AC: 02.06.2025 ITEM NO: 24.2

Deccan Education Society's

Kirti M. Doongursee College of Arts, Science and Commerce (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for
Program: Bachelor of Science
Course: S.Y.B.Sc.
Subject: Statistics

Choice Based Credit System (CBCS)
with effect from
Academic Year 2024-2025
(NEP 2020)

PROGRAM OUTCOMES

PO	Description
A student completing Bachelor's Degree in **Science** Program will be able to	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate Programme. Execute strong theoretical and practical understanding generated from the specific graduate Programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioral skills needed for successful social adaptation, work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependently and collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

Deccan Education Society's

Kirti M. Doongursee College (Autonomous)

Proposed Curriculum as per NEP 2020

Year of implementation- 2024-25

Name of the Department: Statistics

Semester	Course Code	Course Title	Vertical	Credit
III	24STAMJ311	Probability Distributions-I	Major	2
	24STAMJ312	Sampling Theory	Major	2
	24STAMJP31	Practical-I	Major	4
	24STAMR321	Statistical Techniques-II	Minor	2
	24STAMRP31	Practical-I	Minor	2
	24STAEOE331	Introduction to Statistics – II	OE	2
	24STAVC341	Statistics Using R-Software	VSC	2
IV	24STAMJ411	Probability Distributions-II	Major	2
	24STAMJ412	Analysis of Variance & Design of Experiments	Major	2
	24STAMJP41	Practical-II	Major	4
	24STAMR421	Correlation and Regression Analysis	Minor	2
	24STAMRP41	Practical-II	Minor	2
	24STAEOE431	Applied Statistics	OE	2
	24STASE451	Introduction To R-Software	SEC	2

Course Code	MAJOR SEM – III	Credits	Lectures /Week
24STAMJ311	**Paper I - Probability Distributions-I**	**2**	**2**

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Identify and recall key properties of moment generating functions (M.G.F.), cumulant generating functions (C.G.F.), and characteristic functions. Recognize definitions, formulas, and relationships for standard discrete probability distributions.

CO2: Interpret properties such as additive and uniqueness, and explain their application to distributions. Illustrate the relationship between moments and cumulants and analyze real-life applications of discrete distributions.

CO3: Apply M.G.F. and C.G.F. to compute mean, variance, skewness, and kurtosis for given probability distributions. Use transformations and recurrence relations to solve problems.

CO4: Evaluate the suitability of different discrete probability distributions for real-world scenarios.

Unit	Topics	No of Lectures
I	**Moment Generating Function (M.G.F.):** **Definition** Properties: a) Effect of change of origin and scale, b) M.G.F of sum of two independent random variables X and Y, c) Extension of this property for 'n' independent random variables and for 'n' i.i.d. random variables. d) All above properties with proof, e) Uniqueness Property without proof. f) Raw moments using M.G.F: using expansion method and using derivative method. **Cumulant generating Function(C.G.F.):** a) Definition and Properties b) Effect of change and origin and scale, c) Additive Property of C.G.F. and Cumulants, both properties with proof. d) Obtaining Cumulants using C.G.F. e) Derivation of relationship between moments	**15**

	and Cumulants up to order four. **Characteristic Function:** a) Definition and properties (without Proof) b) Examples of obtaining raw moments and central moments up to order four using M.G.F. and C.G.F. for continuous and discrete distributions. **Degenerate distribution:** a) (One point distribution) P(X=c) =1 b) Mean, Variance, Use of Degenerate distribution. **Discrete Uniform distribution**. a) Mean, Variance, coefficient of skewness using m.g.f. **Bernoulli distribution:** a) Mean, Variance, coefficient of skewness using m.g.f. **Binomial distribution:** a) Mean, Variance, Measures of skewness and Kurtosis based on moments using M.G.F. and C.G.F., Additive property, b) If X follows Binomial, then to find distribution of n-X. c) Recurrence relation for moments with proof. $\mu'_{r+1} = npq\mu'_r + pq\frac{d}{dp}\mu'_r$ $\mu_{r+1} = pq[nr\mu_{r-1} + \frac{d}{dp}\mu_r]$ d) Relation between Bernoulli and Binomial using m.g.f. e) Transformation of random Variable (Univariate): examples based on it.	
II	**Standard Discrete Probability Distributions** **Poisson distribution:** a) Mean, Variance, Measures of skewness and Kurtosis based on moments using M.G.F. and C.G.F., Additive property. b) Recurrence relation for moments with proof for μ'_{r+1} μ_{r+1} c) If X and Y are two independent Poisson variables Conditional distribution of X	**15**

