

“Dissemination of Education for Knowledge, Science and Culture”

-Shikshanmaharshi Dr. Bapuji Salunkhe



Shri Swami Vivekanand Shikshan Sanstha's

VIVEKANAND COLLEGE, KOLHAPUR
(An EMPOWERED AUTONOMOUS INSTITUTE)

DEPARTMENT OF STATISTICS

Three/Four- Years UG Programme

Department/Subject Specific Core or Major (DSC)

Curriculum, Teaching and Evaluation Structure
for

B. Sc. II Statistics

Semester-III & IV

(Implemented from academic year 2025-26)

Departmental Teaching and Evaluation scheme (NEP-Phase-II)

Three/Four- Years UG Programme Second Year Semester-III & IV

Sr. No.	Course Abbreviation	Course code	Course Name	Teaching Scheme		Examination Scheme and Marks				Course Credits
				Hours/week		ESE	CIE	PR	Marks	
				TH	PR					
Semester-III										
1	DSC-V	2DSC03STA31	Probability Distributions I	2	-	40	10	-	50	2
2	DSC-VI	2DSC03STA32	Statistical Methods	2	-	40	10	-	50	2
3	MIN-V	2MIN03STA31	Data Science	2	-	40	10	-	50	2
4	MIN-VI	2MIN03STA32	Foundations of Inference & Testing	2	-	40	10	-	50	2
5	OEC-PR-III	2OEC03MTS32	Probability & Probability Distributions		4			25	25	2
6	VSC-PR-I	2VSC03STA39	Statistical computing using MS-Excel	-	4	-	-	25	25	2
7	DSC-PR-III	2DSC03STA39	DSC Statistics Practical III	-	8	-	-	50	50	4
8	MIN-PR-III	2MIN03STA39	MIN Statistics Practical III	-	4	-	-	25	25	2
Semester –III Total				8	20	160	40	125	325	18
Semester-IV										
1	DSC-VII	2DSC03STA41	Probability Distributions II	2	-	40	10	-	50	2
2	DSC-VIII	2DSC03STA42	Testing of Hypothesis	2	-	40	10	-	50	2
3	MIN-VII	2MIN03STA41	Vital Statistics	2	-	40	10	-	50	2
4	MIN-VIII	2MIN03STA42	Sampling Techniques	2	-	40	10	-	50	2
5	OEC-PR-IV	2OEC03MTS42	Inferential Statistics: Large & Small Sample Test		4			25	25	2
6	VSC-PR-II	2VSC03STA49	Introduction to R	-	4	-	-	25	25	2
7	DSC-PR-IV	2DSC03STA49	DSC Statistics Practical IV	-	8	-	-	50	50	4
8	MIN-PR-IV	2MIN03STA49	MIN Statistics Practical IV	-	4	-	-	25	25	2
Semester –IV Total				8	20	160	40	125	325	18

B. Sc. Part – II Semester -III STATISTICS**DSC-V: 2DSC03STA31: Probability Distributions-I****Theory: 30 hrs.****Marks-50****(Credits: 02)****Course Outcomes:** At the end of the course students will be able to:

CO1: Understand some discrete probability distributions and its applications.

CO2: Compute various statistical measures for continuous univariate and bivariate random variables.

CO3: Understand transformation of continuous univariate and bivariate random variable.

CO4: Compute various generating functions for continuous univariate and bivariate random variables.

Unit	Contents	Hours Allotted
1	Some Discrete Probability Distributions: 1.1 Geometric Distribution: p.m.f, Mean, Variance, Additive property, Recurrence relation for probabilities, Memory less property, examples. 1.2 Negative Binomial Distribution: p.m.f. with parameters (k, p), Geometric distribution as a particular case of Negative Binomial distribution, Mean, Variance, p. g. f., Additive property, Recurrence relation for successive probabilities, examples. 1.3 Power series distribution: p.m.f., Mean, Mode, Variance. Particular cases of power series distribution: Binomial, Poisson, Geometric and Negative Binomial distribution. 1.4 Multinomial Distribution: p.m.f., Moment Generating Function, Marginal distribution, Mean, Variance, Covariance, Variance & Covariance matrix, Correlation coefficient, Additive property, Trinomial distribution as particular case of multinomial distribution.	15
2	Univariate & Bivariate Continuous Random Variables: Continuous Univariate Random Variables: 2.1 Definition: Continuous sample space with illustrations, continuous random variable (r.v.), probability density function (p.d.f.), cumulative distribution function (c.d.f.) and its properties. 2.2 Expectation of r.v., expectation of function of r.v., mean, median, mode, quartiles, variance, harmonic mean, raw and central moments, skewness and kurtosis, examples. 2.3 Moments generating function (m.g.f.): definition and properties (i) Standardization property $M_X(0) = 1$ (ii) Effect of change of origin and scale (iii) Uniqueness property of m.g.f., if exists (statement only). Raw and central moments using m.g.f. 2.4 Cumulant generating function (c.g.f.): Definition, Cumulants, Properties of c.g.f, relations between cumulants and central moments (up to four order). 2.5 Transformation of univariate continuous r.v.: Distribution of $Y=g(X)$, where g is monotonic or non-monotonic functions using (i) Jacobian method (ii) Distribution function and (iii) M.g.f.	15

