Academic Council Meeting No. and Date: 10 / April 26,2025
Agenda Number: 03 **Resolution Number: 46,47 / 3.5, 4.0**

Vidya Prasarak Mandal's

B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme: Bachelor of Science

Specific Programme: STATISTICS

[T. Y. B. Sc. Statistics]

Level 5.5

CHOICE BASED GRADING SYSTEM

Revised under NEP

From the Academic Year 2025-26

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Preamble

The B.Sc. Statistics Programme is aimed to develop theoretical and analytical skills of the students so that they may be absorbed in the corporate world or able to pursue higher studies at the Master level in Statistics. The main objectives of the course are:

- To get introduced to some statistical concepts that are relevant in the interpretation of measurements made on individuals, and in the interpretation of statistical study materials.
- To apply their knowledge and skills to be employed and excel in Statistics professional careers and/or to continue their education in Statistics and/or related postgraduate programs.
- To get Knowledge and understanding of basic statistical methods such as sampling and collecting data, probability, distributions, Regression Analysis.
- To gain Knowledge and understanding to confidently read statistics and apply statistical methods within their working environment.
- To be capable of managing Statistics projects with consideration of the human, financial and environmental factors.
- To work effectively as a part of a team to achieve a common stated goal.
- To communicate effectively with the arrangement of audiences both technical and non-technical.
- To develop an aptitude to engage in continuing professional development.

The syllabus is aimed to achieve these above objectives. The students will be ready for the jobs available in different fields like:

- Statistician
- Analyst
- Biostatistician
- Actuaries
- Banking sector
- Machine Learning and Artificial Intelligence
- Data Analytics
- Academics
- Government organizations like NSSO, NSO, ISS, SSC etc. and many others.

PROGRAMME OUTCOMES (POs) OF BACHELOR OF SCIENCE (B.Sc.)

The Undergraduate Programs of Science are intended to cater quality education and attain holistic development of learners through the following Programme outcomes:

PO1 - Disciplinary Knowledge

Lay a strong foundation of conceptual learning in science. Instil ability to apply science in professional, social and personal life.

PO2 - Inculcation of Research Aptitude

Ignite spirit of inquiry, critical thinking, analytical skills and problem-solving approach which will

help learners to grasp concepts related to research methodology and execute budding research ideas.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for curricular, co-curricular and extracurricular learning processes.

PO4 - Sensitization towards Environment

Build a cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Teamwork

Encourage learners to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 - Social and Ethical Awareness

Foster ethical principles which will help in developing rational thinking and becoming socially aware citizens. Build an attitude of unbiased, truthful actions and avoid unethical behavior in all aspects of life.

Eligibility: Cleared S. Y. B. Sc. with a Statistics (Major) from any recognized/ Affiliated University can adopt for T. Y. B. Sc. with the Statistics (Major) subject.

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Duration: 1 year (Including Semester V & VI)

Total Credits for the Program: 44

Starting year of implementation: 2025-26

Mode of Conduct: Offline

Discipline/Subject: Statistics

Programme Specific Outcomes:

By the end of the Programme, Learner enhances knowledge of Statistical tools, able to

1. Apply fundamental concepts of descriptive statistics, statistical methods, probability distributions, sampling theory, ANOVA, DOE, estimation theory, hypothesis testing, and reliability analysis to analyze, interpret, and solve real-world problems across diverse domains. L3
2. Demonstrate proficiency in using Excel, Tableau, Python, and SQL for data handling, cleaning, visualization, analysis, and reporting, enabling them to work effectively in data-driven environments. L2

3. Design and implement statistical models, including probability-based models, stochastic processes, regression techniques, and other inferential procedures to derive meaningful insights from data. L6
4. Apply Operations Research techniques, including linear programming, simplex method, inventory, transportation and assignment problems, and simulation models to optimize decision-making in business, industry, and management applications. L3
5. Build and evaluate basic machine learning models using Python, integrate statistical algorithms with computational approaches, and use programming skills to automate analysis and solve complex data problems. L6
6. Apply statistical techniques to vital statistics, demographic measures, public health data, life tables, and population studies, ensuring accurate interpretation and planning for social, health, and administrative applications. L3

Specific Programme:

Semester V

T.Y.B.Sc. (Statistics) (Major) Credits: 12
T.Y.B.Sc. (Statistics) (Major DSE) Credits: 04
T.Y.B.Sc. (Statistics) (Minor) Credits: 02
T.Y.B.Sc (Statistics) (SEC) Credits: 02
T.Y.B.Sc (Statistics) (On job Training) Credits: 02

Semester VI

T.Y.B.Sc. (Statistics) (Major) Credits: 12
T.Y.B.Sc. (Statistics) (IKS) Credits: 02
T.Y.B.Sc. (Statistics) (Major DSE) Credits: 04
T.Y.B.Sc. (Statistics) (SEC) Credits: 02
T.Y.B.Sc. (Statistics) (On job Training) Credits: 02

Assessment:

Weightage for assessments (in percentage) For all courses

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40%	60%
Practical	-	100%

B. N. Bandodkar College of Science (Autonomous), Thane

Semester V: Major			
Course Code	**Course Title**	**No. of lectures In hrs.**	**Credits**
25BUST5T01	Distribution Theory	**30**	**2**
25BUST5T02	Theory of Estimation	**30**	**2**
25BUST5T03	Introduction to Regression Analysis	**30**	**2**
25BUST5P01	Practical Based on 25BUST6T01	**60**	**2**
25BUST5P02	Practical Based on 25BUST6T02	**60**	**2**
25BUST5P03	Practical Based on 25BUST6T03	**60**	**2**
	Total	**270**	**12**
Semester V: Major DSE			
25BUST5TE1	Biostatistics	**30**	**2**
25BUST5PE1	Practical Based on 25BUST5TE1	**60**	**2**
OR			
25BUST5TE2	Applied Statistics -I	**30**	**2**
25BUST5PE2	Practical Based 25BUST5TE2	**60**	**2**
	Total	**90**	**4**
Semester V: Minor			
25BUST5TMN	Business Statistics	**30**	**2**
	Total	**30**	**2**
Semester V: SEC			
25BUST5SEC	Data Science and Statistical Learning-I	**15**	**1**
	Practical Based on 25BUST5SEC	**30**	**1**
	Total	**45**	**2**
Semester V: On Job Training OR Field Project			
25BUST5OJT	On Job Training in Statistics I	**60**	**2**
OR			
25BUST5FPR	Field Project in Statistics III	**60**	**2**
	Total	**60**	**2**

Semester VI: Major			
Course Code	**Course Title**	**No. of lectures In hrs.**	**Credits**
25BUST6T01	Stochastic Processes	**30**	**2**
25BUST6T02	Testing of Hypothesis	**30**	**2**
25BUST6T03	Optimization Techniques and Reliability	**30**	**2**
25BUST6IKS	Indian Knowledge System in Statistics	**30**	**2**
25BUST6P01	Practical Based on 25BUST6T01	**60**	**2**
25BUST6P02	Practical Based on 25BUST6T02	**60**	**2**
25BUST6P03	Practical Based on 25BUST6T03	**60**	**2**
	Total	**300**	**14**
Semester VI: Major DSE			
25BUST6TE1	Industrial Statistics	**30**	**2**
25BUST6PE1	Practical's Based on 25BUST6PE1	**60**	**2**
	OR		
25BUST6TE2	Applied Statistics-II	**30**	**2**
25BUST6PE2	Practical's Based on 25BUST6TE2	**60**	**2**
	Total	**90**	**4**
Semester VI: SEC			
25BUST6SEC	Data Science and Statistical Learning-II	**15**	**1**
	Practical Based on 25BUST6SEC	**30**	**1**
	Total	**45**	**2**
Semester VI: On Job Training OR Field Project			
25BUST6OJT	On Job Training in Statistics II	**60**	**2**
OR			
25BUST6FPR	Field Project in Statistics IV	**60**	**2**
	Total	**60**	**2**

Semester V
(Statistics-Major)

Course Code: 25BUST5T01

CO1	Explain the theorems on probability and define the joint MGF.	L2
CO2	Define trinomial and multinomial distribution and study different characteristics of distribution.	L1
CO3	Demonstrate key probability inequalities and Weak Law of Large Numbers (WLLN)	L2
CO4	Explain order statistics and be able to find distributions of order statistics.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	0
CO2	3	1	0	0	0	0
CO3	3	3	1	0	1	0
CO4	3	2	1	0	1	0