	given X+Y with proof d) Poisson distribution as limiting distribution of Binomial (with proof). e) Real life examples of Binomial, Poisson distribution. **Geometric Distribution:** a) Definition in terms of No. of failures and No. of trials. b) Mean, Variance, M.G.F., Mean and Variance using M.G.F., C.G.F., Mean and Variance, μ_3, μ_4 using C.G.F., Coefficients of skewness and Kurtosis and nature of probability distribution. c) Lack of Memory property with proof. d) If X and Y are two i.i.d. Geometric variables; Conditional distribution of X given X+Y with proof. e) Distribution of sum of k i.i.d. Geometric variables. **Negative Binomial Distribution:** a) Definition, Mean, Variance, M.G.F., Mean and Variance using M.G.F., C.G.F., b) Recurrence relation for central moments, Mean, Variance, μ_3, μ_4 using C.G.F., c) Coefficients of skewness and Kurtosis. d) Lack of Memory property (without proof). e) Recurrence relation for probabilities, fitting of distribution. f) Limiting distribution of Negative Binomial distribution (with proof). **Hyper geometric distribution:** a) Definition, Mean, Variance, Limiting distribution of Hyper geometric distribution (with proof). b) If X and Y are two independent Binomial variables, Conditional distribution of X given X+Y (with proof). **Truncated distribution:** a) Definition b) Truncated Binomial and Truncated Poisson	

	Distribution: (truncated at 0) c) Probability mass function, mean and variance. • Real life situations of Geometric, Negative Binomial, Hypergeometric distributions.	

References:

1. Introduction to Mathematical Statistics: R.V.Hogg, A.T. Craig; Fourth Edition; Collier McMillanPublishers.
2. Probability and Statistical Inference: R.V.Hogg, E. A.Tannis, Third Edition; Collier McMillan Publishers.
3. Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.
4. Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.

Course Code	MAJOR SEM – III	Credits	Lectures /Week
24STAMJ312	Paper II - Sampling Theory	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Define and identify basic concepts of population, sample, parameter, statistic, estimator, sampling methods, errors. Recall the definitions and procedures for Simple Random Sampling (SRS) and Stratified Sampling.

CO2: Explain the differences between census surveys and sample surveys, sampling and non-sampling errors, and probability and non-probability sampling methods. Interpret the need for stratification in populations and describe the advantages of stratified sampling.

CO3: Apply methods such as SRS (with and without replacement) and stratified random sampling to estimate population mean, total, and proportion. Compute expectations, variances, and unbiased estimators of variance for given sampling methods.

CO4: Analyze the efficiency of SRS and Stratified Sampling under proportional and Neyman allocation. Compare and evaluate the effectiveness of these methods in achieving accurate population estimates based on variance and allocation techniques.

Unit	Topics	No of Lectures
I	**Concepts:** a) Population, Population unit, Sample, Sample unit, Parameter, Statistic, Estimator, Bias, Unbiased, Mean square error & Standard error. b) Census survey, Sample Survey. Steps in conducting sample survey with examples on designing appropriate Questionnaire. c) Concepts of Sampling and Non-sampling errors. d) NSSO, CSO and their functions. e) Concepts and methods of Probability and Non-Probability Sampling. **Simple Random Sampling: (SRS).** a) Definition, Sampling with & without replacement (WR/WOR).	15

	b) Lottery method & use of Random numbers to select Simple random sample. c) Estimation of population mean & total. d) Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators. (WR/WOR). e) Estimation of population proportion. f) Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators(WR/WOR). g) Estimation of Sample size based on a desired accuracy in case of SRS for variables & attributes. (WR/WOR) (Without Proof).	
II	**Stratified Sampling:** a) Need for Stratification of population with suitable examples. b) Definition of Stratified Sample. c) Advantages of stratified Sampling. **Stratified Random Sampling:** a) Estimation of population mean & total in case of Stratified Random Sampling (WOR within each strata). b) Expectation & Variance of the unbiased estimators, Unbiased estimators of variances of these estimators. c) Proportional allocation, Optimum allocation with and without varying costs. d) Comparison of Simple Random Sampling, Stratified Random Sampling using Proportional allocation and Neyman allocation.	**15**

References:

1. Sampling Techniques: W.G. Cochran; 3rd Edition; Wiley(1978)
2. Sampling Theory and methods: M.N. Murthy; Statistical Publishing Society. (1967)
3. Sampling Theory: Des Raj; McGraw Hill Series in Probability and Statistics. (1968).
4. Sampling Theory of Surveys with Applications: P.V. Sukhatme and B.V. Sukhatme; 3rd Edition; Iowa State University Press (1984).
5. Fundamentals of Applied Statistics: S. C. Gupta and V.K. Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
6. Theory and Analysis of Sample Survey Designs: Daroga Singh, F.S.Chaudhary, Wiley Eastern Ltd. (1986).