	Continuous Bivariate Random Variables: 2.6 Definition of bivariate continuous random variable (X, Y), Joint p.d.f., c.d.f with properties, marginal and conditional distribution, independence of random variables. 2.7 Expectation of function of r.v., means, variances, covariance, correlation coefficient, conditional expectation, conditional variance, regression as conditional expectation if it is linear function of other variable and conditional variance, proof of i) $E(X \pm Y) = E(X) \pm E(Y)$ ii) $E[E(X/Y)] = E(X)$. 2.8 If X and Y are independent r.v. then proof of i) $E(XY) = E(X) E(Y)$, ii) $M_{X+Y}(t) = M_X(t) M_Y(t)$. 2.9 Transformation of continuous bivariate random variables: Distribution of bivariate random variables using Jacobin method and examples	
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Reference Books:

1. Parimal Mukhopadhyay: An Introduction to the Theory of Probability. World Scientific Publishing.
2. Hogg R. V. and Criag A.T.: Introduction to Mathematical Statistics (Third edition), Macmillan Publishing, New York.
3. Gupta S. C. & Kapoor V.K.: Fundamentals of Mathematical Statistics. Sultan Chand & sons, New Delhi.
4. Goon, A.M., Gupta M.K. and Dasgupta B: Fundamentals of Statistics Vol. I and Vol. II World Press, Calcutta.
5. Mood A.M., Graybill F.A.: Introduction to theory of Statistics. (Chapter II, IV, V, VII) and Boes D.C. Tata, McGraw Hill, New Delhi. (Third Edition)
6. Walpole R.E. & Mayer R.H.: Probability & Statistics. (Chapter 4, 5, 6, 8, 10) Mac Millan Publishing Co. Inc, New York.

B. Sc. Part – II Semester -III STATISTICS
DSC-VI: 2DSC03STA32: Statistical Methods

Theory: 30 hrs.

Marks-50

(Credits: 02)

Course Outcomes - At the end of this course students will be able to:

CO1: Understand the concept of multiple linear regression and residual.

CO2: Understand the concept of multiple correlation and partial correlation.

CO3: Understand the components and models of time series.

CO4: Apply various methods to remove trend.

Unit	Contents	Hours Allotted
1	Multiple linear Regression & Multiple Correlation (for trivariate data only): Multiple Linear Regression (for trivariate data only): 1.1 Concept of multiple linear regression, plane of regression, Yule's notation, correlation matrix. 1.2 Fitting of regression plane by method of least squares, definition of partial regression coefficients and their interpretation. 1.3 Residual: definition, order of residual, properties, derivation of mean, Variance and Covariance between residuals. Multiple Correlation: 1.4 Concept of multiple correlations. 1.5 Definition of multiple correlation coefficient $R_{i.jk}$ and its derivation 1.6 Properties of multiple correlation coefficient, Interpretation of $R_{i.jk} = 1$, $R_{i.jk} = 0$, 1.7 Coefficient of multiple determination $R^2_{i.jk}$. Partial Correlation: 1.8 Concept of partial correlation, Definition and derivation of partial correlation coefficient $r_{ij.k}$, properties of partial correlation coefficient and examples.	15
2	Time Series: 2.1 Meaning and need of time series analysis, components of time series. 2.2 Additive and Multiplicative model 2.3 Measurement of trend: (i) Moving averages method (ii) Progressive average method (iii) Least square method. 2.4 Measurement of seasonal variation: Simple average method and Link relative Method 2.5 Examples and Problems	15

Reference Books:

1. Gupta S. C. & Kapoor V.K.: Fundamental of Applied Statistics. Sultan Chand & sons, New Delhi.
2. S. C. Gupta: Fundamentals of Statistics, Himalaya Publishing House, seventh revised & enlarged edition.
3. Goon, A.M., Gupta M.K. and Dasgupta B: Fundamentals of Statistics Vol. I and Vol. II, World Press, Calcutta.
4. Parimal Mukhopadhyay: An Introduction to the Theory of Probability, World Scientific Publishing.

B. Sc. Part – II Semester -III STATISTICS**MIN-V: 2MIN03STA31: Data Science****Theory: 30 hrs.****Marks-50****(Credits: 02)****Course Outcomes:**

At the end of the course students will be able to:

CO1: Understand the fundamentals of Data Science and its applications in various industries.