Course Code 25BUST5T01	Course Title **Distribution Theory**	Credits 2	No. of lectures in hours
Unit I	**Unit I: Joint Moment Generating Function and Multinomial Distribution Bivariate Normal Distribution.** **Bivariate MGF:** 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 Bivariate MGF. **Trinomial distribution:** Definition of joint probability distribution of(X, Y). Joint moment generating function, moments μ_{rs} where $r = 0, 1, 2$ and$s = 0, 1, 2$. Marginal & Conditional distributions. Their Means & Variances. Correlation coefficient between (X, Y). Distribution of the Sum $X + Y$ Extension to Multinomial distribution with parameters $(n, p_1, p_{2,} \dots \dots p_{k-1})$ where $p_1 + p_{2+} \dots \dots + p_{k-1} + p_k = 1$ 1. Expression for joint MGF. Derivation of: joint probability distribution of (Xi, Xj). Conditional probability distribution of X_i. **Bivariate Normal Distribution:** Definition of joint probability distribution (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		**15**

	the random variables. Necessary and sufficient condition for the independence of X and Y	
Unit II	**Unit II : Inequalities, Law of Large Numbers and Order Statistics** **Inequalities:** Markov Inequality, Tchebyshev's Inequality, Boole's Inequality, Cauchy Schwarz's Inequality, Weak Law of Large Numbers. Order Statistics (i) Definition of Order Statistics based on a random sample. (ii) Derivation of: (a) Cumulative distribution functions of r^{th} order statistics. (b) Probability density functions of the r^{th} order statistics. (c) Joint Probability density function of the r^{th} and the s^{th} order statistics ($r<s$) (d) Joint Probability density functions of all n order statistics. (e) Distribution of Maximum observation (nth order statistic) and Minimum observation (first order statistics) in case of uniform and Exponential distribution. (f) Probability density function of the difference between r^{th} and s^{th} order statistic ($r<s$) in case of uniform and Exponential distribution.	**15**

Reference Books:

- Biswas, S., 1991. *Topics in Statistical Methodology.* 1st ed. New Delhi: Wiley Eastern Ltd.
- Chandra, T.K. & Chatterjee, D., 2005. *A First Course in Probability.* 3rd ed. New Delhi: Narosa Publishing House.
- Feller, W., 1968. *An Introduction to Probability Theory and Its Applications, Volume 1.* 3rd ed. New York: Wiley Eastern Limited.
- Gupta, S.C. & Kapoor, V.K., 2014. *Fundamentals of Mathematical Statistics.* 11th ed. New Delhi: Sultan Chand & Sons.
- Hogg, R.V. & Craig, A.T., 1995. *Introduction to Mathematical Statistics.* 5th ed. Englewood Cliffs, NJ: Prentice Hall.
- Hogg, R.V. & Tanis, E.A., 1993. *Probability and Statistical Inference.* 4th ed. New York: Macmillan Publishing Company.
- Kapur, J.N. & Saxena, H.C., 2010. *Mathematical Statistics.* 15th ed. New Delhi: S. Chand and Company.
- Mood, A.M., Graybill, F.A. & Boes, D.C., 1974. *Introduction to the Theory of Statistics.* 3rd ed. New York: McGraw-Hill.
- Rohatgi, V.K. & Saleh, A.K.M.E., 2015. An Introduction to Probability and Statistics. 3rd ed. Hoboken, NJ: John Wiley & Sons.

Course Code: 25BUST5T02

CO1	Explain the key properties of a good estimator: unbiasedness, consistency, efficiency, and sufficiency.	L2
CO2	Estimate estimators using the MLE and MOM method.	L5
CO3	Develop a basic understanding of Bayesian estimation methods, incorporating prior distributions, posterior distributions and likelihood functions.	L6

CO4	Estimate confidence intervals for different distributions and normal distribution in different scenarios.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	0	2	1
CO2	3	3	3	0	2	1
CO3	3	3	2	0	2	1
CO4	3	3	3	0	2	1

Course Code **25BUST5T02**	**Course Title** **Theory of Estimation**	**Credits** **2**	**No. of lectures in hours**
Unit I	**Point Estimation and Methods of Point Estimation** **Notion of a Parameter and Parameter Space.** **Problem of Point estimation.** **Definitions: Statistic, Estimator and Estimate. Properties of a good estimator** : **Unbiasedness:** Definition of an unbiased estimator, Illustrations and examples. **Consistency:** Definition of Consistency, Sufficient condition for consistency (Without proof) Illustrations **Sufficiency:** Concept and Definition of sufficient statistic. Neyman's Factorization theorem (without proof), Exponential family of probability distributions and sufficient statistics. **Relative efficiency** of an estimator & illustrative examples. **Minimum variance unbiased estimator (MVUE) and Cramer Rao Inequality:** Definition of MVUE, Uniqueness property of MVUE (proof)., Information function, **Regularity conditions**. Cramer-Rao lower bound (CRLB). **Method of Maximum Likelihood Estimation (M.L.E.) :** 1. Definition of likelihood as a function of unknown parameter for a random sample from: Discrete distribution & Continuous distribution. 2. Derivation of Maximum likelihood estimator (M.L.E.) for parameters of Standard distributions (case of one and two unknown parameters). 3. Properties of MLE (without proof). **Method of Moments :** 1. Derivation of Moment estimators for standard distributions (case of one and two unknown parameters) 2. Illustrations of situations where MLE and Moment		15

	Estimators are distinct and their comparison using mean Square error. **Method of Minimum Chi-square and Modified Minimum Chi- Square**	
Unit II	**Bayesian Estimation Method & Interval Estimation** **Bayes Estimation:** 1. Prior distribution, Posterior distribution 2. Loss function, Risk function 3. Types of Loss function: Squared error Loss function (SELF), Absolute error Loss function (AELF) 4. Bayes risk. 5. Bayes method of finding Point estimator (assuming SELF) **Examples:** (i) Binomial- Beta, (ii)Poisson- Gamma, (iii) Binomial-Uniform, (iv) Normal-Normal, (v) Exponential-Exponential, (vi) Poisson-Exponential **Interval Estimation**: 1. Concept of confidence interval & confidence limits. 2. Definition of Pivotal quantity and its use in obtaining confidence limits. 3. Derivation of 100(1-α) % equal tailed confidence interval for: a) The population mean: μ, $\mu_1 = \mu_2$(population variance known/ unknown) b) The population variance: σ^2, $\frac{\sigma_1^2}{\sigma_2^2}$ (Normal distribution) Confidence interval for the parameters of Binomial, Poisson and Exponential distributions.	15

Reference Books:

- Arora Sanjay and BansiLal (1989): New Mathematical Statistics, SatyaPrakashan, New Market, New Delhi,5
- B. K. Kale, K. Muralidharan (2016): Parametric Inference: An Introduction, Narosa Publishing House
- Gupta S.C., Kapoor V. K.(2014): Fundamentals of Mathematical Statistics; Eleventh Edition; Sultan Chand & Sons.
- Hoel P.G.(1966): Introduction to Mathematical Statistics; Fourth Edition; John Wiley & Sons Inc.
- HoggR.V., Craig A.T. (2012): Introduction to Mathematical Statistics, Seventh Edition; Collier McMillan Publishers.
- HoggR.V., TannisE. A.(2014): Probability and Statistical Inference, Nineth Edition; Collier McMillan Publishers.
- Kapur J.N.,Saxena H. C.(2010): Mathematical Statistics; Fifteenth Edition; S. Chand & Company Ltd.
- Manoj Kumar Srivastava, Abdul Hamid Khan, Namita Srivastava (2014): Statistical Inference: Theory of Estimation, PHI learning
- Miller I., Miller M.& Freund J.E. (1999) John E. Freund's Mathematical Statistics, Sixth Edition: Pearson Education Inc.
- Rohatgi, V. K, Ehsan Saleh A.K. Md.: An introduction to Probability Theory and Mathematical Statistics, Second Edition, Wiley series in Probability and Statistics.
- U. J. Dixit (2016): Examples in Parametric Inference in R, First Edition, Springer

Course Code: 25BUST5T03

CO1	Explain the concepts of the fitting of regression models and estimation of parameters using least square method.	L2
CO2	Extend the regression concept to multiple variables and interpret logistics models.	L2
CO3	Analyze & compare residual diagnostics and apply corrective measures	L4
CO4	Build the appropriate model and estimate the parameters.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	0	2	2
CO2	3	3	3	0	2	2
CO3	3	3	3	0	3	2
CO4	3	3	3	0	3	2