7. Sampling Theory and Methods: S. Sampath, Second Edition (2005),Narosa.
8. Theory and Methods of Survey Sampling: Parimal Mukhopadhyay, (1998), Prentice Hall Of India Pvt. Ltd.

Course Code	**SEM III**	**Credits**	**Lectures/ Week**
24STAMJP31	**Practical - I**	**4**	**8**

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Design questionnaires for collecting data in various scenarios, ensuring clarity and relevance of questions.

CO2: Utilize techniques for fitting standard discrete distributions to empirical data sets.

CO3: Compute probabilities of standard probability distributions.

CO4: Draw random samples by various sampling methods.

Paper I	Title	No. of lectures
1	Moment Generating Function, Moments.	**120**
2	Cumulant generating Function, Cumulants, Characteristic function.	
3	Discrete Uniform Distribution	
4	Bernoulli Distribution	
5	Binomial distribution	
6	Poisson Distribution	
7	Geometric Distribution	
8	Negative Binomial Distribution	
9	Hypergeometric distribution	
10	Fitting of Standard Discrete Distributions - I	
11	Fitting of Standard Discrete Distributions - II	
12	Transformation of discrete & continuous random variables.	
Paper II		
1	Designing of Questionnaire.	
2	Data collection & writing a report.	
3	Simple Random Sampling for Variables-I.	

4	Simple Random Sampling for Variables-II.	
5	Simple Random Sampling for Attributes-I.	
6	Simple Random Sampling for Attributes-II.	
7	Estimation of Sample Size in Simple Random Sampling for Variables.	
8	Estimation of Sample Size in Simple Random Sampling for Variables.	
9	Stratified Random Sampling-I.	
10	Stratified Random Sampling-II.	

References:

1. Introduction to Mathematical Statistics: R.V.Hogg, A.T. Craig; Fourth Edition; Collier McMillanPublishers.
2. Probability and Statistical Inference: R.V.Hogg, E. A.Tannis, Third Edition; Collier McMillan Publishers.
3. Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.
4. Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.
5. Sampling Techniques: W.G. Cochran; 3rd Edition; Wiley (1978)
6. Sampling Theory and methods: M.N. Murthy; Statistical Publishing Society. (1967)
7. Sampling Theory: Des Raj; McGraw Hill Series in Probability and Statistics. (1968).
8. Sampling Theory of Surveys with Applications: P.V. Sukhatme and B.V. Sukhatme; 3rd Edition; Iowa State University Press (1984).
9. Fundamentals of Applied Statistics: S. C. Gupta and V.K. Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
10. Theory and Analysis of Sample Survey Designs: Daroga Singh, F.S.Chaudhary, Wiley Eastern Ltd. (1986).

Course Code	MINOR SEM – III	Credits	Lectures /Week
24STAMR321	Paper I- Statistical Techniques-II	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Recall fundamental concepts of probability, including sample space, events, probability distributions, and moments, as well as definitions and properties of discrete random variables.

CO2: Explain probability theorems, including addition, multiplication theorem on probability, along with the properties of standard discrete distributions, moments, and bivariate distributions.

CO3: Apply probability concepts and Bayes' theorem to solve real world problems, compute mean, variance, and moments for discrete distributions, and calculate probabilities for joint, marginal, and conditional distributions.

CO4: Evaluate the impact of conditional probability and independence on real-world scenarios, and interpret relationships between random variables using measures like covariance, correlation, and joint probability distributions.