CO2: Apply data preprocessing, transformation, and visualization techniques for exploratory data analysis (EDA).

CO3: Evaluate models using train-test split and cross-validation methods.

CO4: Explain and apply different classification techniques.

Unit	Content	Hours Allotted
1	1.1 Introduction to Data Science What is Data Science, Applications in industries: healthcare, finance, e-commerce, etc., Data Science Lifecycle, Roles: Data Scientist, Data Analyst, ML Engineer, etc. 1.2 Exploratory Data Analysis (EDA): Types of Data: Structured vs. Unstructured Data, Categorical vs. Numerical Data, Continuous vs. Discrete Data Data Cleaning: Handling duplicates, dealing with inconsistent data, detecting and treating outliers Data Transformation: Smoothing, Attributes/feature construction, Aggregation, Discretization, Normalization. Data Discretization: Binning techniques (Equal-width binning, Equal-frequency binning, Decision tree-based discretization) Data Visualization: Histograms, Boxplots, Scatterplots, Heatmaps, Correlation Matrices Handling Missing Values: Deletion methods, Mean/Median/Mode imputation	15
2	2.1 Learning Methods: Definition and comparison of Supervised and Unsupervised learning, Applications of both learning methods, Examples of problems solved by each approach 2.2 Classification Problem: Basics of classification: Binary vs. Multi-class classification Train-Test Split: Importance, Overfitting vs. Underfitting Cross-Validation: k-Fold Cross-Validation, Leave-One-Out Cross-Validation, Stratified Sampling 2.3 Classification Techniques: K-Nearest Neighbours (KNN), Naïve Bayes Classifier.	15

Reference Books:

1. Margret. H and Dunham: Data Mining- Introductory and Advanced Topics
2. G. K. Gupta: Introduction to Data Mining with case studies
3. R: Zhao: Data Mining Application.
4. Han, Kamber and Pei: Data Mining: Concepts and technique

B. Sc. Part – II Semester -III STATISTICS
MIN-VI: 2MIN03STA32: Foundations of Inference & Testing

Theory: 30 hrs.

Marks-50

(Credits: 02)

Course Outcomes: At the end of the course students will be able to:

CO1. Understand Normal Distribution and its applications.

CO2: Know the basics of testing of hypothesis.

CO3. Develop test procedures for testing of hypothesis.

CO4: Apply large sample and t tests in real life examples.

Unit	Contents	Hours Allotted
1	Normal distribution & Basic terms for testing: Normal Distribution: 1.1 p. d. f., Mean and Variance (without proof), 1.2 Definition of Standard Normal Variate and its p.d.f., 1.3 Properties of normal curve, 1.4 Examples to find probabilities for given area under standard normal curve. 1.5 Basic Terms: Notion of Population, Sample, Parameter, Statistic, Estimate and Estimator, Unbiased Estimator, Properties and examples, Standard Error, Sampling distribution of Statistic, Test Statistic, Central Limit Theorem, Hypothesis, Simple and Composite Hypothesis, Null and Alternative hypothesis, One and two tailed test, Critical region, type I and type II errors, level of significance, p-value, size & power of test.	15
2	Large Sample Tests: 2.1 General procedure of testing of hypothesis. 2.2 Test for Population Mean: i) Test for testing population mean $H_0: \mu = \mu_0$ ii) Test for testing equality of two population means $H_0: \mu_1 = \mu_2$. 2.3 Test for Population Proportion: i) Test for testing population proportion $H_0: P = P_0$ ii) Test for testing equality of two population proportions $H_0: P_1 = P_2$. 2.4 Small Sample Tests: Definition of student's t variate i) Test for testing population mean $H_0: \mu = \mu_0$ ii) Test for testing equality of two population means $H_0: \mu_1 = \mu_2$. iii) Paired t test	15

Reference Books:

1. Gupta S. C. & Kapoor V.K.: Fundamentals of Mathematical Statistics, Sultan Chand & sons, New Delhi, Twelfth edition.
2. Kulkarni, M. B. Ghatpande, S. B. and Gore, S. D.: "Common Statistical Tests", Satyajeet Prakashan, Pune – 11029.
3. Rohatgi V. K.: An Introduction to Probability Theory and Mathematical Statistics.
4. Gupta, S. P.: "Statistical Methods", Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
5. Mukhopadhyay Parimal: "Mathematical Statistics", New Central Book Agency, Pvt. Ltd. Calcutta.

B. Sc. Part – II Semester -III STATISTICS
OEC-PR-III: 2OEC03MTS32: Probability & Probability Distributions
Marks-25 **(Credits: 02)**

Course Outcomes - At the end of this course students will be able to:

CO1: Understand sample space, events, and event operations.

