Shri Acharyaratna Deshbhooshan Shikshan Prasarak Mandal's, Kolhapur

Mahavir Mahavidyalaya, Kolhapur (Autonomous)

Affiliated to Shivaji University, Kolhapur.

DEPARTMENT OF STATISTICS

Three/Four - Years UG Programme
Department/Subject Specific Core or Minor (MIN)

Curriculum, Teaching and Evaluation Structure

B.Sc.-II Statistics

Semester-III & IV

(Implemented from academic year 2024-25 onwards based on NEP Phase 1.0)

B. Sc. Part – II Semester -III STATISTICS

MIN-V: 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 their applications in different fields.

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 and 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 is 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, Binomial, Poisson, Geometric and Negative Binomial distribution as particular cases of power series 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. and relations between cumulants and central moments (up to order four). **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	

Reference Books:

1. Gupta S. C. & Kapoor V.K.: Fundamentals of Mathematical Statistics. Sultan Chand & sons, New Delhi.
2. K.C. Bhuyan: Probability distribution Theory and Statistical Inference, New Central book agency.
3. Goon, A.M., Gupta M.K. and Dasgupta B: Fundamentals of Statistics Vol. I and Vol. II, World Press, Calcutta.
4. Hogg R.V. and Criag A.T.: Introduction to Mathematical Statistics (Third edition), Macmillan Publishing, New York.
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. Parimal Mukhopadhyay: An Introduction to the Theory of Probability, World Scientific Publishing.
7. V. K. Rohatgi, A.K. Md. Ehsanes Saleh: An Introduction to Probability and Statistics, Wiley series in probability and Statistics second edition.
8. Walpole R.E. & Mayer R.H.: Probability & Statistics.

B. Sc. Part – II Semester -III STATISTICS

MIN-VI: Statistical Methods I

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 concept of simple & weighted index numbers.

CO4: Understand the concept of cost-of-living index number by various methods.

Unit	Contents	Hours Allotted
1	**Multiple linear Regression, Multiple and Partial 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 and Partial Correlation:** **1.4** Concept of multiple correlations. **1.5** Definition of multiple correlation coefficient Ri.jk and its derivation **1.6** Properties of multiple correlation coefficient, Interpretation of Ri.jk =1, Ri.jk = 0, **1.7** Coefficient of multiple determination $R^2_{i.jk}$. **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	**Index Number** **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 formulae. **2.5** Properties of Fishers index number. **2.6** Tests of index numbers: 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. **2.8** Shifting of base, splicing and purchasing power of money.	**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.

B. Sc. Part – II Semester -III STATISTICS

Statistics Practical Paper III Section I (Credits: 02)

Course Outcomes - At the end of this course students will be able to:
CO1: Compute probabilities of standard probability distributions.
CO2 : Compute expected frequencies and test the goodness of fit.
CO3: Understand the generation of random samples from standard probability distributions.
CO4: Understand the real-life situations of geometric & negative binomial distributions

Sr. No.	Title of the Experiment
1	Fitting of Discrete Uniform and Binomial distribution
2	Fitting of Poisson and Hypergeometric distribution
3	Fitting of Geometric & Negative Binomial distribution
4	Model sampling from Discrete Uniform and Binomial distribution.
5	Model sampling from Poisson distribution.
6	Model sampling from Hypergeometric distribution
7	Model sampling from Geometric distribution
8	Model sampling from Negative Binomial distribution.
9	Applications of Geometric and Negative binomial distribution

B. Sc. Part – II Semester -III STATISTICS

Statistics Practical Paper III Section II (Credits: 02)

Course Outcomes - At the end of this course students will be able to:
CO1: Solve the real-life problems based on Multiple Regression.
CO2: Solve the real-life problems based on Multiple & Partial Correlation
CO3: Solve the real-life problems based on Index Number
CO4: Solve the real-life problems based on tests of Index Number

Sr. No.	Title of the Experiment
1	Multiple Regression (For trivariate data)
2	Multiple Correlation (For trivariate data)
3	Partial Correlation (For trivariate data)
4	Index No. I (Computation of Index number)
5	Index No II (Tests of Adequacy)
6	Index No III (Shifting of base year, cost of living index number)
7	Applications of Multinomial Distribution
8	Fitting of a straight line & second-degree curve
9	Fitting of exponential & Power curves

B. Sc. Part – II Semester -IV STATISTICS

MIN-VII: 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/ θ) log (X), where X~U (0, 1) and examples. 1.4 **Gamma distribution:** p.d.f. with rate parameter θ and shape parameter n, special case (θ = 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~N (0, 1) and examples	**15**
2	**Beta distributions and Exact Sampling Distributions:** **2.1 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. **2.2 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. **2.3 Chi-Square distribution:** Definition, p.d.f. of chi square distribution with n degrees of freedom, nature of curve, mean,	**15**

	variance, moments, m.g.f., mode, skewness and kurtosis, additive property and examples. **2.4 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. **2.5 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.	