Unit	Topics	No of Lectures
I	**Elementary Probability Theory** a) Trial, random experiment, sample point and sample space. b) Definition of an event. Operation of events, mutually exclusive and exhaustive events. c) Classical (Mathematical) and Empirical definitions of Probability and their properties. d) Theorems on Addition and Multiplication of probabilities. e) Independence of events, pairwise and mutual independence for two event, Conditional probability.	15

II	**Discrete Random Variable and Some Standard Discrete Distributions** a) Random variable. Definition and properties of probability distribution and cumulative distribution function of discrete random variable. b) Raw and Central moments (definition only) and their relationship (up to order three). c) Expectation of a random variable. Theorems on Expectation & Variance. d) Joint probability mass function of two discrete random variables. e) Marginal and conditional distributions. Theorems on Expectation & Variance, Covariance and Coefficient of Correlation. Independence of two random variables. f) Bernoulli, Binomial and Poisson distributions and derivation of their mean and variance.	**15**

References:

1. Gupta V. K. & Kapoor S. C.: Fundamentals of Mathematical Statistics, Sultan & Chand.
2. Mood A. M., Graybill F. A. and Boes D. C.: Introduction to the Theory of Statistics, McGraw Hill.
3. Hogg, R. V., Tanis, E.A. and Rao J.M.: Probability and Statistical Inference, Seventh Edition, Pearson Education, New Delhi.

Course Code	MINOR SEM - III	Credits	Lectures/ Week
24STAMRP31	**Practical - I**	**2**	**4**

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Recognize the fundamental concepts of probability, discrete random variables, and their probability distributions, including the Binomial and Poisson distributions.

CO2: Explain the relationship between probability and real-world scenarios, such as deriving and interpreting the properties of bivariate probability distributions and discrete random variables.

CO3: Apply probability concepts to solve practical problems involving Binomial and Poisson distributions, and compute probabilities, expectations, and variances using real-world datasets.

CO4: assess the suitability of Binomial and Poisson distributions for modeling given practical data scenarios.

Practical No.	Title	No. of lectures
1	Probability-I	**60**
2	Probability - II	
3	Discrete Random Variables - I	
4	Discrete Random Variables - II	
5	Bivariate Probability Distributions –I	
6	Bivariate Probability Distributions –II	
7	Discrete Uniform Distribution	
8	Bernoulli distribution	
9	Binomial distribution	
10	Poisson distribution	

References:

1. Gupta V. K. & Kapoor S. C.: Fundamentals of Mathematical Statistics, Sultan & Chand.
2. Mood A. M., Graybill F. A. and Boes D. C.: Introduction to the Theory of Statistics, McGraw Hill.
3. Hogg, R. V., Tanis, E.A. and Rao J.M.: Probability and Statistical Inference, Seventh Edition, Pearson Education, New Delhi.

Course Code	OE SEM – III	Credits	Lectures /Week
24STAOE331	**Introduction to Statistics - II**	**2**	**2**

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Recall fundamental concepts of probability, including sample space, events, probability distributions, and moments, as well as definitions and properties of discrete random variables.

CO2: Explain probability theorems, including addition, multiplication theorem on probability, along with the properties of standard discrete distributions, moments, and bivariate distributions.

CO3: Apply probability concepts and Bayes' theorem to solve real world problems, compute mean, variance, and moments for discrete distributions, and calculate probabilities for joint, marginal, and conditional distributions.

CO4: Evaluate the impact of conditional probability and independence on real-world scenarios, and interpret relationships between random variables using measures like covariance, correlation, and joint probability distributions.

Unit	Topics	No of Lectures
I	**Elementary Probability Theory** f) Trial, random experiment, sample point and sample space. g) Definition of an event. Operation of events, mutually exclusive and exhaustive events. h) Classical (Mathematical) and Empirical definitions of Probability and their properties. i) Theorems on Addition and Multiplication of probabilities. j) Independence of events, pairwise and mutual independence for two event, Conditional probability.	**15**

II	**Discrete Random Variable and Some Standard Discrete Distributions** g) Random variable. Definition and properties of probability distribution and cumulative distribution function of discrete random variable. h) Raw and Central moments (definition only) and their relationship (up to order three). i) Expectation of a random variable. Theorems on Expectation & Variance. j) Joint probability mass function of two discrete random variables. k) Marginal and conditional distributions. Theorems on Expectation & Variance, Covariance and Coefficient of Correlation. Independence of two random variables. l) Bernoulli, Binomial and Poisson distributions and derivation of their mean and variance.	**15**

References:

1. Gupta V. K. & Kapoor S. C.: Fundamentals of Mathematical Statistics, Sultan & Chand.
2. Mood A. M., Graybill F. A. and Boes D. C.: Introduction to the Theory of Statistics, McGraw Hill.
3. Hogg, R. V., Tanis, E.A. and Rao J.M.: Probability and Statistical Inference, Seventh Edition, Pearson Education, New Delhi.