CO2: Apply conditional probability, addition, multiplication laws, and Bayes' Theorem.

CO3: Analyse random variables, probability distributions, and key parameters like mean and variance.

CO4: Solve problems using Binomial, Poisson, and Normal distributions effectively.

Sr. No.	Title of Practical
1	Computation of probabilities of events: I
2	Computation of probabilities of events: II
3	Conditional Probability
4	Baye's Theorem
5	Independence of events
6	Descriptive statistics of discrete random variable
7	Descriptive statistics of continuous random variable
8	Application of Binomial distribution
9	Application of Poisson distribution
10	Application of Normal distribution

Reference Books: -

- 1) Statistical Methods, by Dr. S. P. Gupta, Sultan Chand and Sons Publication.
- 2) Introduction to Statistics, by C.B. Gupta.
- 3) Mathematical Statistics, by H.C. Saxena and J.N. Kapur.
- 4) Fundamentals of Statistics, by S. C. Gupta.

Note: Use of non-programmable calculator is allowed.

B. Sc. Part – II Semester -III STATISTICS**VSC PR-I: 2VSC03STA39: Statistical Computing Using MS-Excel****Marks-25****(Credits: 02)****Course Outcomes** - At the end of this course, students will be able to:

CO1: Understand basic knowledge of MS-Excel.

CO2: Edit data using conditional formatting.

CO3: Understand the use of functions & formulae on Excel spreadsheet & analyse the data using pivot table & pivot charts.

CO4: Understand the use of functions of Excel for fitting of discrete distributions.

Sr. No.	Title of the Experiment
1.	Introduction to MSEXCEL and Use as a calculator.
2.	Data sorting, find , replace , filter tools
3.	Graphical representation: Histogram, ogive curve, frequency polygon, frequency curve.
4.	Diagrammatic representation : Simple bar chart, Multiple bar chart, Subdivided chart, Pia chart, Scatter diagram, Boxplot.
5.	Statistical & Mathematical functions: AVERAGE, MAX, MIN, COUNT, VAR, SLOPE,STDEV.P, GEOMEAN, HARMEAN, KURT, FREQUENCY, INTERCEPT, MEDIAN, CORREL, KURT, MODE,QUARTILES, COVARIANCE,PERMUT,PERCENTILES, SKEW. ABS, COMBIN, EXP,FACT, GCD, LCM, INT, LN, LOG, MOD,MDETERM,MINVERSE, MMULT, POWER, RAND, RANDBETWEEN, SQRT, SUM.
6.	Analysis Through Advanced Conditional Formatting
7.	Construction and Manipulation of Pivot Tables and Pivot chart
8.	Fitting of discrete distributions (Discrete uniform, Binomial , Poisson, Hypergeometric, Geometric and Negative Binomial distribution)
9.	Model Sampling from discrete distributions (Discrete uniform, Binomial , Poisson, Hypergeometric, Geometric and Negative Binomial distribution)
10.	Sketching of p.m.f. and c.d.f. for discrete distributions using MS-EXCEL

Reference Books:

1. M.L. Humphrey Excel for Beginners
2. Paul McFedries Microsoft Excel 2019 Formulas and Functions.
3. Joseph Schmuller Statistical Analysis with Excel.
4. Jordan Goldmiere Advanced Excel Essentials
5. Alan Murray- Advanced Excel success
6. Greg Harvey Excel 2019 dummies.

B. Sc. Part – II Semester -III STATISTICS
DSC-PR-III: 2DSC03STA39: DSC Statistics Practical III

Marks-50

(Credits: 04)

Course Outcomes - At the end of this course students will be able to:

CO1: Compute probabilities of standard probability distributions, expected frequencies and test the goodness of fit.

CO2: Understand generation of random samples from standard probability distributions.

CO3: Understand the applications and sketch of various discrete and continuous distributions

CO4: Solve the real-life problems based on Multiple Regression, Multiple & Partial Correlation, Index Number and Time Series.

Sr. No.	Title of the Experiment
Section I	
1	Fitting of discrete uniform and binomial distribution
2	Fitting of Poisson and Hypergeometric distribution
3	Fitting of Geometric and Negative Binomial distribution.
4	Model sampling from discrete uniform and binomial distribution.
5	Model sampling from Poisson and Hypergeometric distribution
6	Model sampling from Geometric distribution.
7	Model sampling from Negative Binomial distribution.
8	Application of Geometric and Negative binomial distribution
9	Application of Multinomial distribution
10	Continuous Univariate random variable (Problems: probabilities, pdf cdf, mean, median, mode)
11	Continuous bivariate random variable (Problems: probabilities, pdf cdf, mean, median, mode)
Section II	
1	Multiple Regression (For trivariate data)
2	Multiple Correlation (For trivariate data)
3	Partial Correlation (For trivariate data)
4	Fitting of straight lines, second degree curves
5	Fitting of exponential and power curves
6	Time Series I (Trend)
7	Time Series II (Seasonality)

B. Sc. Part – II Semester -III STATISTICS
MIN-PR-III: 2MIN03STA39: MIN Statistics Practical III

Marks-25

(Credits: 02)

Course Outcomes: At the end of the course students will be able to:

CO1: Apply basic data science techniques to collect, clean, and preprocess real-world datasets using R.

