanding of linear programming and advanced optimization techniques.
2) Apply operational research methods to solve decision-making and network optimization problems.
3) Understand supervised and unsupervised machine learning techniques using Python.
4) Evaluate machine learning models using appropriate validation and performance measures.

Course Outcomes: Students will be able to…

1) Apply optimization techniques to solve linear programming problems.
2) Analyze operational research problems using appropriate optimization methods.
3) Develop machine learning models for classification using Python.
4) Evaluate and improve the performance of machine learning models using suitable techniques.

List of Experiments	**Hrs.**
1) L.P.P. by simplex method I (Slack variable) 2) L.P.P. by simplex method II (Big M method) 3) Transformation problem-I. 4) Transformation problem-II. (Degeneracy) 5) Assignment problem. 6) Sequencing Problem. 7) Construction of CPM and PERT-I 8) Construction of CPM and PERT-II 9) k-nearest neighbor (KNN) for Classification and Regression 10) Logistic Regression for Classification and Regression 11) Apply Naïve Bayes and Bayesian belief network 12) Decision Tree and Random Forest for Classification and Regression 13) Xgboost Algorithm Classification and Regression 14) Techniques for handling class-imbalanced data 15) Hierarchical clustering and Apriori algorithm for market basket analysis	60

Reference Books:

1) Gass, S. I., Linear Programming Method and Applications, 5th Edn. Dover Publications, 2011.
2) Taha, H. A., Operations Research – An Introduction, 10th Edition, Pearson, 2017.
3) Saceini, M., Yaspan, A. and Friedman, L., Operations Research: Methods and Problems, Literary Licensing, 2013.
4) Sharma J. K., Mathematical Models in Operations Research,5th Edn., MACIN, 2012.
5) Kapoor, V.K., Operation Research: Concepts, Problems and Solutions, Sultan Chand and Sons, New Delhi, 2012.
6) Shrinath, L.S., PERT-CPM Principles and Applications, Affiliated East-West Press Pvt. Ltd., New Delhi, 2001.
7) Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, Elsevier, 3rd Edition,2012
8) T. M. Mitchell, Machine Learning, McGraw-Hill.,1997
9) V. N. Vapnik, The nature of Statistical learning theory, Springer, 2000
10) Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Jonathan Taylor, An Introduction to Statistical Learning, Springer, 2013.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: VSC	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: STATISTICAL DATA ANALYSIS USING PYTHON – I (BSPVSC III)

(Practical Batch: 12 Students / Batch)

Course Objectives: Students should…

1) Understand Python fundamentals, including data types, data structures, control structures, and functions for data analysis.
2) Explain the concept of data wrangling, aggregation, visualization, and statistical modelling problems using libraries like NumPy, Pandas, Seaborn, and Matplotlib.
3) Differentiate between discrete and continuous probability distributions, and evaluate statistical models through fitting and testing.
4) Apply time series analysis, financial market analysis, and hypothesis testing to solve real-world statistical problems using Python.

Course Outcomes: Students will be able to,

1) Recognize basic and advanced data structures, operations on arrays and data frames, and visualization techniques in Python.
2) Perform data preparation, aggregation, plotting problems using Pandas, Matplotlib and Seaborn.
3) Evaluate fitting methods for probability distributions and perform both parametric and non-parametric hypothesis testing.
4) Demonstrate time series forecasting (Exponential Smoothing, ARIMA) and financial market data analysis (Bitcoin, stocks) using Python programming skills.

List of Experiments	**Hrs.**
1) Python - Data Types and Python - Data Structures 2) Python – loops and Python - Functions 3) Working with NumPy Arrays 4) Working with Pandas Data frames and Data Wrangling with Pandas 5) Aggregating Pandas Data frames and Joins of Data Frames in Pandas (inner, outer, left, right, self joins) 6) Visualizing Data with Pandas and Matplotlib 7) Plotting with Seaborn and matplotlib and plotting with Seaborn and matplotlib - 3D plots 8) Time and Date Operations with Python 9) Time Series Analysis – Exponential Smoothing 10) Time Series Analysis – ARIMA model 11) Financial Analysis: Bitcoin and the Stock Market 12) Sketching of the discrete distribution. 13) Sketching of the Continuous distributions 14) Fitting of the Distributions 15) Model Sampling from Distributions Note- All of these practical should be performed using a Python Jupiter Notebook.	60

Reference Books:-

1) Allen B. Downey, Think Python: How to Think Like a Computer Scientist, O'Reilly Media, 2015.
2) Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Python, O'Reilly Media, 2018.
3) Jake VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data – O'Reilly Media, 2016.
4) Stefanie Molin, Hands-On Data Analysis with Pandas: Efficiently Perform Data Collection, Wrangling, Analysis, and Visualization Using Python – Packt Publishing, 2019.
5) Peter Bruce, Andrew Bruce, and Peter Gedeck, Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python, O'Reilly Media, 2020.
6) Bob Mather, Time Series Analysis with Python: How to Analyze Time Series Data and Forecast Trends, Abiprod Pty Ltd, 2019.
7) Cameron Davidson-Pilon, Bayesian Methods for Hackers: Probabilistic Programming and Bayesian Inference, Addison-Wesley Professional, 2015.
8) Peter J. Brockwell and Richard A. Davis, Introduction to Time Series and Forecasting, Springer, 2016.
9) Sandro Tosi, Matplotlib for Python Developers, Packt Publishing, 2009.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: OJT	**Marks:** 100
Credits: 4	**From:** A. Y. 2026-27

Name of the Course & Code: ON JOB TRAINING IN STATISTICS (BSPOJT)

Course Objectives: Students should…

1) Understand advanced statistical techniques and their practical applications.
2) Develop skills in using statistical software for analysing real-world data.
3) Enhance problem-solving, communication and reporting abilities in professional environments.
4) Gain practical exposure to workplace-based statistical projects and data analysis.