Course Code	VOCATIONAL SKILL COURSE SEM – III	Credits	Lectures /Week
24STAVC341	Statistics Using R-Software	2	4

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Learn how to compute probabilities, percentiles, and cumulative distribution functions for various distributions using R functions.

CO2: Understand basic syntax and data structures in R, including vectors, matrices, data frames, and lists.

CO3: Compute and interpret measures of central tendency such as mean, median, and mode and measures of dispersion including range, variance, standard deviation, and interquartile range using R.

CO4: Develop skills in creating a variety of graphical representations including histograms, bar plots, scatter plots, and box plots using R.

Practical No.	Title	No. of lectures
1	Fundamentals of R - I	**60**
2	Fundamentals of R - II	
3	Graphs and Diagrams using R	
4	Measures of Central Tendency using R - I	
5	Measures of Central Tendency using R - II	
6	Measures of Dispersion using R	
7	Discrete Probability distributions using R	
8	Continuous Probability distributions using R	
9	Regression Analysis using R	
10	ANOVA using R	

References:

1. Dalgaard, Peter: Introductory Statistics with R, Springer.
2. Wickham, Hadley & Grolemund, Garrett: R for Data Science, O'Reilly Media.
3. Verzani, John: Using R for Introductory Statistics, CRC Press.
4. Crawley, Michael J.: The R Book, Wiley.
5. Bruce, Peter, Bruce, Andrew, & Gedeck, Peter: Practical Statistics for Data Scientists: 50 Essential Concepts with R and Python, O'Reilly Media.

Course Code	MAJOR SEM – IV	Credits	Lectures /Week
24STAMJ411	**Paper I – Probability Distributions - II**	**2**	**2**

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Recognize and define the properties, parameters of standard continuous probability distributions, along with exact sampling distributions like Chi-square, Student's t, and Snedecor's F-distributions.

CO2: Interpret the characteristics, applications, and significance of continuous probability distributions and exact sampling distributions in real-world scenarios.

CO3: Utilize statistical software or tools like Excel or R to compute probabilities, derive distribution parameters, and conduct hypothesis testing using Chi-square, t-tests, and F-tests for practical datasets.

CO4: Evaluate relationships and transformations in continuous random variables, analyze complex scenarios using Central Limit Theorem, and assess the applicability of exact sampling distributions in decision-making processes, including variance and goodness-of-fit tests.

Unit	Topics	No of Lectures
I	**Standard Continuous Probability Distributions:** **Rectangular or Continuous Uniform** over (a, b) a) Mean, Median Standard deviation, C.D.F., M.G.F., Mean, variance, μ_3 using M.G.F., skewness of distribution. **Exponential Distribution** a) Definition, M.G.F., C.G.F. raw moments and central moments up to order four using M.G.F. and C.G.F. b) Forgetfulness Property with proof and examples based on it (Without Proof). c) Distribution of ratio of two i.i.d. Exponential random variables. **Cauchy (with location and scale parameter)** a) Properties. b) Quartiles and percentiles. **Gamma (with Scale and shape parameter)** a) Expression for r^{th} raw moment. b) Mean, variance & Standard deviation.	**15**

	c) M.G.F., Additive property, C.G.F.. raw moments and central moments up to order four using M.G.F.. and C.G.F. d) Coefficients of skewness and Kurtosis. e) Distribution of sum of independent exponential random variables. **Beta Distribution: Type I & Type II:** a) Expression for r^{th} raw moment, Mean and Standard deviation. b) If a r.v. X follows Beta of type 1, distribution of 1- X. **Normal Distribution:** a) Definition, Derivation of Mean, Median, Mode, Standard deviation, M.G.F., C..G,F., Moments & Cumulants (up to fourth order). skewness & kurtosis, Nature of Normalcurve, b) Mean absolute deviation. c) Properties of Normal Distribution. d) Expression for even order central moments and to show that odd order centralmoments are zero. Percentiles. e) Distribution of Standard normal variable, Percentiles. Distribution of linear function of independent Normal variables (i)aX, (ii). X+b, (iii). aX+bY in particular X+Y and X-Y, (iv) $\sum_{i=1}^{p} a_i x_i$ (all with proof) f) Fitting of Normal Distribution. g) Central Limit theorem for i.i.d. random variables.(with proof) h) Log Normal Distribution: Derivation of mean & variance. i) Distribution of product of n log normal random variables.	