CO2: Apply different classification techniques using R.

CO3. Compute probability of Type I and Type II Error.

CO4: Apply large sample tests in real life examples.

Sr. No.	Title of Practical
1	Data Types, Cleaning & Missing Values
2	Data Transformation & Discretization
3	Exploratory Data Analysis & Visualization
4	Classification Basics & Model Validation
5	Applications of Normal Distribution
6	Computation of Probability of Type I and Type II Error.
7	Large sample test for means.
8	Large sample test for Proportions.
9	Small sample test for means
10	Paired t test

B. Sc. Part – II Semester -IV STATISTICS
DSC-VII: 2DSC03STA41: Probability Distributions-II

Theory: 30 hrs.

Marks-50

(Credits: 02)

Course Outcomes: At the end of the course students will be able to:

CO1: Understand various continuous probability distributions.

CO2: Understand applications of various continuous probability distributions in different fields.

CO3: Compute descriptive statistics, moments, skewness, kurtosis, m. g. f. for continuous distributions.

CO4: Understand the relation between various probability distributions.

Unit	Contents	Hours Allotted
1	Uniform, Normal, Exponential distribution: 1.1 Uniform distribution: p.d.f., nature of curve, c.d.f., m.g.f., mean, variance, moments. Distribution of (i) $(X-a)/(b-a)$ (ii) $(b-X)/(b-a)$ (iii) $Y = F(x)$ where $F(x)$ is c.d.f. of any continuous r.v. and examples. 1.2 Normal distribution: p.d.f, properties of normal curve, nature of curve, m.g.f., mean, variance, median, mode, mean deviation about mean, moments, cumulants, measures of skewness and kurtosis, Additive property, Definition of standard normal distribution, distribution of linear combination of independent normal variates and examples. 1.3 Exponential distribution: p.d.f with rate parameter θ, nature of curve, c.d.f., mean, variance, m.g.f., C.V., moments, Cumulants, median, quartiles, lack of memory property, Additive property, distribution of $-(1/\theta) \log(X)$, where $X \sim U(0, 1)$ and examples.	15
2	Gamma Distribution, Beta distributions and Exact Sampling Distributions: 2.1 Gamma distribution: p.d.f. with rate parameter θ and shape parameter n, special case ($\theta = 1, n = 1$), m.g.f., mean, variance, mode, moments, cumulants, skewness and kurtosis, additive property, distribution of sum of i.i.d. exponential variates, distribution of X^2 if $X \sim N(0, 1)$ and examples. 2.2 Beta distribution of first kind: p.d.f. with parameters m and n, mean, variance, H.M., mode, distribution is symmetric when $m = n$, Uniform distribution as a particular case when $m = n = 1$, distribution of $(1-X)$ and examples. 2.3 Beta distribution of second kind: p.d.f. with parameters m and n. mean, variance, H.M., mode, relation between beta distribution of first kind and second kind, distribution of $X+Y$, X/Y and $X/(X+Y)$ where X and Y are independent gamma variates and examples. 2.4 Exact Sampling Distributions: 1. Chi-Square distribution: Definition, p.d.f. of chi square distribution with n degrees of freedom, nature of curve, mean, variance, moments, m.g.f., mode, skewness and kurtosis, additive property and examples. 2. Student's t- distribution: Definition, p.d.f. with n degrees of freedom, nature of curve, mean, variance, mode, moments, skewness and kurtosis and examples. 3. Snedecor's F distribution: Definition, p.d.f., nature of curve, mean, variance, mode, reciprocal property, interrelation between t, F and χ^2 variates (without proof) and examples.	15

Reference Books:

1. Parimal Mukhopadhyay: An Introduction to the Theory of Probability, World Scientific Publishing.
2. Gupta S. C. & Kapoor V.K.: Fundamentals of Mathematical Statistics, Sultan Chand & sons, New Delhi, Twelfth edition.
3. Goon, A.M., Gupta M.K. and Dasgupta B: Fundamentals of Statistics Vol. I and Vol. II World Press, Calcutta.
4. Mood A.M., Graybill F.A.: Introduction to theory of Statistics. (Chapter II, IV, V, VII) and Boes D.C. Tata, McGraw Hill, New Delhi. (Third Edition)

B. Sc. Part – II Semester -IV STATISTICS
DSC-VIII: 2DSC03STA42: Testing of Hypothesis

Theory: 30 hrs.