Course Outcomes: Students will be able to,

1) Apply advanced statistical methods in professional settings.
2) Use statistical software to analyse real world datasets.
3) Develop problem-solving, communication and reporting skills.
4) Gain practical experience in statistical projects and data analysis.

On Job Training	**Hrs.**
OJT will provide the opportunities for internship with local/regional industries, business organization, health and allied areas, local government, etc. so that students may actively engaged with the employability opportunities. Students will undergo 4 credit work-based learning/OJT/internship. Duration=1 Month	120

Evaluation Pattern:

Total Marks: 100

Internal Evaluation: 40 Marks	**End Semester Exam: 60 Marks**
• Appendix VII: Supervisor Evaluation of intern: 20 Marks • Attendance Diary/ logbook: : 20 Marks	• Viva/ Voce/ Presentation: 20 Marks • Depth of Knowledge and skill acquired: 20 Marks • Report: 20 Marks

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** V
Type: CEP	**Marks: 50**
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: COMMUNITY ENGAGEMENT PROGRAMME (BSPCEP I)

Course Objectives: Students should…

1) To inculcate social responsibility and civic sense among students.
2) To expose students to real-life issues in rural and marginalized communities.
3) To encourage scientific thinking and practical application of knowledge for community betterment.
4) To develop skills in communication, teamwork, and participatory learning

Course Outcomes: Students will be able to…

1) Apply scientific knowledge in real-world problem-solving.
2) Demonstrate skills in organizing and conducting awareness campaigns or surveys.
3) Appreciate the significant contributions of local communities to Indian society and economy.
4) Recognize the socio-economic and environmental issues of local communities.

Module Title	Module Content	Hours
Module 1: Orientation	Introduction to CEP, ethics, community overview, safety, and communication training; concept and importance of community engagement; roles and responsibilities of engaged citizens	15 Hrs
Module 2: Community Study	Village/slum visit, mapping, observation, data collection, household survey, and community interactions.	15 Hrs
Module 3: Scientific Activity	Demonstrations on health, hygiene, water testing, environmental awareness, etc.	30 Hrs
Module 4: Reflection & Report	Field diary writing, group discussions, report preparation, and presentation.	--
Module 5: Viva and Evaluation	Oral examination and final assessment by faculty and external evaluator.	---
Total		**60 Hrs**

Evaluation Pattern:

Total Marks:50

Internal Examination: 20 Marks

- Attendance and Participation: 5 Marks
- Field Diary / Logbook: 10 Marks
- Scientific Activity / Demonstration: 5 Marks

Final Examination (ESE): 30 Marks

- Final Report: 10 Marks
- Presentation: 5 Marks
- Viva Voce: 15 Marks

Bachelor of Science (B.Sc.) Part III

SEMESTER-VI

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** – VI
Type: Major XIII	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: PROBABILITY DISTRIBUTION – II (BST 361)

Course Objectives: Students should…

1) Understand the different modes of convergence and the fundamental limit theorems, including the Weak Law of Large Numbers and the Central Limit Theorem.
2) Understand the concepts of discrete-time Markov chains, transition probability matrices, and the classification of states.
3) Understand and apply fundamental concepts of probability to analyse model and solve real-life problems across various fields.
4) Understand the theoretical properties, moments, and cumulants of the non-central $\chi 2$ distribution.

Course Outcomes: Students will acquire**,**

1) The knowledge of the convergence of random variables and the ability to apply the Central Limit Theorem to solve statistical probability problems.
2) The knowledge of how to construct transition probability matrices, apply Chapman-Kolmogorov equations, and analyse the states of a Markov chain.
3) The knowledge required to formulate and solve difference-differential equations for various continuous-time birth and death processes.
4) The knowledge of how to derive the moment-generating function and apply the reproductive properties of the non-central $\chi 2$ distribution.

Module	Title and Contents	Hrs.
Module -1:	**Convergence and Central Limit Theorem** 1.1 Convergence: Definition of convergence of a sequence of random variables (a) in distribution (b) in probability, almost sure convergence (c) in r^{th} mean. If $X_n \xrightarrow{p} X$ then $g(X_n) \xrightarrow{p} g(X)$ where g is a continuous function without proof. Examples and problems. 1.2 Weak Law of Large Numbers (WLLN): Statement and proof for i.i.d. random variables with finite variance. 1.3 Central limit theorem (CLT): Statement and proof for i.i.d. random variables with finite variance, proof based on m.g.f. 1.4 Examples based on Bernoulli, Binomial, Poisson and Chi-square distribution.	8
Module -2:	**Markov Chain** 2.1 Definition of Stochastic Process, state space, parameter space, types of stochastic processes, first order Markov property, Markov Chains (MC), finite MC, timehomogeneous MC one step transition probabilities and transition probability matrix (TPM).	8

	2.2 Stochastic matrix, Chapman Kolmogorov equation, n step transition probability matrix, n-step TPM of two state M.C. and some typical t. p. m initial distribution, finite dimensional distribution functions, partial sum (functions of independent and identically distributed random variables as Markov chain, illustrations such as random walk, Gambler'srun problem, Ehrenfest chain). 2.3 Communicating states, first return probability, probability of ever return. Classificationof states, as persistent and transient states, irreducible MC.	
Module -3:	**Stochastic Process** 3.1. Definition of stochastic process. 3.2. Postulates and difference differential equations for: i) Pure birth process ii) Poisson process with initially 'a' member, for a =0 and a>0 iii) Yule Furry process iv) Pure death process v) Death process with $\mu_n = \mu$ vi) Death process with $\mu_n = n\mu$ vii)Birth and death process	8
Module -4:	**Non-central χ2 Distribution** 4.1.Non-central χ2 distribution: Definition of Non-central χ2 distribution, Non-central χ2 distribution with Non-centrality Parameter λ. 4.2.Moment generating function of Non-central χ2 distribution. 4.3.Additive or Reproductive Property, Cumulants of Non-central χ2 distribution.	6