II	**Exact Sampling Distributions:** **Chi-Square Distribution:** a) Derivation of p.d.f., Concept of degrees of freedom. Mean, Mode & Standard deviation. M.G.F., C.G.F., Measures of skewness and Kurtosis, Additive property. b) Distribution of ratio of two independent Chi-square variables c) Distribution of $\frac{X}{x+Y}$ if X and Y are two independent Chi-square variables(All with proof). d) Distribution of the sum of squares of independent Standard Normal variables. e) Sampling distributions of sample mean and sample variance and their independencefor a sample drawn from Normal distribution (with proof). **Applications of Chi-Square:** a) Development of decision criterion with test procedures of (i) Test of significance for specified value of variance of a Normal population (ii) Test for goodness of fit b) Test Procedure for independence of attributes. (i) r×c contingency table, (ii) 2× 2 contingency table, Derivation of test statistic, Yates' correction withproof c) Derivation of Confidence interval for the variance of a Normal population when (i) mean is known, (ii) mean is unknown. **Student's t-distribution:** a) Derivation of p.d.f. , Mean, Median, Mean Deviation & Standard deviation. b) M.G.F., C.G.F. , Measures of skewness and Kurtosis and Additive property c) Limiting distribution of t distribution with proof. **Applications of t:** a) Development of decision criterion with test procedure of Test of significance for specified value of mean of Normal population. b) Test procedure of test of significance for difference between	**15**

	means of: (i) Two independent Normal populations with equal variances (ii) Dependent samples (Paired t test) c) Derivation of Confidence intervals for: (i) Mean of Normal population, (ii) Difference between means of two independent Normal populations having the same variance. **Snedecor's F-distribution:** a) Derivation of p.d.f. , Expression for r^{th} raw moment, Mean, variance, Mode & Standard deviation b) Distribution of Reciprocal of F variable with proof. c) Applications of F: Test procedure for testing equality of variances of two independent Normal populations (i) Mean is known (ii) Mean is unknown d) Derivation of confidence interval for ratio of variances of two independent Normal populations	

References:

1. Probability and Statistical Inference: R.V.Hogg, E. A.Tannis, Third Edition; Collier McMillan Publishers.
2. Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.
3. Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.

Course Code	MAJOR SEM – IV	Credits	Lectures /Week
24STAMJ412	**Paper II - Analysis of Variance &Design of Experiments**	**2**	**2**

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Identify the fundamental concepts of analysis of variance (ANOVA) and design of experiments, including key terms such as experimental unit, treatment, block, and replicate.

CO2: Explain the principles of experimental design (randomization, replication, and local control) and their role in improving precision and reducing experimental error in agricultural and non-agricultural contexts.

CO3: Perform analysis of variance for one-way and two-way classifications and apply Completely Randomized Design (CRD) and Randomized Block Design (RBD) using statistical software to construct ANOVA tables and calculate efficiency.

CO4: Evaluate the efficiency of different experimental designs, compare the results of CRD and RBD, and assess the implications of assumptions and variances in the estimation of parameters in real-life experimental data.

Unit	Topics	No of Lectures
I	**Analysis of Variance:** a) Introduction, Uses, Cochran's Theorem (Statement only). b) One-way classification with equal & unequal observations per class c) Two-way classification with one observation per cell. d) Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. e) Least square estimators of the parameters, Variance of the estimators.	**15**
II	**Design of Experiments:** a) **Concepts**: Experiments, Experimental unit, Treatment, Yield, Block, Replicate,Experimental Error, Precision.	**15**

	b) Principles of Design of Experiments: Replication, Randomization & Local Control. c) Efficiency of design D_1 with respect to design D_2. d) Choice of size, shape of plots & blocks in agricultural & nonagricultural experiments. **Completely Randomized Design (CRD) & Randomized Block Design (RBD):** a) Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. b) Least square estimators of the parameters, Variance of the estimators, c) Efficiency of RBD relative to a CRD.	

References:

1. Experimental Designs: W.G. Cochran and G.M.Cox; Second Edition;John Wiley and Sons.
2. The Design and Analysis of Experiments: Oscar Kempthorne, John Wiley and Sons.
3. Design and Analysis of Experiments: Douglas C Montgomery; 6th Edition;John Wiley & Sons.
4. Design and Analysis of Experiments: M.N.Das and N.C.Giri, 2nd Edition; New Age International (P) Limited;1986.
5. Experimental Design, Theory and Application: Walter T Federer; Oxford & IBH Publishing Co. Pvt. Ltd.
6. Fundamentals of Applied Statistics: S.C.Gupta and V.K.Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
7. Statistical Principles in Experimental Design: B.J. Winer, McGraw Hill Book Company.