Marks-50

(Credits: 02)

Course Outcomes: At the end of the course students will be able to:

CO1. Understand the basic concepts of testing of hypothesis.

CO2. Distinguish between large and small sample tests.

CO3. Apply small and large sample tests in real life examples.

CO4. Understand the concept of National income.

Unit	Contents	Hours Allotted
1	Large Sample Tests 1.1 Basic Terms: Notion of Population, Sample, Parameter, Statistic, Estimate and Estimator, Unbiased Estimator, Properties and examples, Standard Error, Sampling distribution of Statistic, Test Statistic, Central Limit Theorem, Hypothesis, Simple and Composite Hypothesis, Null and Alternative hypothesis, One and two tailed test, Critical region, type I and type II errors, level of significance, p-value, size & power of test, Pivotal Quantity, Confidence Interval. 1.2 Large Sample Tests: i) General procedure of testing of hypothesis ii) Test for means: Testing population mean $H_0: \mu = \mu_0$ and testing equality of two population means $H_0: \mu_1 = \mu_2$. iii) Test for proportion: Testing population proportion $H_0: P = P_0$ and testing equality of two population proportions $H_0: P_1 = P_2$. iv) Test population correlation coefficient $H_0: \rho = \rho_0$ and testing equality of two population correlation coefficients $H_0: \rho_1 = \rho_2$ by Fisher's Z transformation.	15
2	Small Sample Tests & Confidence Interval 2.1 Small Sample Tests: i) Definition of student's t variate, t test for (a) testing population mean $H_0: \mu = \mu_0$ and testing equality of two population means $H_0: \mu_1 = \mu_2$, (b) paired t test, (c) test for population correlation coefficient $H_0: \rho = \rho_0$. ii) Chi square tests: (a) Testing population variance $H_0: \sigma^2 = \sigma_0^2$ (b) Test for goodness of fit. (c) Test for independent of attributes: i) $m \times n$ contingency table ii) 2×2 contingency table iii) Yate's correction for continuity iii) F test for testing equality of two population variances $H_0: \sigma_1^2 = \sigma_2^2$ 2.2 Confidence Interval: Confidence Interval for the following cases: i. Mean μ of normal distribution (σ^2 known and σ^2 unknown). ii. Variance σ^2 of normal distribution (μ known and μ unknown). iii. Difference between two means $\mu_1 - \mu_2$ for samples from two independent normal populations.	15

Reference Books:

1. Gupta S. C. & Kapoor V.K.: Fundamentals of Mathematical Statistics, Sultan Chand & sons, New Delhi, Twelfth edition.
2. E.L. Lehmann, Joseph P. Romano: Testing Statistical Hypothesis
3. Hogg, R. V. and Craig, A. T., McKean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.
4. Parimal Mukhopadhyay: "Mathematical Statistics", New Central Book Agency, Pvt. Ltd. Calcutta.
5. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
6. Mood, A. M., Graybill F. A. and Bose, F. A. (1974), Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI), McGraw - Hill Series G A 276

B. Sc. Part – II Semester -IV STATISTICS**MIN-VII: 2MIN03STA41: Vital Statistics****Theory: 30 hrs.****Marks-50****(Credits: 02)****Course Outcomes:** At the end of the course students will be able to:

CO1: Understand and differentiate various concepts and measures of national income, including GDP, GNP, NNP, and per capita income.

CO2: Explain and apply different methods of national income estimation.

CO3: Compute simple and weighted Index numbers.

CO4: Understand the use of index number and concept of cost of living.

Unit	Contents	Hours Allotted
1	National Income: 1.1 Definitions of national income by (a) Marshall, (b) Pigou and (c) Fisher. 1.2 Different concept of national income (a) gross national product (GNP), (b) net national product (NNP). 1.3 Personal income, disposable income, per capita income, gross domestic product (GDP), national income at market price, national income at factor cost, national income at current prices, national income at constant prices. 1.4 Methods of estimation of national income and the difficulties in methods. (a) output method, (b) income method, (c) expenditure method. 1.5 Importance of national income.	15
2	Index Numbers: 2.1 Meaning and utility of index numbers, problems in construction of index numbers. 2.2 Types of index numbers: price, quantity and value. 2.3 Unweighted and weighted index numbers using (i) aggregate method, (ii) average of price or quantity relative method (A.M. or G.M. is to be used as an average) 2.4 Index numbers using Laspeyre's, Paasche's and Fisher's formula. 2.5 Properties of Fisher's index number. 2.6 Tests of index number: unit test, time reversal test, factor reversal test. 2.7 Cost of living index number: Definition, Construction by using (i) Family Budget method (ii) Aggregate expenditure method.	15