Course Code **25BUST5T03**	**Course Title** **Introduction to Regression Analysis**	**Credits** **2**	**No. of lectures in hours**
Unit I	**Unit I: Linear Regression Models and Introduction to Logistic Regression** **1.Simple linear regression model** Review of Simple linear Regression Model: $Y=\beta 0+\beta 1X+\varepsilon$ 2. **Multiple linear regression model** Assumptions of the models, Derivation of ordinary least square (OLS) estimators of regression coefficients for simple and multiple regression models, Properties of least square estimators (without proof), Estimation of σ^2, Coefficient of determination R^2 and adjusted R^2, procedure overall significance of the models, Significance of individual coefficients, Confidence intervals for the regression coefficients, testing normality of data Residual analysis: Standardized residuals, Studentized residuals, residual plots with R- software, Introduction to Logistics Regression, estimation of parameters and its applications		15

Unit II	**Unit II :Validity of Assumptions and Model Building** Autocorrelation: Concept and detection using Durbin Watson Test, Interpretation of output produced by DW-test function in R, Heteroscedasticity: Concept and detection using Breusch – Pagan-Godfrey Test, Interpretation of output produced by BP test function in R, Multicollinearity: Concept and detection Variance Inflation Factor(VIF), Interpretation Of Output produced by mc test function in R, Consequences of using OLS estimators in presence of Autocorrelation, Heteroscedasticity and Multicollinearity, and Brief introduction to ridge regression.	15

Reference Books:

- Chatterjee S. and Hadi A.S.(2012): Regression Analysis by Examples, 5th Edition, Wiley.
- Draper, N. R. and Smith, H. (1998), Applied Regression Analysis (John Wiley), Third Edition.
- Hosmer, D.W and lameshow, S.(1989). Applied Logistic Regression (Wiley).
- Kleinbaum G. and Klein M.(2011): Logistic Regression, IIIrd Edition a self-learning text, Springer.
- Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003), Introduction to Linear Regression Analysis (Wiley).
- Neter, J., W., Kutner, M. H. ;Nachtsheim, C.J. and Wasserman, W.(1996), Applied Linear Statistical Models, fourth edition, Irwin USA.

Course Code: 25BUST5P01

CO1	Find the bivariate MGF of random variables	L3
CO2	Solve problem based on trinomial and multinomial distribution.	L1
CO3	Solve problem based on Bivariate Normal Distribution.	L3
CO4	Solve the problem based on ordered statistics and different inequalities.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	0
CO2	3	1	0	0	0	0
CO3	3	2	1	0	1	0
CO4	3	3	1	0	1	0

Course Code 25BUST5P01	Course Title **Practicals Based on 25BUST5T01**	Credits 2
5.1.1	Bivariate Moment Generating Function -I	
5.1.2	Bivariate Moment Generating Function -II	
5.1.3	Trinomial Distribution	
5.1.4	Multinomial Distribution	
5.1.5	Bivariate Normal Distribution-I	
5.1.6	Markov Inequality	
5.1.7	Tchebyshev's Inequality	
5.1.8	Boole's Inequality	
5.1.9	Cauchy Schwarz's Inequality	
5.1.10	Weak Law of Large Numbers	
5.1.11	Order statistics-I	
5.1.12	Order statistics-II	

Course Code: 25BUST5P02

CO1	Find minimum variance unbiased estimator and Minimum Variance Bound Unbiased Estimator	L1
CO2	Estimate parameters using MLE and MOM method.	L5
CO3	Estimate parameters using Bayes' Estimation.	L5
CO4	Construct confidence intervals for different cases of normal distribution and some standard distributions.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	0	3	1
CO2	3	3	2	0	3	1
CO3	3	3	2	0	3	1
CO4	3	3	2	0	3	1

Course Code 25BUST5P02	Course Title **Practical Based on 25BUST5T02**	Credits 2
5.2.1	Unbiased Estimator	
5.2.2	Consistent and Sufficient Estimator	
5.2.3	Minimum Variance Unbiased Estimator	
5.2.4	Minimum Variance Bound Unbiased Estimator	
5.2.5	Maximum Likelihood Estimator	
5.2.6	Method of Moments	
5.2.7	Method of minimum chi square and minimum modified chi square	
5.2.8	Baye's Estimation I	
5.2.9	Baye's Estimation II	
5.2.10	Confidence Interval I	
5.2.11	Confidence Interval II	
5.2.12	Practical using R software	

Course Code: 25BUST5P03

CO1	Apply linear Regression models to real life data	L3
CO2	Apply simple linear regression models for bivariate and multivariate data using R	L3
CO3	Analyze and interpret Results after applying regression models to data	L4
CO4	Evaluate and verify the assumptions for applied regression models	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	0	3	1
CO2	3	3	3	0	3	1
CO3	3	3	3	0	3	1
CO4	3	3	3	0	2	1

Course Code 25BUST5P03	Course Title **Practical Based on 25BUST5T03**	Credits 2
5.3.1	Fundamentals of R -I	
5.3.2	Fundamentals Of R -II	
5.3.3	Simple Linear Regression-I	
5.3.4	Simple Linear Regression using R-I	
5.3.5	Simple Linear Regression using R -II	
5.3.6	Multiple Linear Regression using R -I	
5.3.7	Multiple Linear Regression using R -I	
5.3.8	Logistic Regression using R-I	
5.3.9	Logistic Regression using R-II	
5.3.10	Ridge Regression using R	
5.3.11	Validity of Assumptions -I	
5.3.12	Validity of Assumption- II	

Semester V
(Statistics-Major DSE)

Course Code: 25BUST5TE1

CO1	Explain the principles of different epidemic models and their assumptions and critically assess the effectiveness of various epidemic models based on their assumptions, strengths, and limitations.	L4
CO2	Design dose-response analysis, and apply statistical tests (e.g., analysis of variance, regression models) to determine the efficacy of treatments or substances.	L6
CO3	Demonstrate the principles of clinical trial design, including randomization, blinding, sample size determination, and the ethical considerations involved.	L2
CO4	Explain the concepts of bioequivalence, such as pharmacokinetic parameters (AUC, C_{max}) and its importance in regulatory approval of generic drugs.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	0	2	3
CO2	3	3	2	0	2	3
CO3	3	3	2	1	3	3
CO4	3	3	2	0	2	3

Course Code 25BUST5TE1	**Course Title Biostatistics**	**Credits 2**	**No. of lectures in hours**
Unit I	**Epidemic Models and Bioassays** 1) The features of Epidemic spread. Definitions of various terms involved. Simple mathematical models for epidemics: Deterministic model without removals (for 'a' introductions), Carrier model (Without Proof). 2) Chain binomial models. Reed-Frost and Greenwood models. Distribution of individual chains and total number of cases. Maximum likelihood estimator of `p' and its asymptotic variance for households of sizes up to 3. 3) Meaning and scope of bioassays. Relative potency. Direct assays. Fieller's Theorem.(Statement only) 4) Indirect assays. Dose-response relationship. Conditions of similarity and Monotony. Linearizing transformations. Parallel line assays. Symmetrical (2, 2) parallel line assays. Point Estimate and Interval Estimate of Relative potency. 5) Quantal Response assays. Tolerance distribution. Median effective dose ED50 and LD50. Probit and Logit analysis.		15

Unit II	**Clinical Trials and Bioequivalence** 1) The need and ethics of clinical trials. Common terminology used in clinical trials. Overview of phases (I-IV). Introduction to ICH E9 guidelines, Study Protocol. 2) Concept of : Case record/Report form, Blinding (Single/Double) Randomized controlled (Placebo/Active controlled), Study Designs (Parallel, Cross Over). Types of Trials : Inferiority, Superiority and Equivalence, Multicentric. 3) Statistical tools: Analysis of parallel Design using Analysis of Variance. Concept of odds ratio. 4) Definitions of Generic Drug product. Bioavailability, Bioequivalence, Pharmacokinetic (PK) parameters C_{max}, AUC_t, $AUC_{0-\infty}$, T_{max}, K_{el}, T_{half}. 5) Designs in Bioequivalence: Parallel, Cross over (Concept only). Advantages of Crossover design over Parallel design. 6) Analysis of Parallel design using logarithmic transformation (Summary statistics, ANOVA and 90% confidence interval). 7) Confidence Interval approach to establish bioequivalence (80/125 rule).	15

Reference Books:

- Bailey N.TJ. : The Mathematical theory of infectious diseases, Second edition, Charles Griffin and Co. London.
- Daniel Wayne W. : Biostatistics . A Foundation for Analysis in the Health Sciences, 7thEdition, Wiley Series in Probability and Statistics.
- Das M.N. and Giri N.C. : Design and Analysis of Experiments, Second edition, Wiley Eastern.
- Finney D.J. : Statistical Methods in Biological Assays, First edition, Charles Griffin and Co. London.
- Fleiss J. L. The Design and Analysis of Clinical Experiments, Second edition, Wiley and Sons.
- Friedman L. M., Furburg C., Demets D. L. : Fundamentals of Clinical Trials, First edition, Springer Verlag.
- Hogg R.V.,CraigA.T.: Introduction to Mathematical Statistics, Fourth Edition; Collier McMillan Publishers.
- Sanford Boltan and Charles Bon : Pharmaceutical Statistics, Fourth edition, Marcel Dekker Inc.
- Shein-Chung-Chow ; Design and Analysis of Bioavailability & Bioequivalence studies, Third Edition, Chapman & Hall/CRC Biostatistics series.
- Wayne W. Daniel: Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10th edition, ISV
- Zar Jerrold H. :Biostatistical Analysis, Fourth edition, Pearson's education.