Reference Books :-

1) Cramer, H. Mathematical Methods of Statistics. Mumbai: Asia Publishing House, 2005.
2) Lindgren, B. W. Statistical Theory. 3rd ed. New York: Macmillan Publishing Co. Inc., 2017.
3) Hogg, R. V., and A. T. Craig. Introduction to Mathematical Statistics. 3rd ed. New York: Macmillan Publishing Company, 2009.
4) Arora, Sanjay, and Bansi Lal. New Mathematical Statistics. 1st ed. New Delhi: Satya Prakashan, 1989.
5) Gupta, S. C., and V. K. Kapoor. Fundamentals of Mathematical Statistics. New Delhi: Sultan Chand and Sons, 2000.
6) Rohatgi, V. K. An Introduction to Probability Theory and Mathematical Statistics. Wiley, 2008.
7) Medhi, J. Stochastic Processes. New Delhi: Wiley Eastern Ltd., 2009.
8) Feller, W. An Introduction to Probability Theory and Its Applications. Wiley Eastern, 2002.
9) Bhat, B. R. Modern Probability Theory. New Delhi: Sultan Chand and Sons, 1997.
10) Bhat, B. R. Stochastic Models: Analysis and Applications. New Age International, 2003.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** – VI
Type: Major XIV	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: STATISTICAL INFERENCE - II (BST 362)

Course Objectives: Students should ,

1) Understand the concepts of parametric and non-parametric hypothesis testing.
2) Apply statistical tests for decision-making using appropriate testing procedures.
3) Analyze the performance of statistical tests using error probabilities and power.
4) Select suitable statistical tests for practical data analysis.

Course Outcomes: Students will be able to,

1) Explain the concepts of hypothesis testing and construct MP and UMP tests.
2) Apply Likelihood Ratio Tests for testing population parameters.
3) Implement Sequential Probability Ratio Tests for statistical decision-making.
4) Interpret appropriate non-parametric tests for data analysis.

Module	Title and Contents	Hrs.
Module -1:	**Parametric Tests** 1.1. Statistical hypothesis, problems of testing of hypothesis, definitions and illustrations of (i) simple hypothesis (ii) composite hypothesis, critical region, type I and type II error, probabilities of type I & type II errors. Power of a test, p-value, size of a test, level of significance, problem of controlling probabilities of type I & type II errors. 1.2. Definition of Most Powerful (MP) test. Statement and proof (sufficient part) of the Neyman-Pearson (NP) lemma for simple null hypothesis against a simple alternative hypothesis for the construction of MP test. 1.3. Examples of the construction of the MP test of the level $\propto$. 1.4. Power function of a test, power curve, definition of uniformly most powerful (UMP) level $\propto$ test. Use of NP lemma for constructing UMP level α test for a one-sided alternative. Illustrative examples. 1.5. UMP tests for two-sided alternatives examples, their existence and nonexistence.	10
Module -2:	**Likelihood Ratio Test** 2.1. Notion of likelihood ratio test (LRT), $\Lambda(x) = \text{Sup } L(\theta_0 \mid x) / \text{Sup } L(\theta \mid x)$ 2.2. Construction of LRT for $H_0: \theta = \theta_0$ against $H_1: \theta \neq \theta_0$ for the mean of normal distribution for: i) Known σ^2 ii) unknown σ^2 (one-sided and two-sided alternatives). 2.3. LRT for variance of normal distribution for i) known μ ii) unknown μ (one-sided and two-sided alternative hypotheses).	6
Module -3:	**Sequential Tests** 3.1. General theory of sequential analysis and its comparison with fixed sample procedure.	6

	3.2. Wald's SPRT of strength ($\propto$, β), for a simple null hypothesis against a simple alternative hypothesis. 3.3. Illustrations for standard distributions like binomial, Poisson, exponential and normal, Graphical and tabular procedure for carrying out the test. 3.4. Illustrative examples.	
Module -4:	**Non- parametric Test** 4.1. Notion of non-parametric statistical inference (test) and its comparison with parametric Statistical inference. Concept of distribution free statistic. 4.2. Test procedure of: i) Run test for one sample (i.e. test for randomness) and run test for two independent sample problems. ii) Sign test for one sample and two sample paired observations iii) Wilcoxon's signed rank test for one sample and two sample paired observations. iv) Mann-Whitney U -test (two independent samples) v) Median test vi) Empirical distribution function Sn(x). Properties of Sn(x) as estimator of F(.) Kolmogorov Smirnov test for one and for two independent samples. Comparison with chi-square test.	8