Reference Books:

1. Gupta V.K. & Kapoor S.C.: Fundamentals of Applied Statistics, Sultan & Chand
2. S. C. Gupta: Fundamentals of Statistics, Himalaya Publishing House, seventh revised & enlarged edition.
3. Walter A. Shewhart: Index Number
4. M. K. Jhingan: Macro Economic Theory: Vrinda Publications Pvt. Ltd. New Delhi
5. R. D. Gupta: Keynes Post – Keynesian Economics: Kalyani Publishers, New Delhi.
6. M. L. Sheth: Macro Economics: Lakshmi-Narayan Agarwal education publishers, Agra
7. H. L. Ahuja: Modern Economics: S. Chand publishers, New Delhi.

B. Sc. Part – II Semester -IV STATISTICS

MIN-VIII: 2MIN03STA42: Sampling Techniques

Theory: 30 hrs.

Marks-50

(Credits: 02)

Course Outcomes: At the end of the course students will be able to:

CO1: Understand basic concepts of sample survey.

CO2: Understand and use probability sampling methods.

CO3: Find appropriate sample size in various methods.

CO4: Apply various sampling methods to real life problems.

Unit	Contents	Hours Allotted
1	Sampling Survey: 1.1 Population, Sample, Sampling unit, Sampling frame, Sampling method, Census method. 1.2 Advantages and disadvantages of sampling methods. 1.3 Principles of sampling survey, Principal steps in sample survey. 1.4 Designing a questionnaire, Characteristics of good Questionnaire. 1.5 Sampling and non-sampling errors. 1.6 Determination of sample size: Cochran's & Sterling's formula.	15
2	Methods of Sampling: 2.1 Probability Sampling: a) SRS: Simple random sampling from finite population of size N with replacement (SRSWR) and without replacement (SRSWOR): Definitions, population mean and population total as parameters. Following results with proof. i. In SRSWOR, the probability of a specified unit being selected in sample at any given draw is equal to $1/N$. ii. In SRSWOR, the probability of a specific unit included in the sample is n/N . iii. In SRSWOR, the probability of drawing a sample of size 'n' from a population of size N units is $\frac{1}{\binom{N}{n}}$ iv. In SRSWR, the probability of a specific unit included in the sample is $(1 - \frac{1}{N})^n$ v. In SRSWR, the probability of drawing a sample of size 'n' from population of size N units is $\frac{1}{N^n}$ b) statement of unbiased estimator of population means and its variance under SRSWR & SRSWOR 2.2 Stratified random sampling: Definition, statement of unbiased estimator of population means and its variance, sample size determination of i^{th} stratum under equal allocation, proportional allocation and optimum allocation and its variance. 2.3 Concept of Systematic sampling and Cluster Sampling	15

Reference Books:

1. Gupta V.K. & Kapoor S.C.: Fundamentals of Applied Statistics- Sultan & Chand
2. Gupta S. P. (2002): Statistical Methods, Sultan Chand and Sons, New Delhi.
3. W. G. Cochran- Sampling Techniques, Wiley Publication third edition.
4. Sukhatme P.V. and Sukhatme, B.V.: Sampling Theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi.
5. Des Raj: Sampling Theory.
6. Mukhopadhyay Parimal: Theory and Methods of Survey Sampling, Prentice Hall.

B. Sc. Part – II Semester -IV STATISTICS

OEK-PR-IV: 2OEK03MTS42: Inferential Statistics: Large & Small Sample Test

Marks-25

(Credits: 02)

Course Outcomes: At the end of the course students will be able to:

CO1. Understand concept of testing of hypothesis.

CO2: Develop test procedures for testing of hypothesis.

CO3. Apply large sample tests in real life examples.

CO4: Implement appropriate small sample tests for real life testing of hypothesis problems.

Sr. No.	Title of Practical
1	Computation of Probabilities of Type I & type II error
2	Large sample test for single mean.
3	Large sample test for equality of two means.
4	Large sample test for Proportion.
5	Large sample test for difference between two Proportions.
6	Test based on t distribution (single mean)
7	Test based on t distribution (equality of two means)
8	Test based on t distribution (Paired t test)
9	Tests based on Chi square distribution-I
10	Tests based on Chi square distribution-II

Reference Books:

1. Gupta S. C. & Kapoor V.K.: Fundamentals of Mathematical Statistics, Sultan Chand & sons, New Delhi, Twelfth edition.
2. Kulkarni, M. B. Ghatpande, S. B. and Gore, S. D.: “Common Statistical Tests”, Satyajeet Prakashan, Pune – 11029.
3. Rohatgi V. K.: Statistical Inference.
4. Rohatgi V. K.: An Introduction to Probability Theory and Mathematical Statistics.
5. Gupta, S. P.: “Statistical Methods”, Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.