Course Code: 25BUST5PE1

CO1	Find number of susceptible and infective and Estimate probabilities using chain binomial models.	L5
CO2	Design direct assays, parallel line assays and quantal response assays by various methods.	L6
CO3	Apply various statistical methods in clinical trials.	L3
CO4	Find various pharmacokinetics parameters.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	2	1
CO2	3	3	1	0	2	1
CO3	3	2	2	1	2	1
CO4	3	3	2	0	2	1

Course Code **25BUST5PE1**	**Course Title** **Practical Based on 25BUST5TE1**	**Credits** **2**
Practical No.	**Name of the Practical**	
5.4.1	Epidemic Models (Number of Susceptibles and Infectives)	
5.4.2	Estimation of Probability of number of Infectives	
5.4.3	Estimation of S.E. of Probability of number of Infectives	
5.4.4	Direct Assays	
5.4.5	Parallel Line Assays	
5.4.6	Quantal Response Assays	
5.4.7	Correlation	
5.4.8	Clinical Trials-I	
5.4.9	Clinical Trials-II	
5.4.10	Sample Size	
5.4.11	Bioequivalence	
5.4.12	Practical using R software	

Course Code: 25BUST5TE2

CO1	Explain the concepts of decision making environments in the business and Apply various decision making techniques	L2
CO2	Summarize concepts of queuing theory and apply in real life situations.	L2
CO3	Define the principles and concepts of time series modeling	L1
CO4	Apply various time series analysis techniques and Evaluate the stationarity of time series data and implement appropriate transformations if necessary.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	0	2	1
CO2	3	2	2	0	2	1
CO3	3	2	2	0	2	1
CO4	3	3	2	0	2	1

Course Code 25BUST5TE2	**Course Title Applied Statistics-I**	**Credits 2**	**No. of lectures in hours**
Unit I	**Unit I: Decision theory and Queuing Theory** **Decision theory** Decision making under uncertainty: Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwitz criterion, Minimax Regret criterion. Decision making under risk: Expected Monetary Value criterion, Expected Opportunity Loss criterion, EPPI, EVPI. Decision tree analysis. **Queuing Theory** Basic elements of the Queuing model. Roles of the Poisson and Exponential distributions. Derivation of Steady state probabilities for birth and death process. Steady state probabilities and various average characteristics for the following models: (i)(M/M/1):(GD/∞/∞) (ii) (M/M/1):(GD/N/∞) (iii)(M/M/c):(GD/∞/∞) (iv)(M/M/c):(GD/N/∞)		15
Unit II	**Unit II: Time Series Analysis** ● Definition of time series. Its components. ● Models of time series. ● Estimation of trend by: i) Freehand curve method ii) Method of semi average iii) Method of Moving average iv) Method of least squares (linear trend only)		**15**

	● Estimation of seasonal component by i) method of simple average, ii) Ratio to moving average, iii) Ratio to trend method. ● Concept of stationary time series (graphical and DF test, Methods of converting non-stationary time series into stationary time series by differencing method and de trending method.	

Reference Books:

- Brockwell, P. J. and Davis, R. A. (2003): Introduction to Time Series Analysis, Springer
- Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci (2011), Introduction to Time Series Analysis and Forecasting, John Wiley & Sons
- Ferguson, T. S. (1967): Mathematical Statistics: A decision theoretic approach. Academic Press.
- Fuller, W. A. (1996): Introduction to Statistical Time Series, 2nd Ed. Wiley.
- Gupta, S. C. and Kapoor, V. K. (2014), Fundamentals of Applied Statistics, Fourth Edition, Sultan Chand and Sons Publishers, New Delhi.
- Kantiswarup, P.K.Gupta, Manmohan: Operations Research, Twelfth edition, Sultan Chand & sons.
- Paul S.P. Cowpertwait and andrew V. Metcalfe (2009), Introductory Time Series with R, Springer
- Sharma S. D.: Operations Research, Eighth edition, Kedarnath Ramnath & Co.
- Shumway, R. H. and Stoffer, D. S. (2010): Time Series Analysis & Its Applications, Springer.
- Taha, H. A. (2010): Operations Research: An introduction. Pearson. 9th Edition.
- Vora N. D. : Quantitative Techniques in Management, Third edition, McGraw Hill

Course Code: 25BUST5PE2

CO1	Identify decision making environments and apply statistical methods of taking optimum decisions	L3
CO2	Analyze and classify different types queuing models.	L4
CO3	Estimate future time series values by trends, and different seasonal components.	L5
CO4	Apply differencing and detrending methods to convert non-stationary time series into stationary time series.	L3

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	0	2	1
CO2	3	3	2	0	2	1
CO3	3	3	2	0	2	1
CO4	3	3	2	0	2	1

Course Code 25BUST5PE2	Course Title **Practical Based on 25BUST5TE2**	Credits 2
Practical No.	**Name of the Practical**	
5.4.1	Decision Theory-I	
5.4.2	Decision Theory-II	
5.4.3	Decision Theory-III	
5.4.4	Decision Tree	
5.4.5	Queuing Theory -I	
5.4.6	Queuing Theory -II	
5.4.7	Queuing Theory -III	
5.4.8	Estimation of Trend	
5.4.9	Exponential Smoothing	
5.4.10	Estimation By Seasonal Component	
5.4.11	Time Series (Stationarity)-I	
5.4.12	Time Series (Stationarity)-II	

Semester V
(Statistics-Minor)

Course Code: 25BUST5TMN

CO1	Explain the concepts of Interests and annuities in finance	L2
CO2	Apply the mathematical methods in the area of Loan	L3
CO3	Explain the concepts of mutual funds and shares mathematically	L2
CO4	Illustrate the concepts of NAV in case of mutual funds	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	0	2	1
CO2	3	2	2	0	2	0
CO3	3	2	2	0	2	0
CO4	3	3	2	0	2	0

Course Code **25BUST5TMN**	**Course Title** **Business Statistics**	**Credits** **2**	**No. of lectures in hours**
Unit I	**Unit I: Interest and Annuity:** Interest: Simple Interest, Compound Interest (Nominal & Effective Rate of Interest), Annuity: Annuity Immediate and its Present value, Future value. Equated Monthly Installment (EMI) using reducing balance method & amortization of loans. Problems based on these topics.		15
Unit II	**Unit II : Shares and Mutual Funds:** Shares: Concept of share, face value, market value, dividend, equity shares, preference shares, bonus shares. Simple examples. Mutual Funds: Simple problems on calculation of Net income after considering entry load, dividend, change in Net Asset Value (N.A.V.) and exit load. Problems based on these topics.		15

Reference Books:

- Business Statistics, Gupta S.P, Gupta M.P., Sultan Chand & Sons , 2017.
- Mathematics for Economics and Finance Methods and Modelling by Martin Anthony and Norman Biggs, Cambridge University Press, Cambridge low-priced edition, 2000

Semester V
(Statistics-SEC)

Course Code: 25BUST5SEC

CO1	Explain the core concepts, life cycle, and real-world applications of Data Science along with the roles of Data Scientist, Data Analyst, and ML Engineer	L2
CO2	Apply data preprocessing, model evaluation, and machine learning techniques to analyze datasets using classification algorithms and optimize model performance.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	0	1	1
CO2	3	3	3	0	2	1

Course Code **25BUST5SEC**	**Course Title** **Data Science and Statistical Learning-I**	**Credits** **1**	**No. of lectures in hours**
Unit I	**Data Science** Introduction to Data Science**,** Data Science life cycle, Applications and Real-world Use Cases, The Data Science Workflow, Roles: Data Scientist vs Data Analyst vs ML Engineer **Data Preprocessing** Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization, Outlier analysis, Testing and Training, Statistical Errors **Model Evaluation & Optimization** Train-Test Split & Cross-Validation, Feature Selection and Dimensionality Reduction (PCA), Evaluation Metrics for classification (Accuracy, Precision, Recall, F1-Score, ROC Curve), Evaluation Metrics for Regression (MAE, MSE, RMSE, RMSLE), Hyperparameter Tuning (Grid Search, Random Search), Overfitting vs Underfitting (Bias-Variance Tradeoff), Model Evaluation using Visualization – Residual Plot – Distribution Plot, Generalization Error, Ridge and Lasso Regression **Introduction to Learning Methods:** Supervised and unsupervised learning techniques, Associations, and Correlations- Frequent Itemsets, Closed Itemsets, and Association Rules, Apriori Algorithm, FP-Growth, What Is Classification? What is regression, Types of classifications and regression, difference between classification and regression **Classification Models:** Decision tree, Naïve Bayes (Bayesian Classification), Neural network, Logistic regression, k-Nearest-Neighbor, SVM, Random Forests		15