Reference Books :-

1) Kale, B. K., A First Course on Parametric Inference, S. Chand & Company Ltd., New Delhi, 2004.
2) Rohatgi, V. K., Statistical Inference, Sultan Chand and Sons,2001
3) Rohatgi, V. K., An Introduction to Probability Theory and Mathematical Statistics, S. Chand & Company Ltd., New Delhi, 2008.
4) Saxena, H. C., & Surenderan, Statistical Inference, S. Chand & Company Ltd., 2011.
5) Kendall, M. G., & Stuart, A., The Advanced Theory of Statistics (Vol. 2), Charles Griffin & Company Ltd., London, 1977.
6) Lindgren, B. W., Statistical Theory (4th ed.), Chapman & Hall/CRC, 2000.
7) Casella, G., & Berger, R. L., Statistical Inference (2nd ed.), Duxbury Press, 2002.
8) Gibbons, J. D., & Chakraborti, S., Nonparametric Statistical Inference (5th ed.), Chapman & Hall/CRC, 2011.
9) Daniel, W. W., Applied Nonparametric Statistics (2nd ed.), PWS-Kent Publishing Company, 1990.
10) Siegel, S., & Castellan, N. J. Jr., Nonparametric Statistics for the Behavioral Sciences (2nd ed.), McGraw-Hill, 1988.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** – VI
Type: Major XV	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: DESIGN OF EXPERIMENTS (BST 363)

Course Objectives: Students should,

1) Understand the basic principles and terminology of experimental design including randomization, replication and local control
2) Identify appropriate experimental designs for different research problems in agriculture, biology, industry and social sciences
3) Apply statistical methods to plan, conduct and analyze Completely Randomized Design, Randomized Block Design and Latin Square Design using experiments ANOVA techniques
4) Learn factorial experiments and understand main effects, interaction effects and confounding.

Course Outcomes: Students will be able to,

1) Explain the need and scope of Design of Experiment and state its fundamental principles.
2) Perform ANOVA for CRD, RBD, and LSD and interpret F-test results for treatment comparisons.
3) Set up and analyze 2^2, 2^3, factorial experiments and understand interaction effects
4) Develop critical thinking to evaluate experimental errors and improve precision of experiments.

Module	Title and Contents	Hrs.
Module -1:	**Completely Randomized Design (CRD),** 1.1. Basic Concepts: i. Basic terms in design of experiments: Experimental Module, treatment, layout of an experiment. ii. Basic principles of design of experiments: Replication, randomization and local control. iii. Choice of size and shape of a plot for uniformity trials, the empirical formula for the variance per Module area of plots. iv Concept and definition of efficiency of a design. 1.2. Completely Randomized Design (CRD), Application of the principles of design of experiments in CRD, layout, model, assumptions and interpretations: 1.3. Estimation of parameters, expected values of mean sum of squares, components of variance. Breakup of total sum of squares in to components. 1.4. Technique of one-way analysis of variance (ANOVA) and its applications to CRD, Testing for equality of treatment effects, and its interpretation. F-test for testing H_0, test for equality of two specified treatment effects.	8

Module -2:	**Randomized Block Design (RBD)** 2.1. Application of the principles of design of experiments in RBD, layout, model, assumptions, and interpretations. 2.2. Estimation of parameters, expected values of mean sum of squares, and components of variance. Breakup of a total sum of squares into components. 2.3. Technique of two-way analysis of variance (ANOVA) and its applications to RBD. Tests and their interpretations, test for equality of two specified treatment effects, comparison of treatment effects using critical difference (C.D.). 2.4. Missing plot technique. Analysis of RBD with a single missing observation. Efficiency of RBD over CRD.	8
Module -3:	**LSD and ANOCOVA** 3.1. Latin Square Design (LSD) i. Application of the principles of design of experiments in LSD, layout, model, assumptions, and interpretations: Breakup of total sum squares into components. ii. Estimation of parameters, expected values of mean sum of squares, components of variance. preparation of analysis of variance (ANOVA) table. iii. Tests and their interpretations, test for equality of two specified treatment effects, comparison of treatment effects using critical difference (C.D.). iv. Analysis of LSD with a single missing observation. v. Efficiency of LSD over CRD and LSD over RBD. 3.2 Analysis of Covariance (ANOCOVA) with one concomitant variable i. Purpose of analysis of covariance. ii. Practical situations where analysis of covariance is applicable. iii. Model for analysis of covariance in CRD and RBD. Estimation of parameters (derivations are not expected). iv. Preparation of analysis of covariance (ANOCOVA) table, test for $\beta = 0$, test for equality of treatment effects (computational technique only). Note:- For given data, irrespective of the outcome of the test of regression coefficient (β), ANOCOVA should be carried out.	8
Module -4:	**Factorial Design** 4.1. General description of factorial experiments, 2^2 and 2^3 factorial experiments arranged in RBD. Definition of main effects and interaction effects in 2^2 and 2^3 factorial experiments. 4.2. Model, assumptions, and their interpretation. Preparation of ANOVA table using Yate's procedure, test for main effects and interaction effects. 4.3. General idea and purpose of confounding in factorial experiments. Total confounding (Confounding only one interaction) : ANOVA table, testing main effects and interaction effects. 4.4. Partial Confounding (Confounding only one interaction per replicate): ANOVA table, testing main effects and interaction effects. Construction of layout in total confounding and partial confounding in 2^3 factorial experiments.	6

Reference Books :-

1) Federer, W. T. Experimental design: Theory and application. Oxford & IBH Publishing Co. 1955.
2) Cochran, W. G., & Cox, G. M. . Experimental designs (2nd ed.). John Wiley & Sons. 1957
3) Montgomery, D. C. Design and analysis of experiments (10th ed.). John Wiley & Sons. 2021
4) Das, M. N., & Giri, N. C. Design and analysis of experiments (2nd ed.). Wiley Eastern Ltd.1986.
5) Goulden, C. H.. Methods of statistical analysis (2nd ed.). Asia Publishing House. 1952
6) Kempthorne, O.. The design and analysis of experiments. John Wiley & Sons. 1952
7) Snedecor, G. W., & Cochran, W. G.. Statistical methods (8th ed.). Iowa State University Press / Affiliated East-West Press. 1989
8) Goon, A. M., Gupta, M. K., & Dasgupta, B.. Fundamentals of statistics (Vols. 1-2, 8th ed.). The World Press. 2005
9) Gupta, S. C., & Kapoor, V. K. . Fundamentals of applied statistics (4th ed.). S. Chand & Sons. 2020.
10) Wu, C. F. J., & Hamada, M.. Experiments: Planning, analysis, and parameter design optimization (2nd ed.). John Wiley & Sons. 2009