B. Sc. Part – II Semester -IV STATISTICS
VSC-PR-II: 2VSC03STA49: Introduction to R

Marks-25

(Credits: 02)

Course Outcomes: At the end of this course students will be able to:

CO1: Understand basics of R programming.

CO2: Know various built-in functions in R.

CO3: Evaluate various descriptive statistics measures using R.

CO4: Apply different parametric tests using R.

Sr. No.	Title of Practical
1	Data Input-Output
2	Matrix manipulation & Operators
3	Graphical Representation
4	Diagrammatic Representation
5	Descriptive Statistics
6	Parametric tests
7	Fitting of discrete distributions
8	Model sampling from discrete distributions
9	Fitting of continuous distributions
10	Model sampling from continuous distributions

Remark: In fitting and model sampling from distributions, cover all the distributions which are learnt in theory syllabus up to SEM IV.

Reference Books:

1. Crawley, M. J. (2006): Statistics - An introduction using R. John Wiley, London 32
2. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015): Statistics using R, second edition. Narosa Publishing House, New Delhi.
3. Verzani, J. (2005): Using R for Introductory Statistics, Chapman and Hall /CRC Press, New York

B. Sc. Part – II Semester -IV STATISTICS
DSC-PR-IV: 2DSC03STA49: DSC Statistics Practical IV

Marks: 50

(Credits: 04)

Course Outcomes - At the end of this course students will be able to:

CO1: Understand fitting of various continuous distributions.

CO2: Understand model sampling from various continuous distributions.

CO3: Apply large and small sample tests to real life problems.

CO4: Compute National income by using different methods.

Sr. No.	Title of the Experiment
Section I	
1	Fitting of continuous uniform distribution
2	Fitting of exponential distribution
3	Fitting of Normal distribution
4	Model sampling from continuous uniform distribution.
5	Model sampling from exponential distribution.
6	Model sampling from normal distribution using: (i) Normal table and (ii) Box-Muller transformation
7	Applications of Exponential distribution
8	Applications of Normal distribution
9	Sketch of pdf and c.d.f of continuous distribution using Ms-Excel
Section II	
1	Computation of Size and Power of test
2	Large sample tests for means.
3	Large sample tests for proportions.
4	Tests for population correlation coefficients. (Using Fisher's Z transformation.)
5	Tests based on Chi square distribution. (Test for population variance, Test for goodness of fit)
6	Tests based on Chi square distribution. (Tests for independence)
7	Tests based on t distribution (Mean and equality of means)
8	Tests based on t distribution (Paired t test & correlation coefficient)
9	Tests based on F distribution
10	Interval estimation of location and scale parameters of normal distribution (single sample).
11	Interval estimation of difference of location parameters of normal distribution (two samples).

B. Sc. Part – II Semester -IV STATISTICS
MIN-PR-IV: 2MIN03STA49: MIN Statistics Practical IV

Marks-25

(Credits: 02)

Course Outcomes - At the end of this course students will be able to:

CO1: Compute different simple and weighted index number.

CO2: Construct various control charts for variables and attributes.

CO3: Understand basic concepts of sample survey.

CO4: Apply different methods of sampling in real life.

Sr. No.	Title of Practical
1	National Income I
2	National Income II
3	Index Numbers-Average relative method & Aggregate method
4	Index Number- Laspeyre's, Paasche's & Fisher's Formulae
5	Index Numbers-Tests of adequacy, cost of living index number
6	Determination of Sample Size.
7	Simple Random Sampling (SRSWR & SRSWOR).
8	Stratified Random Sampling.
9	Case Study

Case Study (05 Marks): Selection of problem, Formulation of questionnaire, Appropriate method of sampling, Determination of sample size, Selection of sample.

Nature of Theory Question Paper

Instructions:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of scientific calculator is allowed.

Time: 2-hour

Total Marks: 40

Question Number	Marks
Q.1. Choose correct alternative.	(8x1=8)
Q.2 Attempt any two. i) ii) iii)	(8x2=16)
Q.3. Attempt any four. a) b) c) d) e) f)	(4x4=16)

Internal Evaluation

Semester	Evaluation	Marks
III & IV	Unit test /Assignment	10

Nature of Practical Paper

1. Practical examination is of 25 marks.
2. Each practical question paper must contain three questions each carry 10 marks.
3. Each question should contain two bits from different units.
4. Student should attempt any two questions.
5. There are 3 marks for journal and 2 marks for oral.

Evaluation Pattern for Practical Course

Mark Distribution of Practical (LAB) course for each semester

Course	Experimental work	Oral+ Journal assessment	Total Marks
Major	40	10	50
Minor/ OE/VSC	20	05	25