Reference Books:

- Bhatnagar, S. (2020).Machine learning for decision makers. BPB Publications.
- Chakraborty, B., & Roy, A. (2020).Artificial intelligence and machine learning. PHI Learning.
- Jain, P. (2018).Machine learning: Step-by-step guide for beginners. BPB Publications.
- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (1st ed.), New York, Springer

- Prasad, B. (2021**).**Fundamentals of machine learning. Wiley India.
- Raj, M. (2019).Introduction to machine learning. Oxford University Press India.
- Ramesh, K., & Vishnu, P. (2019).Machine learning techniques and applications. McGraw Hill Education India.
- William, P., Sakhare, N. N., &Pardeshi, D. B. (2023). Machine Learning. NiraliPrakashan.

Course Code: 25BUST5SEC

CO3	Apply data preprocessing techniques including cleaning, transformation, and outlier detection to prepare real-world datasets for statistical modeling and machine learning.	L3
CO4	Build, implement, and evaluate supervised classification models such as Decision Tree, Naïve Bayes, k-NN, Random Forest, SVM, and Logistic Regression using appropriate performance metrics.	L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO3	3	2	3	0	2	1
CO4	3	3	3	0	2	1

Course Code **25BUST5SEC**	**Course Title** **Practical Based on Data Science and Statistical Learning-I**	**Credits** **1**
Practical No.	**Name of Practical**	
5.5.1	Data Cleaning, Transformation & Outlier Detection	
5.5.2	Train-Test Split & Cross-Validation	
5.5.3	Classification & Regression Model Evaluation	
5.5.4	Implement SVM and Decision Tree using Python	
5.5.5	Implement Logistic Regression and Naïve Bayes using Python	
5.5.6	Implement k-NN and Random Forest using Python	

Semester V
(Statistics-OJT)

Course Code: 25BUST5OJT
Course Title: On Job Training in Statistics I

CO1	Extend subject knowledge and give exposure to real-life statistical applications, industrial practice and work place culture.	L2
CO2	Develop competencies in data collection, documentation, analysis and reporting	L6
CO3	Build professional behavior, communications skills, teamwork and ethical responsibility in industry	L3
CO4	Analyze experiences, interpret and create reports, presentations reflecting industry exposure.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	3	2
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3

Semester V
(Statistics-Field Project in Statistics III)

Course Code: 25BUST5FPR
Course Title: Field Project in Statistics III

CO1	Identify real-life problems and formulate clear research objectives and statistically testable hypotheses.	L3
CO2	Design an appropriate methodology including selection of variables, sampling techniques, and data collection tools.	L6
CO3	Collect, organize, and preprocess primary and secondary data while following ethical and quality standards	L3
CO4	Apply preliminary and some advance statistical techniques and exploratory data analysis (EDA) using suitable software tools.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	3	2
CO2	3	3	3	1	3	2
CO3	3	3	3	1	3	2
CO4	3	3	2	1	3	2

Semester VI
(Statistics-Major)

Course Code: 25BUST6T01

CO1	Classify stochastic processes (SPs) based on state space and time domain, focusing on Markov chains	L2
CO2	Explain Chapman-Kolmogorov equation First time passage time distribution and Ergodic theorem.	L2
CO3	Define Poisson processes and its distribution,	L1
CO4	Explain the postulates and derive the difference-differential equations for birth and death processes.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	1	0
CO2	3	2	1	0	0	0
CO3	3	1	1	0	0	0
CO4	3	2	1	0	1	0

Course Code 25BUST6T01	**Course Title** **Stochastic Processes**	**Credits 2**	**No. of lectures in hours**
Unit I	**Markov Chain** Introduction to stochastic Processes (SP's), Classification of SP's according to State space & time domain. Markov chain, countable state Markov chain, construction and calculation of n step transition probability matrix & its limit. Conditional probability, unconditional probability with initial distribution, Chapman-Kolmogorov equation, Classification of states, criteria for various states, First time passage time distribution (Without Proof), stability of Markov chain, Ergodic theorem (Without Proof). Limiting Probabilities and Stationary distribution. examples of various stochastic processes.		**15**
Unit II	**Poisson, Birth and Death Processes** Poisson process, properties of Poisson process and related distributions. Postulates and difference differential equations for :(i)Pure birth process, (ii)Poisson process with initially 'a' members, 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, (viii)Linear growth model. Derivation of $P_n(t)$, mean and variance wherever applicable.(State its mean and variances)		**15**

Reference book

- Adke, S. R. and Manjunath, S.M. (1984) An Introduction to finite Markov Processes, Wiley Eastern.
- Bhat, B. R. (2000) Stochastic Models: Analysis and Applications, New Age International, India.

- Cinlar E.(1975) Introduction to Stochastic Process, Prentice Hall.
- Feller, W.(1968) Introduction to Probability and its Applications, (Vol.1) Wiley Eastern.
- Harris, T.E. (1963). The Theory of Branching Processes, (Springer-Verlag).
- Hoel, P.G., Port, S. C. and Stone, C. J. (1972) Introduction to Stochastic Processes, Houghton Miffin & Co.
- Jagers, P. (1974) Branching Processes with Biological Applications, Wiley.
- Karlin & Taylor, A. (1975) First Course in Stochastic Process, (Vol.1) Academic Press.
- Madhira, S., & Deshmukh, S. (2003): Introduction to Stochastic processes using R, Springer.
- Medhi, J. (1994) Stochastic Processes, Wiley Eastern.
- Parzen E. (1962) Stochastic Process, Holden-Pay.
- Ross, S. (2005) Introduction to Probability Models, 6th Ed. Academic Press.
- Srinivas and Mehta (1976) Stochastic Processes, Tata McGraw Hill, New Delhi.
- Taylor and Karlin (1984) An Introduction to Stochastic Modeling, Academic Press.

Course Code: 25BUST6T02

CO1	Analyze the properties of MP and UMP tests, such as size and power, and their application to different distributions and test scenarios.	L4
CO2	Relate the general procedure of performing an LRT, including computing the likelihood functions for both the null and alternative hypotheses.	L2
CO3	Explain the concept and working principle of SPRT, including the process of sequentially collecting data and stopping when a decision is made.	L5
CO4	Design a non-parametric test plan for a given hypothesis test problem where assumptions of parametric tests are not met.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	0	2	0
CO2	3	3	2	0	2	0
CO3	3	2	2	0	2	1
CO4	3	3	3	0	2	1

Course Code 25BUST6T02	**Course Title** **Testing of Hypothesis**	**Credits** 2	**No. of lectures in hours**
Unit I	**Uniformly Most Powerful Test** 1) Problem of testing hypotheses. 2) Definitions and illustrations of i) Simple hypothesis ii) Composite hypothesis iii) Null Hypothesis iv) Alternative Hypothesis v)Test of hypothesis vi) Critical region vii) Type I and Type II errors viii) Level of significance ix) p-value x) Size of the test xi) Power function of a test. 3) Definition of the most powerful test of size α for a simple hypothesis against a simple alternative hypothesis. Neyman-Pearson fundamental lemma (Without Proof). Randomized test 4) Definition, Existence and Construction of Uniformly most powerful (UMP) test.		15

Unit II	**Sequential Probability Ratio Test and Non-Parametric Tests** Sequential test procedure for testing a simple null hypothesis against a simple alternative hypothesis. Its comparison with fixed sample size (Neyman- Pearson) test procedure. Definition of Wald's SPRT of strength (α, β). Problems based on Bernoulli, Binomial, Poisson, Normal & Exponential distributions. Need for non-parametric tests. Distinction between a parametric and a non-parametric test. Concept of a distribution free statistic. Single sample and two sample Nonparametric tests. (i) Sign test (ii) Wilcoxon's signed rank test (iii) Median test (iv) Mann–Whitney test (v) Run test (vi) Fisher exact test (vii) Kruskal -Wallis test (viii) Friedman test	15

Reference Books:

- B. K. Kale, K. Muralidharan (2016): Parametric Inference: An Introduction, Narosa Publishing House
- Daniel W.W (1978).: Applied Non-Parametric Statistics, First edition Boston-Houghton Mifflin Company.
- Gupta S.C. and Kapoor V.K (2014). : Fundamentals of Mathematical Statistics, Eleventh edition New Delhi S. Chand & Company Ltd.
- Hogg R.V. and Craig A.T (2020): Introduction to Mathematical Statistics, Eighth edition London Macmillan Co. Ltd.
- Hogg R.V. and Tanis E. A (2019). : Probability and Statistical Inference, Third edition Delhi Pearson Education.
- Lehmann, E. L. and Romano, J. P. (2005): Testing Statistical Hypothesis, Springer. 3 rd Edition.
- Mood , F. Graybill & D. Boes(1978): Introduction to the theory of Statistics
- Rao, C. R. (2002): Linear Statistical Inference and its applications, Second Edition Wiley Series in Probability and Statistics.
- Rohtagi, V. K. and A.K.M.AD. Ehsanes Saleh (2001): An Introduction to Probability and Statistics. John Wiley. Second Edition.
- Sanjay Arora and BansiLal (1989): New Mathematical Statistics, SatyaPrakashan, New Market, New Delhi, 5.
- Sidney Siegal& N John Castellan Jr.(1988):Non parametric test for behavioral sciences
- U. J. Dixit (2016): Examples in Parametric Inference in R, First Edition, Springer
- Wald A. (1947): Sequential Analysis, First edition New York John Wiley & Sons

Course Code: 25BUST6T03

CO1	Understand the importance and challenges of inventory management.	
CO2	Develop the ability to analyze and optimize inventory systems using mathematical models and algorithms.	L3
CO3	Understand the different policies for replacement of items that deteriorate over time and those that fail completely, including individual and group replacement policies.	
CO4	Develop the ability to conduct post optimality sensitivity analysis to evaluate the impact of changes on the optimal solution and the feasibility of the problem.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	0	2	1
CO2	3	3	2	0	2	1
CO3	3	3	2	0	2	1
CO4	3	3	3	0	2	1

Course Code **25BUST6T03**	**Course Title** **Optimization Techniques and Reliability**	**Credits** **2**	**No. of lectures in hours**
Unit I	**UNIT I : Inventory Control** Introduction to Inventory Problem Deterministic Models: Single item static EOQ models for a. Constant rate of demand with instantaneous replenishment, with and without shortages. b. Constant rate of demand with uniform rate of replenishment, with and without shortages. c. Constant rate of demand with instantaneous replenishment without shortages, with at most two price breaks. Probabilistic models: Single period with Instantaneous demand (discrete and continuous) without setup cost. Uniform demand (discrete and continuous) without setup cost		15
Unit II	**UNIT II: Replacement Problem and Reliability**: Replacement of items that deteriorate with time and value of money (i) remains constant, (ii) changes with time. Replacement of items that fail completely :Individual replacement and Group Replacement policies(without proof) Concept of reliability, Hazard-rate. Bathtub curve. Failure time distributions: (i)Exponential,(ii)Gamma,(iii)Weibull, Definitions of increasing (decreasing) failure rate. Mean Time to Failure of a system (MTTF). System Reliability. Reliability of (i) series (ii) parallel system of independent components having exponential life distributions.		15

Reference Books:

- BarlowR.E.and Prochan Frank: Statistical Theory of Reliability and Life Testing Reprint, First. Edition, Holt, Reinhart and Winston.
- Kanti swarup, P. K. Gupta, Manmohan: Operations Research,Twelfth edition,Sultan Chand & sons
- Mann N. R. ,Schafer R. E., Singapurwalla N. D. : Methods for Statistical Analysis of Reliability and Life Data. First edition, John Wiley & Sons.Sharma S. D.: Operations Research, Eighth edition, Kedarnath Ramnath & Co.
- Taha Hamdy A. :Operations Research: Eighth edition, Prentice Hall of India Pvt. Ltd.
- Vora N. D.: Quantitative Techniques in Management, Third edition, McGraw Hill Companies.

Semester VI
(Indian Knowledge System in Statistics)
Course Code: 25BUST6IKS

CO1	Explain the fundamental principles, key vocabulary and methods of Indian Knowledge Systems, Pramana Theory.	L2
CO2	Summarize ancient Indian contributions to Statistics and understand applications in traditional knowledge streams	L3
CO3	Outline links between modern statistical procedures and ancient Indian statistical approaches.	L2
CO4	Summarize the Development of sampling techniques and design of experiments in India.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	0	1	2	2
CO2	3	2	0	0	2	2
CO3	2	2	0	0	2	2
CO4	2	2	2	0	2	3

Course Code 25BUST6IKS	**Title** **Indian Knowledge System in Statistics**	**Credits 2**	**No. of lectures**
Unit I:	**Introduction:** ● Introduction to IKS: What does it mean in statistics? ● Key Vocabulary: Anumana (Inference), Pramana (Sources of Knowledge), Pratyaksha (Perception), Upamana (Comparison), Shabda (Verbal Testimony), Arthapatti (Postulation), Anupalabdhi,(Non-cognition), Chhanda (Metrics), Jyotisha Vedanga (Calendrical Calculations) and Sankhya (Classification) ● Introduction to ancient mathematics as an integral part of Indian heritage, Indian classical combinatorics (e.g. binomial/arrangement reasoning in Indian Statistics) ● Origin of Probability ideas in Indian games, dice, gambling in historical texts ● Traditional Indian inference and “proof/logic” systems (Nyāya, Buddhist logic) and relation to hypothesis testing ● Contributions of Indian Scientists/Statisticians in development of Sankhya Shastra. (P. C. Mahanolobis, P.V. Sukhatme, C. R. RAo, V. S. Huzurbazar, Raj Chandra Bose, Debabrata Basu)		**15**
	Development of sampling techniques and design of experiments India: ● Origin and history of development of sampling in India		

Unit II :	• Development of the official statistical system in India, Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), Indian Statistical Institute and National Statistical Commission. • Importance and Historical development of various designs of experiments • A profile of design of experiments at IASRI.	**15**

Reference Books and research papers:

1. B. Datta and A.N. Singh, History of Hindu Mathematics: A Sourcebook, 2 vols. Bombay: Asia Publishing House, repr. 1962.
2. Indian Knowledge Systems - Vol 1 & 2, Avadhesh K. Singh, Kapil Kapoor (2021)
3. Evolution of Statistics in India. J. K. Ghosh, P. Maiti, T. J. Rao, and B. K. Sinha. Journal International Statistic Review 1999, ISI
4. Official Statistics in India: The past and the present. T.J. Rao. Journal of Official Statistics vol. 26, no.2,2010.
5. Probability in Ancient India. C. K. Raju, Handbook of Philosophy of Statistics, edited by Paul Thagard Dov M. Gabbay and John Woods, handbook of Philosophy of Science, Elsevier, 2011.
6. Aloke Dey and Rahul Mukerjee, Development of Research in Experimental Design in India, International Statistical Review/ Revue International de Statistique, Vol. 80, No. 2 (August 2012), pp. 231-252 (22 pgs) Published by: Indian Statistical Institute (ISI)
7. Ghosh, J.K. , Mitra, S. K. , and Parthasarathy, K. R. (1992) Glimpses of India's Statistical Heritage, Wiley Eastern, New Delhi.
8. Glimpses of India's Statistical Heritage – Bhāvanā (bhavana.org.in)
9. B.L.S. Prakasa Rao. C.R. Rao: A Life in Statistics. Current Science. 10 Sep. 2014. 107(5): 895–90
10. Anil Gore, Sharayu Paranjpe and Madhav Kulkarni (2009), 'Statistics for everyone', SIPF academy, Publishers and consultants, Nashik, India.
11. Rajender Prasad and VK Gupta, A profile of Design of Experiments at IASRI.
12. MoSPI website: https://www.mospi.gov.in/

Course Code: 25BUST6P01

CO1	Solve the problem based on conditional and unconditional probabilities in a Markov chain and classify the states.	L3
CO2	Find limiting probabilities and stationary distribution of Markov chain.	L1
CO3	Solve the problems based Poisson Processes.	L3
CO4	Solve the problems based Birth and Death process.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	1	0
CO2	3	1	0	0	0	0
CO3	3	1	1	0	0	0
CO4	3	1	1	0	0	0

Course Code **25BUST6P01**	**Course Title** **Practical Based on 25BUST6T01**	**Credits** **2**
6.1.1	Transition Probability Matrix	
6.1.2	Markov Chain: Conditional Probability	
6.1.3	Markov Chain: Unconditional Probability	
6.1.4	Classification of States	
6.1.5	Limiting Probability	
6.1.6	Stationary Distribution	
6.1.7	Poisson Processes	
6.1.8	Pure Birth Processes	
6.1.9	Yule Furry process	
6.1.10	Pure Death Processes	
6.1.11	Birth and Death Processes	
6.1.12	Linear Growth Model	