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, Twelfths 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

MIN-VIII: Statistical Methods II

Theory: 30 hrs. **Marks-50** **(Credits: 02)**

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

CO1. Understand concept of time series and its components.

CO2.Understand the concept of SQC and various statistical quality control charts.

CO3. Understand the basic concepts of testing of hypothesis.

CO4. Understand the concept of small and large sample tests in real life examples.

Unit	Contents	Hours Allotted
1	**1.1 Time Series** Meaning and need of time series analysis, components of time series; (i) Secular trend (ii) Seasonal Variation (iii) Cyclical Variation (iv) Irregular Variation, Additive and Multiplicative model, utility of time series. Measurement of trend: (i) Moving averages method (ii) Progressive average method (iii) Least square method. (iv) Measurement of seasonal indices by simple average method. **1.2 Statistical Quality Control** Meaning and purpose of S.Q.C., Process control, Product control, chance causes, assignable causes, Shewhart's control chart- construction & working, lack of control situation. Control charts for variables - control chart for mean, control chart for range, construction and working of mean & range charts for unknown standards, revised control limits. Control charts for Attributes – Defects, defectives, fraction defective, control chart for fraction defective (p- chart) for fixed sample size and unknown standards, construction and working of chart. Control charts for number of defects (C-chart), for unknown standards, construction and working of C-chart.	**15**
2	**2.1 Testing of Hypothesis:** Notion of Population, Sample, Parameter, Statistic, Sampling distribution of Statistic, 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, power of test. **2.2 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 H0:$\rho_1 = \rho_2$ by Fisher's Z transformation.	**15**

	2.3 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×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: $\sigma_1^2=\sigma_2^2$	

Reference Books:

1. Gupta S. C. & Kapoor V.K.: Fundamentals of Mathematical Statistics, Sultan Chand & sons, New Delhi, Twelfths edition.
2. E.L. Lehmann, Joseph P. Romano: Testing Statistical Hypothesis
3. Scott Hartshorn: Hypothesis Testing
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

Statistics Practical Paper IV Section I (Credits: 02)

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: Understand the real-life situation of exponential distribution
CO4: Understand the real-life situation of normal distribution

Sr. No.	Title of the Experiment
1	Fitting of continuous uniform distribution.
2	Fitting of exponential distribution.
3	Fitting of normal distribution.
4	Model sampling from a continuous uniform distribution.
5	Model sampling from an exponential distribution.
6	Model sampling from Normal distribution using: i) Normal table & ii) Box Muller Transformation.
7	Applications of Exponential distribution.
8	Applications of Normal distribution.

B. Sc. Part – II Semester -IV STATISTICS

Statistics Practical Paper IV Section II (Credits: 02)

Course Outcomes - At the end of this course students will be able to:
CO1: Understand large sample tests to real-life problems
CO2: Understand small sample tests to real-life problems
CO3: Understand the concept of control charts for Variables.
CO4: Understand the concept of control charts for Attributes.

Sr. No.	Title of the Experiment
1	Estimation of Trend & Seasonality.
2	Control Charts for Variables.
3	Control Charts for Attributes.
4	Large sample tests for means.
5	Large sample tests for proportions.
6	Test for Population Correlation Coefficient (Using Fisher's Z transformation)
7	Tests based on Chi square distribution -I (Test for population variance, Test for goodness of fit)
8	Test based on Chi square distribution – II (Test for independence.)
9	Test based on t & F distribution.

Assessment Structure

Suggested methods of Teaching:	
1.	Offline Traditional Board Teaching
2.	Power Point Presentation
3.	Online Teaching on platform of Zoom or Google Meet

Structure of Question Paper

Nature of Theory Question Paper

Instructions:

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

Scheme of Course Evaluation		
1.	End Semester Examination (ESE)	40
2.	Continuous Internal Evaluation (CIE)	10
3.	**Total Marks**	**50**

Suggested techniques for Continuous Internal Evaluation (10 Marks)	
1.	Seminar
2.	Field Report
3.	Assignments
4.	Open book test
5.	Offline / online MCQ test
6.	Visit/Tour report
7.	Surprise test
8.	Formula Test

End Semester Examination Question Paper Pattern (40 Marks) Theory			
Q. No.	**Nature /Type of Question**	**Marks**	**Total**
1.	Multiple Choice Question (06)	Each for 01 Marks	**06**
2.	Write definition or Formulas (5)	Each for 02 Marks	**10**
3.	Solve the following question Any 3 out of 5	Each for 04 Marks	**12**
4.	Solve the following question A Or B	Each for 06 Marks	**06**
5.	Solve the following question A Or B	Each for 06 Marks	**06**
Total			**40**

Nature of Practical Paper:

1. Practical examination is of 25 marks for each semester & each section.
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. Complete and certified journal is of 3 marks and oral will be of 2 marks.