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** –VI
Type: Major XVI (Elective)	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: INDUSTRIAL STATISTICS (BST 364)

Course Objectives: Students should be able to,

1) Understand different statistical techniques in Statistical Quality Control which involves the techniques for maintaining and improving the quality of product.
2) Explain quality tools and statistical charts, solve problems related to sampling plans and compute relevant industrial statistics.
3) Differentiate between various quality control techniques, obtain control limits evaluate process capability; Identify sources of process variation.
4) Apply statistical tools in real industrial scenarios, demonstrate process improvement methods, formulate quality improvement strategies using Six Sigma and Lean methodologies.

Course Outcomes: Students should be able to,

1) Gain proficiency in the concepts of quality, process control, sampling inspection, and Six Sigma methodology in industrial contexts.
2) Apply the techniques and approaches of Statistical Quality Control used in industry to achieve high-quality production and cost-effective manufacturing.
3) Brief idea about the various sampling plans to assure the quality of the product.
4) Apply quality improvement cycles such as PDCA and DMAIC; Demonstrate the use of statistical tools in industrial settings; Formulate data-driven strategies for process and product optimization.

Module	Title and Contents	Hrs.
Module -1:	**Quality and Quality Tools** 1.1 Meaning and Dimensions of Quality 1.2 Quality philosophy 1.3 Magnificent tools of quality (Seven Basic Quality Tools) 1.4 Deming's PDCA cycle for continuous improvement 1.5 Case Study based on Quality Tools and PDCA	8
Module -2:	**Process Control** 2.1: Introduction to Variable control charts: X-bar & R-chart, X-bar & s-chart. 2.2: Introduction to attribute control charts: np-chart, p-chart, c-chart and u-chart 2.3: CUSUM chart and its use 2.4: Moving Average (MA) charts. 2.5. Exponentially Weighted Moving Average (EWMA) charts	8
Module -3:	**Product Control** 3.1. Acceptance sampling plan: Principle of acceptance sampling plans. 3.2. Single sampling plan, 3.3. Double sampling plan 3.4. Concept of OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation. 3.5. Case Study on OC, AQL, LTPD, AOQ, AOQL, ASN, ATI	8

Module -4:	**Lean and Six Sigma** 4.1. Overview of Lean and Six Sigma principles 4.2. Methodologies: SCORE, DMAIC 4.3. Six Sigma roles and responsibilities 4.4. Tools used in Define, Measure, Analyze, Improve, Control phases 4.5. Elimination of waste in Lean Six Sigma	6

Reference Books:-

1) Mood, A. M., Graybill, F. A., & Boes, D. C. Introduction to the Theory of Statistics, 3rd ed. McGraw-Hill Education, 2005.
2) Montgomery, D. C. Introduction to Statistical Quality Control, 8th ed. Wiley, 2020.
3) Duncan, A. J. Quality Control and Industrial Statistics, 5th ed. Irwin, 1986.
4) Grant, E. L., & Leavenworth, R. S. Statistical Quality Control, 7th ed. McGraw-Hill, 1996.
5) Juran, J. M., & Godfrey, A. B. Juran's Quality Handbook, 5th ed. McGraw-Hill, 1999.
6) Mitra, A. Fundamentals of Quality Control and Improvement, 3rd ed. Wiley, 2012.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** – VI
Type: Major XVI (Elective)	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course & Code: MEDICAL STATISTICS AND CLINICAL TRIALS (BST 365)

Course Objectives: Students should…

1) Understand the concepts of population studies and demographic measures.
2) Develop knowledge of epidemiological methods for health data analysis.
3) Understand the principles and statistical methods used in clinical trials.
4) Apply appropriate clinical trial designs in biomedical and pharmaceutical research.

Course Outcomes: Students will be able to…

1) Analyze population and demographic data using appropriate statistical measures.
2) Apply epidemiological techniques to assess disease occurrence and risk factors.
3) Explain the design, conduct, and statistical analysis of clinical trials.
4) Evaluate different clinical trial designs for evidence-based medical research.

Module	Title and Contents	Hrs.
Module -1:	**Population Study** 1.1 India's population and census. 1.2 Population growth and models for population growth. 1.3 Birth and death rates.	8
Module -2:	**Epidemiology** 2.1. Introduction to Epidemiology 2.2. Odds ratio: Properties, inference for odds ratios and log odds ratios. Relationship between odds ratio and relative risk. 2.3. Estimation of odds ratio, Confidence interval for OR. Relation 2.4. Symmetry in square contingency tables, collapsing tables and Simpson's paradox.	8
Module -3:	**Clinical Trials** 3.1. General information on the history of drug discovery, including Louis Pasteur (rabies and small pox), Ronald Ross and malaria, Alexander Fleming and penicillin, Jonas Salk and polio, cholera, asthma, diabetes, blood pressure, heart attack, and arthritis. 3.2. Phases of clinical trial, purpose, duration, cost, drug regulatory bodies, ICH, statistical analysis plan, clinical study report.	8
Module -4:	**Design of Clinical Trials** 4.1. Phases of clinical trial, purpose, duration, cost, drug regulatory bodies, ICH, statistical analysis plan, clinical study report. 4.2. Parallel designs, case control studies, longitudinal studies, safety studies 4.3. Treatments, 2-period cross over design. 4.4. Bioequivalence and bio-availability, non-inferiority trial	6