Course Code: 25BUST6P02

CO1	Find the power of the test by constructing critical regions and most powerful tests.	L1
CO2	Develop SPRT for different distributions in different scenarios.	L6
CO3	Solve examples based on various non parametric tests based on the given real life problems.	L3
CO4	Construct critical regions and solve non parametric tests using various softwares.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	0	2	1
CO2	3	2	2	0	2	1
CO3	3	3	3	0	2	1
CO4	3	3	2	0	2	1

Course Code **25BUST6P02**	**Course Title** **Practical Based on 25BUST6T02**	**Credits** **2**
6.2.1	Testing of Hypothesis-I	
6.2.2	Testing of Hypothesis-II	
6.2.3	UMP Test-I	
6.2.4	UMP Test-II	
6.2.5	SPRT - I	
6.2.6	SPRT - II	
6.2.7	Non-parametric Test (Single Sample)	
6.2.8	Non-parametric Test - I (Two Sample)	
6.2.9	Non-parametric Test – II (Two Sample)	
6.2.10	Practical using R-software (Testing of Hypothesis)	
6.2.11	Practical using R software (Non Parametric test)	
6.2.12	Practical using MS-Excel (Non Parametric test)	

Course Code: 25BUST6P03

CO1	Identify Inventory problem in the given real life logistics situation	L3
CO2	Apply appropriate Inventory model to solve the Inventory problem	L3
CO3	Evaluate and Interpret Replacement problems in real life	L5
CO4	Demonstrate skills to understand system reliability problems.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	0	2	1
CO2	3	2	2	0	2	1
CO3	3	3	2	0	2	1
CO4	3	3	2	0	2	1

Course Code **25BUST6P03**	**Course Title** **Practical Based on 25BUST6T03**	**Credits** **2**
6.3.1	Inventory I	
6.3.2	Inventory II	
6.3.3	Inventory III	
6.3.4	Inventory IV	
6.3.5	Probabilistic Inventory Model	
6.3.6	Replacement Problem-I	
6.3.7	Replacement Problem-II	
6.3.8	Replacement Problem-III	
6.3.9	Reliability-I	
6.3.10	Reliability-II	
6.3.11	Reliability III	
6.3.12	MTTF of a system	

Semester VI
(Statistics-Major DSE)

Course Code: 25BUST6TE1

CO1	Summarize six-sigma applications of six-sigma tools	L2
CO2	Solve linear programming problem using dual simplex method.	L3
CO3	Explain methods of investment analysis	L2
CO4	Apply statistical tools in measuring risk in returns	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	0	2	1
CO2	3	2	2	0	2	1
CO3	3	3	2	0	3	1
CO4	3	3	3	0	3	1

Course Code 25BUST6TE1	**Course Title Industrial Statistics**	**Credits 2**	**No. of hours**
Unit I	**Unit I : INTRODUCTION TO SIX SIGMA** Concept, Basic Principles, Goals, six sigma v/s TQM, ISO 9000, Traditional Management, Quality defined, VOC and CTQ, Quality measurement to six sigma, Seven tools of quality and its application. Cause and Effect diagram (Fish bone Diagram), Control charts (**only concept of control chart**), DMAIC with case study, introduction to Lean Six Sigma. Failure Modes and Effect Analysis, Measurement System Analysis, Control charts and process capability(Cp , Cpk values), Lean Principles(waste reduction, 5S, Kaizen) LPP, Dual and Dual Simplex method to solve LPP, Its applications.		**15**
Unit II	**Unit II : INVESTMENT ANALYSIS** Investment Decision Analysis Phase of Investment , Decision Factors , Influencing Investment Decision, Time Value of money Technique of investment analysis Deterministic Methods Probabilistic Methods Basics of risk and return: concept of returns, systematic and unsystematic risk, application of standard deviation, coefficient of variation, beta, practical problems on standard deviation, variance and beta		**15**

Books and References:

- Sharma S. D. : Operations Research, Eighth edition, Kedarnath Ramnath & Co.
- Sharpe, W.F., Alexander, G.J. & Bailey, J. Investments, (6th edition),Prentice Hall of India. Chapter 15
- Six Sigma Deployment,(2003), Cary W. Adams, Charles E Wilson Jrs, Praveen Gupta, Elsevier Science.
- Six Sigma For Beginners: Pocket Book (2018), Rajiv Tiwari Kindle Edition 10. Introduction to Statistical Quality Control(2009), Montgomery, Douglas, C ,Sixth Edition, John Wiley &Sons.Inc.:.
- Six Sigma For Business Excellence, (2005), Penelope Przekop, McGraw-Hill Six Sigma Handbook, by Pyzdek, McGraw Hill Education; 4 edition (1 July 2017).

- Vora N. D.: Quantitative Techniques in Management, Third edition, McGraw Hill Companies.
- What Is Design For Six Sigma,(2005), Roland Cavanagh, Robert Neuman, Peter Pande, Tata McGraw-Hill

Course Code: 25BUST6PE1

CO1	Apply DMAIC framework to identify, analyze and solve process-related problems	L3
CO2	Apply statistical tools to measure process control tools to analyze data effectively	L3
CO3	Apply Dual simplex method to solve linear programming problems	L3
CO4	Evaluate investment options using techniques like NPV, IRR, etc.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	0	2	1
CO2	3	3	2	0	2	1
CO3	3	3	2	0	2	1
CO4	3	3	2	0	2	1

Course Code **25BUST6PE1**	**Course Title** **Practical Based on 25BUST6TE1**	**Credits** **2**
Practical No.	**Name of Practical**	
6.4.1	Six Sigma-I	
6.4.2	Six Sigma-II	
6.4.3	Control Chart -I	
6.4.4	Control Chart -II	
6.4.5	Dual Simplex-I	
6.4.6	Dual Simplex-II	
6.4.7	Investment Analysis-I	
6.4.8	Investment Analysis-II	
6.4.9	Portfolio Management -I	
6.4.10	Portfolio Management -II	
6.4.11	Practical Using Excel -I	
6.4.12	Practical Using Excel -II	

Course Code: 25BUST6TE2

CO1	Define index numbers and explain their significance in economic and statistical analysis.	L1
CO2	Construct various types of index numbers (e.g., Laspeyres, Paasche, Fisher) and interpret their meaning.	L6
CO3	Explain the importance of demographic methods in population studies.	L5
CO4	Construct and interpret a life table and calculate crude birth and death rates, age-specific rates, fertility, and mortality indicators.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	0	3	1
CO2	3	3	2	0	3	1
CO3	3	3	2	0	2	1
CO4	3	3	2	0	2	1

Course Code 25BUST6TE2	**Course Title** <u>**Applied Statistics -II**</u>	**Credits 2**	**No. of hours**
Unit I	**Unit I : Index Numbers** Index numbers as a comparative tool. Stages in the construction of Price Index Numbers. Measures of Simple and Composite Index Numbers. Laspeyre's, Paasche's, Marshal-Edgeworth's, Dobisch & Bowley's and Fisher's Index Numbers formula. Quantity Index Numbers and Value Index Numbers, Time reversal test, Factor reversal test, Circular test. Fixed base Index Numbers, Chain base Index Numbers. Base shifting, splicing and deflating. Cost of Living Index Number. Concept of Real Income based on Wholesale Price Index Number		**15**
Unit II	**Unit II: Introduction to Vital statistics and Demographic methods** Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.		**15**

Books and References:

- Agarwal B. L.(2013): Basic Statistics, New Age International Ltd.
- Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
- Gun A.M., Gupta M.K. and Dasgupta,B.(2008): Fundamental of Statistics, Vol. II, 9th Edition

World Press, Kolkata
- Gupta, S. C. and Kapoor, V. K. (2014), Fundamentals of Applied Statistics, Fourth Edition, Sultan Chand and Sons Publishers, New Delhi.
- Gupta, S. C. and Kapoor, V. K. (2014), Fundamentals of Mathematical Statistics, Eleventh Edition, Sultan Chand and Sons Publishers, New Delhi.
- Keyfitz N., Beckman John A.(2010): Demography through Problems, Springer
- Mukhopadhyay,P.(1999): Applied Statistics, New Central Book Agency, Calcutta.