Course Code	SEM IV	Credits	Lectures/ Week
24STAMJP41	**Practical - II**	**4**	**8**

Course Outcomes:
After successful completion of this course, students would be able to:
CO1: Recall the fundamental properties and formulas of standard continuous probability distributions, including Normal, Chi-square, t, and F distributions, and their real-world applications.
CO2: Interpret the results of analysis of variance (ANOVA) for one-way and two-way classifications and explain the significance of the F-test in determining statistical differences among group means.
CO3: Conduct ANOVA and implement Completely Randomized Design (CRD) and Randomized Block Design (RBD) for given datasets using statistical software like R, interpreting outputs such as F-statistics and p-values.
CO4: Evaluate the efficiency of CRD and RBD, compare results from ANOVA tests, and assess the suitability of various experimental designs for solving practical problems across diverse fields using R-software.

Paper I		No. of lectures
1	Rectangular Distribution	120
2	Exponential Distribution	
3	Gamma Distribution	
4	Beta distribution of type - I	
5	Beta distribution of type - II	
6	Normal Distribution - I	
7	Normal Distribution - II	
8	Chi-square Distribution - I	
9	Chi-square Distribution - II	
10	t-distribution - I	
11	t-distribution - II	
12	F-distribution	
Paper II		
1	Analysis of Variance- One Way.	
2	Analysis of Variance- Two Way.	
3	Completely Randomized Design-I.	
4	Completely Randomized Design-II.	

5	Randomized Block Design-I.	
6	Randomized Block Design-II.	
7	Completely Randomized Design-I Using R-software.	
8	Completely Randomized Design-II Using R-software.	
9	Randomized Block Design-I Using R-software.	
10	Randomized Block Design-II Using R-software.	

References:

1. Probability and Statistical Inference: R.V.Hogg, E. A.Tannis, Third Edition; Collier McMillan Publishers.
2. Introduction to Mathematical Statistics: P.G. Hoel; Fourth Edition; John Wiley & Sons Inc.
3. Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth Edition; Sultan Chand & Sons.
4. Experimental Designs: W.G. Cochran and G.M.Cox; Second Edition;John Wiley and Sons.
5. The Design and Analysis of Experiments: Oscar Kempthorne, John Wiley and Sons.
6. Design and Analysis of Experiments: Douglas C Montgomery; 6th Edition;John Wiley & Sons.
7. Design and Analysis of Experiments: M.N.Das and N.C.Giri, 2nd Edition; New Age International (P) Limited;1986.
8. Experimental Design, Theory and Application: Walter T Federer; Oxford & IBH Publishing Co. Pvt. Ltd.
9. Fundamentals of Applied Statistics: S.C.Gupta and V.K.Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
10. Statistical Principles in Experimental Design: B.J. Winer, McGraw Hill Book Company.

Course Code	MINOR SEM – IV	Credits	Lectures /Week
24STAMR421	Correlation and Regression Analysis	2	2

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Recall the concepts of scatter diagrams, correlation coefficients, and their properties for understanding relationships between variables.

CO2: Explain the principles of linear regression, the method of least squares, and the interrelationship between regression and correlation coefficients.

CO3: Compute and interpret correlation coefficients (product moment and Spearman's rank) and fit linear regression lines to datasets using manual calculations.

CO4: Fit regression line and different types of curves using the method of least squares.

Unit	Topics	No of Lectures
I	**Correlation Analysis**: a) Scatter Diagram. b) Product moment correlation coefficient and its properties. c) Spearman's Rank correlation. (With and without ties)	15
II	**Regression Analysis:** a) Concept of linear regression. b) Principle of least squares. Fitting a straight line by method of least squares. c) Relation between regression coefficients and correlation coefficients.	15

References:

1. Gupta V. K. & Kapoor S. C.: Fundamentals of Mathematical Statistics, Sultan & Chand
2. Hogg R. V. and Crag R. G.: Introduction to Mathematical Statistics
3. Gupta S. P. (2002): Statistical Methods, Sultan Chand and Sons, New Delhi.

Course Code	MINOR SEM - IV	Credits	Lectures/ Week
24STAMRP41	**Practical - II**	**2**	**4**

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Recall and identify the key concepts of correlation analysis, including scatter diagrams, product moment correlation, and Spearman's rank correlation, to understand variable relationships.

CO2: Understand the properties of correlation coefficients and the role of regression analysis in predicting relationships between variables.

CO3: Carry out a simple linear regression and interpret regression coefficient and coefficient of determination.