	4.5. Practice-based medical research, evidence-based medicine	

Reference Books:-

1) Gore A. P. and Paranjape S. A., Course on Mathematical and Statistical Ecology, Kluwer Publishing Holland, 2000.
2) Kulkarni M.B. and Prayag V. R., Introduction to Statistical Ecology, SIPF Academy, Nasik, 2004.
3) Matthews J.N.S., Introduction to Randomized Controlled clinical Trials, Chapman and Hall, 2006.
4) Stephen S., Statistical Issues in drug Development, John Wiley, 2000.
5) Steven D., Clinical Trials – A methodological perspective, John Wiley, 2000.
6) FriedmonL.M., ForbesC.D., DeMets D.L., Fundamentals of Clinical Trials, Spinner, 2015.
7) Selvin, S., Statistical analysis of epidemiologic data. Oxford University Press, 2004.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• CCE - I: 10 Marks: Activity • CCE - II: 10 Marks: Activity • CCE - III: 10 Marks: MCQ Test (The Best of two will be considered for the final mark entry)	• Question -1: Solve the following questions. (Five questions of 2 Marks) • Question -2: Attempt any two questions. (Three questions of 10 marks) • Question -3: Attempt any four questions. (Six questions of 5 marks) (50 Marks converted to 30 marks)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** – VI
Type: Major Practical	**Marks: 50**
Credits:2	**From:** A. Y. 2026-27

Name of the Course & Code: PRACTICAL PAPER VII (BSP 366)

(Practical Batch: 12 Students / Batch)

Course Objectives: The students should…

1) Develop practical skills in simulating and fitting probability distributions using R software.
2) Apply computational techniques for modelling probability distributions and stochastic processes.
3) Implement parametric hypothesis testing procedures using appropriate statistical methods.
4) Perform non-parametric statistical tests and interpret the results for practical data analysis.

Course Outcomes: The students will be able to…

1) Simulate random samples and fit standard probability distributions using R software.
2) Analyze stochastic models and classify transition probability matrices using computational tools.
3) Construct and perform MP, UMP, LRT and SPRT for statistical hypothesis testing.
4) Apply and interpret non-parametric tests, including Run, Sign, Wilcoxon, Mann–Whitney, Median and Kolmogorov–Smirnov tests.

List of Experiments	**Hrs.**
1) Model sampling from Log-normal using R-Software. 2) Model sampling Weibull and Logistic distribution distributions using R-Software. 3) Model sampling from a truncated Binomial and truncated Poisson using R-Software. 4) Model sampling from truncated Normal and truncated Exponential using R-Software. 5) Fitting of Laplace and Log-normal distribution using R-Software. 6) Fitting of Lognormal distribution using R-Software. 7) Classification of TPM, States and computation of higher transition probabilities. 8) Construction of MP test for Discrete distribution & continuous distribution 9) Construction of UMP test for Discrete distribution & continuous distribution. 10) Construction of LRT test for Continuous distribution. 11) Construction of SPRT test for Discrete distribution & continuous distribution. 12) NP test -Run test (for one sample & for two independent samples). 13) NP test – Sign test and Wilcoxon's signed rank test (for one and two samples paired observation). 14) NP test – Mann-Whitney U-test (for two independent samples). 15) NP test – Median test (for two large independent samples) and Kolmogorov – Smirnov test (for one and two independent samples).	60

Reference Books:-

1) Verma, A. K., R Programming, Cengage India, New Delhi, 2017.
2) Shinde, P. P., Desai, V. P., Oza, K. S., & Kamat, R. K., Programming in R with Applications in Machine Learning and Data Analytics, Viva Books, New Delhi, 2023.
3) Rakshit, S., R for Beginners, McGraw Hill Education, New Delhi, 2017.
4) Cramér, H., Mathematical Methods of Statistics, Asia Publishing House, Mumbai, 2005.
5) Gupta, S. C., & Kapoor, V. K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons,

New Delhi, 2020.
6) Casella, G., & Berger, R. L., Statistical Inference (2nd ed.), Duxbury Press, 2002.
7) Gibbons, J. D., & Chakraborti, S., Nonparametric Statistical Inference (5th ed.), Chapman & Hall/CRC, 2011.
8) Daniel, W. W., Applied Nonparametric Statistics (2nd ed.), PWS-Kent Publishing Company, 1990.
9) Siegel, S., & Castellan, N. J., Jr., Nonparametric Statistics for the Behavioral Sciences (2nd ed.), McGraw-Hill, 1988.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** – VI
Type: Major Practical	**Marks: 50**
Credits:2	**From:** A. Y. 2026-27

Name of the Course & Code: PRACTICAL PAPER VIII (BSP 367) E-I

(Practical Batch: 12 Students / Batch)

Course Objectives: The students should…

1) Understand and learn the practical implementation of statistical quality control and industrial data analysis techniques such as control charts, sampling plans, and process capability indices.
2) Differentiate among quality tools; obtain process parameters; evaluate outcomes of statistical tests; identify variations and improvement areas in industrial processes.
3) Understand the importance of experimental design.
4) Differentiate between CRD, RBD, and LSD. Calculate factor levels that optimize the outcome of an experiment.

Course Outcomes: The students will be able to…

1) Explain various quality control tools and charts; solve statistical problems related to industrial processes.
2) Apply quality improvement cycles such as PDCA and DMAIC; demonstrate the use of statistical tools in industrial settings; formulate data-driven strategies for process and product optimization
3) Analyze experimental data using statistical techniques such as ANOVA for Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD).
4) Interpret the results of experimental analyses and prepare technical reports with appropriate statistical inferences and recommendations.