Course Code: 25BUST6PE2

CO1	Apply Laspeyres, Paasche, and Fisher's formulas to construct price and quantity index numbers using datasets.	L3
CO2	Interpret the implications of index number changes in economic contexts.	L5
CO3	Solve crude birth and death rates, infant mortality rate, fertility rates, and age-specific death rates using census or survey data.	L3
CO4	Interpret life expectancy and mortality patterns from life table data.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	0	2	1
CO2	3	3	2	0	2	1
CO3	3	3	2	0	3	1
CO4	3	3	3	0	3	1

Course Code **25BUST6PE2**	**Course Title** **Practical Based on 25BUST6PE2**	**Credits** **2**
Practical No.	**Name of Practical**	
6.4.1	Simple Index Numbers	
6.4.2	Composite Index Numbers	
6.4.3	Quantity Index Numbers	
6.4.4	Value Index Numbers	
6.4.5	Fixed base Index Numbers	
6.4.6	Splicing and deflating	
6.4.7	CDR, IMR and Age Specific death rate	
6.4.8	Standardized death rate by:- (i) Direct method (ii) Indirect method	
6.4.9	Life Tables	
6.4.10	Problems based on CBR, GFR,	
6.4.11	Problems based on SFR, TFR	
6.4.12	Problems based on GRR and NRR	

Semester VI
(Statistics-SEC)

Course Code: 25BUST6SEC

CO1	Explain unsupervised learning methods such as clustering and dimensionality reduction, and evaluate their applications in pattern discovery and anomaly detection.	L2
CO2	Interpret and compare ensemble learning strategies including bagging, boosting, stacking, and reinforcement learning approaches like Q-learning and MDP.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	1	0
CO2	3	3	2	0	1	1

Course Code 25BUST6SEC	Course Title **Data Science and Statistical Learning-II**	Credits 1	No. of Lectures in hours
Unit I	**Unsupervised Learning** Clustering: What is Cluster Analysis, Major Clustering Methods, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Model-Based Clustering Methods, Outlier Analysis, Dimensionality Reduction (t-SNE, PCA), Isolation Forest Model. **Ensemble Learning** Bagging (Random Forest), Boosting (AdaBoost, Gradient Boosting, XGBoost). Stacking and Blending **Reinforcement Learning (Intro)** Markov Decision Process (MDP), Q-Learning, Applications of Reinforcement Learning **Applications & Case Studies** Real-world applications in Finance, and retails. Tools: Python and ML Libraries (Scikit-learn, TensorFlow). Stacking and Blending **Introduction to SQL:** Database, Create Database, Data Types, DDL, DML, DCL Statements, SQL Function, Joins & Relationship Between Tables, Grouping & Aggregation. Subqueries.		15

Reference Books:

- Bhatnagar, S. (2020). Machine learning for decision makers. BPB Publications.
- Chakraborty, B., & Roy, A. (2020). Artificial intelligence and machine learning. PHI Learning.
- Jain, P. (2018). Machine learning: Step-by-step guide for beginners. BPB Publications.
- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (1st ed.)
- Prasad, B. (2021). Fundamentals of machine learning. Wiley India.
- Raj, M. (2019). Introduction to machine learning. Oxford University Press India.
- Ramesh, K., & Vishnu, P. (2019). Machine learning techniques and applications. McGraw Hill Education India.
- William, P., Sakhare, N. N., & Pardeshi, D. B. (2023). Machine Learning. NiraliPrakashan.

Course Code: 25BUST6SEC

CO3	Analyze unsupervised and ensemble learning algorithms using Python libraries on real-world datasets and analyze their predictive performance using appropriate evaluation metrics.	L4
CO4	Apply SQL commands to create, manipulate, and query relational databases, and apply grouping, aggregation, and subqueries to extract meaningful insights.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO3	3	3	3	0	2	1
CO4	3	2	3	0	2	1

Course Code **25BUST6SEC**	**Course Title** **Practical Based on Data Science and Statistical Learning-II**	**Credits** **1**
Practical No.	**Name of Practical**	
6.5.1	Implement Clustering Techniques: K-Means and DBSCAN on suitable datasets	
6.5.2	Dimensionality Reduction using PCA and t-SNE	
6.5.3	Outlier Detection using Isolation Forest and Z-score Techniques	
6.5.4	Ensemble Learning: Random Forest, AdaBoost, and XGBoost Comparison	
6.5.5	SQL for Data Science: DDL and DML operations	
6.5.6	SQL for Data Science: Join operation and Subquery operation	

Semester VI
(Statistics-OJT)

Course Code: 25BUST6OJT(Statistics)
Course Title: On Job Training in Statistics II

CO1	Identify and Describe real-world statistical applications.	L3
CO2	Apply and analyze data collection processing and analytical methods to solve work-place based statistical problems.	L3
CO3	Demonstrate and Evaluate Build professional behavior, communications skills, teamwork and ethical conduct and time management	L2
CO4	Adapt the data interpretation skills, create reports, presentations reflecting industry exposure and career preparedness.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	3	2
CO2	3	3	3	1	3	3
CO3	3	4	3	2	3	3
CO4	3	4	3	2	4	3

Semester VI
(Statistics-Field Project in Statistics IV)

Course Code: 25BUST6FPR
Course Title: Field Project in Statistics IV

CO1	Apply advanced statistical methods such as regression analysis, ANOVA, hypothesis testing, estimation, or multivariate techniques to real-world data.	L3
CO2	Apply statistical software tools for data analysis, visualization, and interpretation of results.	L3
CO3	Interpret results critically, draw valid statistical inferences, and relate findings to practical or domain-specific contexts.	L5
CO4	Design and present a comprehensive project report and oral presentation demonstrating analytical skills, teamwork, and professional ethics.	L6

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	3	2
CO2	3	3	3	1	3	2
CO3	3	3	3	1	3	2
CO4	3	3	2	1	3	2

VPM's B.N. Bandodkar College of Science (Autonomous), Thane

Curriculum Structure for the Undergraduate Degree Programme T.Y.B.Sc. Statistics

	SEMESTER – V	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
25BUST5T01	Distribution Theory	--	--	√	--	--	--	--
25BUST5T02	Theory of Estimation	--	--	√	--	--	--	--
25BUST5T03	Introduction to Regression Analysis	√	--	√	--	--	--	--
25BUST5P01	Practical Based on 25BUST6T01	√	--	√	--	--	--	--
25BUST5P02	Practical Based on 25BUST6T02	√	--	√	--	--	--	--
25BUST5P03	Practical Based on 25BUST6T03	√	--	√	--	--	--	--
	DSE Course Title							
25BUST5TE1	Biostatistics	--	--	√	--	--	--	--
25BUST5PE1	Practical Based on 25BUST5TE1	√	--	√	--	--	--	--
25BUST5TE2	Applied Statistics -I	--	--	√	--	--	--	--
25BUST5PE2	Practical Based 25BUST5TE2	√	--	√	--	--	--	--
	Minor Course Title							
25BUST5TMN	Business Statistics	√	--	√	--	--	--	--
	Skill Enhancement Course (SEC)							
25BUST5SEC	Data Science and Statistical Learning-I	√	√	√	--	--	--	--
	On Job Training							
25BUST5OJT	On Job Training in Statistics I	√	√	√	√	√	√	√
25BUST5FPR	Field Project in Statistics III	√	√	√	√	√	√	√
14	***Total***	**10**	**03**	**14**	**02**	**02**	**02**	**02**

	SEMESTER – VI	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
25BUST6T01	Stochastic Processes	--	--	√	--	--	--	--
25BUST6T02	Testing of Hypothesis	--	--	√	--	--	--	--
25BUST6T03	Optimization Techniques and Reliability	√	--	√	--	--	--	--
25BUST6IKS	Indian Knowledge System in Statistics	--	--	--	--	--	--	--
25BUST6P01	Practical Based on 25BUST6T01	√	--	√	--	--	--	--
25BUST6P02	Practical Based on 25BUST6T02	√	--	√	--	--	--	--
25BUST6P03	Practical Based on 25BUST6T03	√	--	√	--	--	--	--
	DSE Course Title							
25BUST6TE1	Industrial Statistics	√	--	√	--	--	--	--
25BUST6PE1	Practical's Based on 25BUST6PE1	√	--	√	--	--	--	--
25BUST6TE2	Applied Statistics-II	--	--	√	--	--	--	--
25BUST6PE2	Practical's Based on 25BUST6TE2	√	--	√	--	--	--	--
	Skill Enhancement Course (SEC)							
25BUST6SEC	Data Science and Statistical Learning-II	√	√	√	--	--	--	--
	On Job Training							
25BUST6OJT	On Job Training in Statistics II	√	√	√	√	√	√	√
25BUST5FPR	Field Project in Statistics IV	√	√	√	√	√	√	√
14	***Total***	**10**	**03**	**14**	**02**	**02**	**02**	**02**