CO4: Critically evaluate and compare the strength and direction of relationships between variables through correlation and regression techniques, using real-world datasets and statistical tools.

Paper I		No. of lectures
1	Correlation Analysis - I	60
2	Correlation Analysis - II	
3	Regression Analysis - I	
4	Regression Analysis - II	
5	Curve fitting-I.	
6	Curve fitting-II.	
7	Correlation Analysis Using Excel.	
8	Regression Analysis Using Excel.	
9	Curve fitting Using Excel.	
10	Revision of practicals.	

References:

1. Gupta V. K. & Kapoor S. C.: Fundamentals of Mathematical Statistics, Sultan & Chand
2. Hogg R. V. and Crag R. G.: Introduction to Mathematical Statistics
3. Gupta S. P. (2002): Statistical Methods, Sultan Chand and Sons, New Delhi.

Course Code	OE SEM – IV	Credits	Lectures /Week
24STAOE431	**Applied Statistics**	**2**	**2**

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Recall the concepts of scatter diagrams, correlation coefficients, and their properties for understanding relationships between variables.

CO2: Explain the principles of linear regression, the method of least squares, and the interrelationship between regression and correlation coefficients.

CO3: Compute and interpret correlation coefficients (product moment and Spearman's rank) and fit linear regression lines to datasets using manual calculations.

CO4: Fit regression line and different types of curves using the method of least squares.

Unit	Topics	No of Lectures
I	**Correlation Analysis**: a) Scatter Diagram. b) Product moment correlation coefficient and its properties. c) Spearman's Rank correlation. (With and without ties)	**15**
II	**Regression Analysis:** a) Concept of linear regression. b) Principle of least squares. Fitting a straight line by method of least squares. c) Relation between regression coefficients and correlation coefficients.	**15**

References:

1. Gupta V. K. & Kapoor S. C.: Fundamentals of Mathematical Statistics, Sultan & Chand
2. Hogg R. V. and Crag R. G.: Introduction to Mathematical Statistics
3. Gupta S. P. (2002): Statistical Methods, Sultan Chand and Sons, New Delhi.

Course Code	SKILL ENHANCEMENT COURSE SEM – IV	Credits	Lectures /Week
24STASE451	Introduction To R-Software	2	4

Course Outcomes:

After successful completion of this course, students would be able to:

CO1: Install R, managing packages, and navigating the R environment. Import, manipulate, and export data efficiently using R

CO2: Understand basic syntax and data structures in R, including vectors, matrices, data frames, and lists.

CO3: Develop skills in creating a variety of graphical representations including histograms, bar plots, scatter plots, and box plots using R.

CO4: Perform various mathematical operations using R.

Practical No.	Title	No. of lectures
1	Fundamentals of R - I	60
2	Fundamentals of R - II	
3	Data Structures in R	
4	Mathematical Operations using R - I	
5	Mathematical Operations using R - II	
6	Graphs and Diagrams using R - I	
7	Graphs and Diagrams using R - II	
8	Measures of Central Tendency using R	
9	Measures of dispersion using R	
10	Probability distributions using R	

References:

1. Dalgaard, Peter: Introductory Statistics with R, Springer.
2. Wickham, Hadley & Grolemund, Garrett: R for Data Science, O'Reilly Media.
3. Verzani, John: Using R for Introductory Statistics, CRC Press.
4. Crawley, Michael J.: The R Book, Wiley.
5. Bruce, Peter, Bruce, Andrew, & Gedeck, Peter: Practical Statistics for Data Scientists: 50 Essential Concepts with R and Python, O'Reilly Media.

Evaluation Scheme for Second Year (UG) under NEP

(2 credits)

I. Internal Evaluation for Theory Courses – 20 Marks

1) Continuous Internal Assessment(CIA) Assignment – 10 marks

2) Continuous Internal Assessment(CIA) ONLINE Unit Test – 10 marks

II. External Examination for Theory Courses – 30 Marks

Duration: 1 Hours

Theory question paper pattern: All questions are compulsory.

Question	Based on	Marks
Q.1	Unit I	15
Q.2	Unit II	15

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be sub-divided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.

III. Practical Examination

- Each core subject carries 50 Marks.
- Duration: 2 Hours for each practical course.
- Minimum 80% practical from each core subjects are required to be completed.
- Certified Journal is compulsory for appearing at the time of Practical Exam

NOTE: To pass the examination, attendance is compulsory in both Internal & External (Theory + Practical) Examinations.