List of Experiments	**Hrs.**
1) Analysis of CRD and RBD. 2) Analysis of Latin Square Design (LSD). 3) Missing Plot Technique for RBD and LSD with one missing observation. 4) Efficiency of RBD over CRD. 5) Efficiency of LSD over CRD and RBD. 6) Analysis of Covariance in CRD and RBD 7) Analysis of 2^2 and 2^3 Factorial Experiment 8) Total Confounding and Partial Confounding 9) Construction and Analysis of EWMA Chart and CUSUM Chart 10) Construction and Analysis of 11) Estimation of Six Sigma Control Limits for Process Mean 12) Design and Evaluation of Single Sampling Plan – I (Small Sample and Large Sample) 13) Design and Evaluation of Double Sampling Plan – I (Small Sample and Large Sample) 14) Preparation and Interpretation of Fishbone (Cause and Effect) Diagram	60

15) Construction and Analysis of Moving Average Control Chart.

Reference Books:-

1) Federer, W. T. Experimental design: Theory and application. Oxford & IBH Publishing Co. 1955.
2) Cochran, W. G., & Cox, G. M. . Experimental designs (2nd ed.). John Wiley & Sons. 1957
3) Montgomery, D. C.. Design and analysis of experiments (10th ed.). John Wiley & Sons. 2021
4) Das, M. N., & Giri, N. C.. Design and analysis of experiments (2nd ed.). Wiley Eastern Ltd.1986.
5) Goulden, C. H.. Methods of statistical analysis (2nd ed.). Asia Publishing House. 1952
6) Han, J., Kamber, M., & Pei, J. Data Mining: Concepts and Techniques (3rd ed.). Morgan Kaufmann, 2011.
7) Dunham, M. H. Data Mining: Introductory and Advanced Topics. Pearson Education, 2006.
8) Zhao, Y. Data Mining Applications with R. Elsevier, 2012.
9) Juran, J. M., & Godfrey, A. B. Juran's Quality Handbook (5th ed.). McGraw-Hill, 1999.
10) Mitra, A. Fundamentals of Quality Control and Improvement (3rd ed.). Wiley, 2012.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** – VI
Type: DSE Practical	**Marks:** 50
Credits:2	**From:** A. Y. 2025-26

Name of the Course & Code: PRACTICAL PAPER VII (BSP 367) E-II

(Practical Batch: 12 Students / Batch)

Course Objectives: Students should…

1) Apply the principles of randomization, replication, and local control in agricultural, industrial, and scientific experiments
2) Perform the analysis of various experimental designs, including Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) and Factorial Experiments
3) Understand population trends, census data, and models used to describe population growth in India.
4) Compute odds ratios, relative risk, and their confidence intervals.

Course Outcomes: Students will be able to…

1) Perform Analysis of Variance (ANOVA) and interpret experimental results to identify significant treatment effects
2) Prepare technical reports and effectively communicate experimental findings for agricultural, industrial, and research applications.
3) Describe the concepts of population growth, birth and death rates, and census data, and explain their significance in demographic studies.
4) Apply statistical methods to calculate odds ratios and evaluate their significance in epidemiological studies.

List of Experiments	**Hrs.**
1) Analysis of CRD and RBD. 2) Analysis of Latin Square Design (LSD). 3) Missing Plot Technique for RBD and LSD with one missing observation. 4) Efficiency of RBD over CRD. 5) Efficiency of LSD over CRD and RBD. 6) Analysis of Covariance in CRD and RBD 7) Analysis of 22 and 23 Factorial Experiment 8) Total Confounding and Partial Confounding 9) Modeling Population Growth Using Exponential and Logistic Models 10) Computation and Comparison of Birth and Death Rates, Odds Ratio and Relative Risk from 2×2 Contingency Tables 11) Calculation of Estimation and Interpretation of Confidence Intervals for Odds Ratios 12) Demonstration of Simpson's Paradox and Collapsing Contingency Tables 13) Timeline and Key Contributions in the History of Drug Discovery 14) Preparation of a Sample Clinical Trial Protocol. 15) Designing a 2-Period Crossover Study and Simulated Data Analysis	

Reference Books:-

1) Federer, W. T. Experimental design: Theory and application. Oxford & IBH Publishing Co. 1955.
2) Cochran, W. G., & Cox, G. M. . Experimental designs (2nd ed.). John Wiley & Sons. 1957
3) Montgomery, D. C.. Design and analysis of experiments (10th ed.). John Wiley & Sons. 2021
4) Das, M. N., & Giri, N. C.. Design and analysis of experiments (2nd ed.). Wiley Eastern Ltd.1986.
5) Goulden, C. H.. Methods of statistical analysis (2nd ed.). Asia Publishing House. 1952
6) Matthews J.N.S. (2006). Introduction to Randomized Controlled clinical Trials, Chapman and Hall
7) Stephen S.(2000). Statistical Issues in drug Development, John Wiley.
8) Steven D. (2000). Clinical Trials – A methodological perspective, John Wiley.
9) Friedmon L.M., Forbes C.D., DeMets D.L. (2015). Fundamentals of Clinical Trials, Spinner.
10) Selvin, S., (2004). Statistical analysis of epidemiologic data. Oxford University Press.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester:** VI
Type: VSC	**Marks:** 50
Credits: 2	**From:** A. Y. 2026-27

Name of the Course& Code: STATISTICAL DATA ANALYSIS USING PYTHON – II (BSPVSC IV)

(Practical Batch: 12 Students / Batch)

Course Objectives: Students should…

1) Understand one-sample, two-sample, and multi-sample parametric and non-parametric test.
2) Implement different sampling methods and estimate the appropriate sample size.
3) Design and analyze basic experimental designs such as CRD, RBD and LSD.
4) Perform regression and classification tasks.

Course Outcomes: Students will be able to…

1) Apply regression and classification techniques to analyze and interpret data
2) Implement hierarchical and non-hierarchical clustering methods.
3) Apply association rule mining to find interesting relationships in data sets.
4) Demonstrate proficiency in Python coding for practical problem-solving.

List of Experiments	**Hrs.**
1) One-sample parametric and non-parametric tests and Two-sample parametric and non-parametric tests 2) Multi-sampling parametric and non-parametric test 3) Sampling Methods - I and Sampling Methods – II 4) Sample Size Estimation 5) Completely Randomized Design 6) Randomized Complete Block Design 7) Latin Square Design 8) Randomized Complete Block Design with missing values 9) Linear programming problems 10) Regression Using KNN and Classification Using KNN 11) Multiple Linear Regression 12) Logistic regression 13) Regression Using Decision Tree and Classification Using Decision Tree 14) Hierarchical Clustering and Non-hierarchical Clustering 15) Association Rule Mining Note- All of these practical should be performed using a Python Jupyter Notebook.	60

Reference Books:-

1) McKinney, Wes. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. 3rd ed. Sebastopol, CA: O'Reilly Media, 2022.
2) VanderPlas, Jake. Python Data Science Handbook: Essential Tools for Working with Data. Sebastopol, CA: O'Reilly Media, 2016.
3) Raschka, Sebastian, and Vahid Mirjalili. Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2. 3rd ed. Birmingham, UK: Packt Publishing, 2019.
4) Geron, Aurélien. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. 3rd ed. Sebastopol, CA: O'Reilly Media, 2022.
5) Grus, Joel. Data Science from Scratch: First Principles with Python. 2nd ed. Sebastopol, CA: O'Reilly Media, 2019.
6) Zhao, Yuxing, and Shuai Ma. Mastering Machine Learning with scikit-learn: Learn Advanced Techniques and Algorithms for Machine Learning with scikit-learn, 2nd Edition. Birmingham, UK: Packt Publishing, 2017.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)

Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Statistics

Programme: B.Sc.	**Semester** – VI
Type: SEC	**Marks: 50**
Credits:2	**From:** A. Y. 2026-27

Name of the Course & Code: PRACTICAL APPROACH TO RELATIONAL DATABASES USING MYSQL WORKBENCH (BSPSEC III)

(Practical Batch: 12 Students / Batch)

Course Objectives: Students should …

1) Provide a strong foundation in relational database concepts and MySQL environment, enabling students to work with MySQL tools effectively.
2) Enable students to design, create, and manipulate databases using SQL commands (CREATE, INSERT, UPDATE, DELETE).
3) Develop advanced query skills, including the use of JOINs, subqueries, and views for solving complex data problems.
4) Solve complex data retrieval tasks using JOINs, subqueries, and views, for example, generating reports from multiple tables in an enterprise system.

Course Outcomes: Students will be able to…

1) Develop proficiency in the fundamental concepts of relational databases and the MySQL environment.
2) Apply built-in MySQL functions, including string, mathematical, date, comparison, and aggregate functions in queries.
3) Develop and implement advanced SQL queries using subqueries, aggregate functions, and views for real-world applications.
4) Demonstrate proficiency in using MySQL for real-world problem solving in academic and business contexts.

List of Experiments	**Hrs.**
1) Installation and setup of MySQL Server and MySQL Workbench 2) Creating database and tables 3) Inserting records using INSERT statement 4) Retrieving data using SELECT statement 5) Using WHERE clause with comparison operators 6) Using WHERE clause with arithmetic operators 7) Using logical operators (AND, OR, NOT) 8) Pattern matching using LIKE operator 9) Using BETWEEN and IN operators 10) Sorting and limiting data using ORDER BY and LIMIT 11) Updating records using UPDATE statement 12) Deleting records and tables using DELETE and DROP 13) Modifying tables using ALTER, RENAME, and TRUNCATE 14) Using functions a. String functions b. Mathematical functions c. Date functions d. Comparison functions 15) Using aggregate functions, GROUP BY, HAVING, JOINS, and Views	60

Reference Books:-

1) Silberschatz, A., Korth, H. F., Sudarshan, S., Database System Concepts, McGraw-Hill Education, 7th Edition, 2020.
2) Groff, J. R., Weinberg, P. N., Oppel, A. J., SQL: The Complete Reference, McGraw-Hill Education, 3rd Edition, 2009.
3) Bagaria, G., MySQL For Beginners, Self-published, 2018
4) Patni, J. C., A Comprehensive Study of SQL: Practice and Implementation, CRC Press, 2023.
5) Ben-Gan, I., T-SQL Fundamentals, 4th Edition, Microsoft Press, 2023.
6) Saini, N., SQL Quest: A Journey Through Data, Self-published, 2023.
7) Ghosh, S., Fundamentals of SQL, IP Innovative Publication, 2019
8) Faroult, S., Robson, P., The Art of SQL, O'Reilly Media, 1st Edition, 2006.
9) Celko, J., SQL for Smarties: Advanced SQL Programming, Morgan Kaufmann Publishers, 5th Edition, 2015.
10) Winand, M., SQL Performance Explained, Self-published, 3rd Edition, 2023.

Evaluation Pattern:

Total Marks: 50

Continuous Comprehensive Evaluation (20 Marks):	**End Semester Examination (30 Marks):**
• Journal: 10 Marks • Students' Performance: 05 Marks • Viva: 05 Marks	• Section I: Attempt any TWO questions. (10 marks each) • Section II: Attempt any TWO questions. (05 marks each)