Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara (Autonomous)

Undergraduate Programme

B. Sc. in Statistics

Syllabi of the course

Choice based credit system syllabus

(To be implemented from academic year 2019-20)

Department of Statistics

Syllabus for B.Sc. II Statistics

Structure of Syllabus:

B.Sc. – II Semester–III

Paper Title	Theory			Practical		
	PaperCode	Lectures Per week	Credits	Paper Code	Lectures Per week	Credits
Continuous Probability Distributions- I	BST301	3	2	BSP303	8	4
Statistical Methods- I	BST302	3	2			

B.Sc. – II Semester–IV

Paper Title	Theory			Practical		
	PaperCode	Lectures Per week	Credits	Paper Code	Lectures Per week	Credits
Continuous Probability Distributions- II	BST301	3	2	BSP403	8	4
Statistical Methods- II	BST402	3	2			

Note: B: B. Sc. T=Theory and P= Practical

1. Titles of papers

B.Sc. – II Semester – III

Theory: 45 lectures, 36 hours (for each paper)

BST 301: Continuous Probability Distributions- I

BST 302: Statistical Methods- I

Practical: 80 lectures, 64 hours

BSP303: Practical – III

B.Sc. – II Semester – IV

Theory: 45 lectures, 36 hours (for each paper)

BST 401: Continuous Probability Distributions- II

BST 402: Statistical Methods- II

Practical: 80 lectures, 64 hours

BSP403: Practical – IV

B. Sc.–II: Statistics / Semester – III
BST301 Continuous Probability Distributions-I (Credit – 02)

Course Objectives: Students Should to

1. Understand concept of continuous distributions with real life situations.
2. Distinguish between discrete and continuous distributions.
3. Find various measures of r.v. and probabilities using its probability distributions.
4. Know the relations among the different distributions.
5. Understand the concept of transformation of univariate and bivariate continuous random variables.

Unit-1: Continuous Univariate Distributions: 15

1.1 Definition of the continuous sample space with illustrations, Definition of continuous random variable (r.v.), probability density function (p.d.f.), cumulative distribution function(c.d.f.)and its properties.

1.2 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

1.3 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 propertyof m.g.f., (statement only).Generation of raw and central moments.

1.4 Cumulative generating function (c.g.f.): definition, relations between cumulants and central moments (up to order four).Examples.

Unit-2: Continuous Uniform and Exponential Distribution: 10

2.1 Uniform distribution: Definition of Uniform distribution over (a, b) 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.

2.2 Exponential distribution: p.d.f. (one parameter), c.d.f., m.g.f., c.g.f., mean, variance, C.V., moments, Cumulants, median, quartiles, lack of memory property, distribution of $-(1/\theta)\log X$ where X~U (0, 1).

Unit-3: Continuous Bivariate Distributions: **10**

3.1 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, evaluation of probabilities of various regions bounded by straight lines.

3.2 Expectation of function of r.v.s means, variances, covariance, correlation coefficient, conditional expectation, 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) $[E(X/Y)] = E(X)$.

3.3 If X and Y are independent r.v.s. then (i) $E(XY) = E(X)\,E(Y)$, (ii) $M_{x+y}(t) = M_x(t)\,M_y(t)$

3.4 Examples.

Unit-4: Transformations of continuous r.v.: **10**

4.1 Transformation of univariate continuous r.v.: Distribution of $Y=g(X)$, where g is monotonic or non-monotonic functions using (i) Jacobian of transformation, (ii) Distribution function and (iii) m.g.f. methods.

4.2 Transformation of continuous bivariate r.v.s : Distribution of bivariate r.v.s. using Jacobin of transformation.

4.3 Examples

Books Recommended:

1. An Introduction to the Theory of Probability, Parimal Mukhopadhyaya, World Scientific Publishing, 2011
2. Introduction to Mathematical Statistics, Hogg R.V. and Criag A.T. ,Macmillan Publishing, New York, Seventh Edition,2013
3. Fundamentals of Mathematical Statistics, Gupta S. C. & Kapoor V.K., Sultan Chand & sons, New Delhi, 2014
4. Applied Statistics, Gupta S. C. & Kapoor V.K.: Sultan Chand & sons, New Delhi,2018
5. Probability & Statistics. (Chapter 4, 5, 6, 8, 10), Walpole R.E. & Mayer R.H., MacMillan Publishing Co. Inc, New York
6. Fundamentals of Statistics Vol. I and Vol. II, Goon, A.M., Gupta M.K. and Dasgupta B :World Press, Calcutta, 2016

Course Outcomes: Students are able to

Unit-1: Continuous Univariate Distributions:

1. Learn the basic concepts of Statistics.
2. Understand concept of continuous distributions with real life situations

Unit-2: Continuous Uniform and Exponential Distribution:

1. Learn uniform and exponential distributions
2. Solve examples on Continuous distributions

Unit-3: Continuous Bivariate Distributions:

1. Learn Bivariate distributions
2. Solve examples on Bivariate distributions

Unit-4: Transformations of continuous r.v.:

1. Understating Transformation of univariate and Bivariate continuous r.v
2. Solve examples on Transformation of univariate and Bivariate continuous r.v

BST302: Statistical Methods -I (Credits:2)

Course Objectives: Students Should to

1. Know the concept and use of time series
2. Understand the need of vital statistics and concept of mortality and fertility
3. Understand concept of Binary Systems, Reliability of binary System, Ageing Properties.
4. Solve the examples on order statistics.

Unit 1: Time Series **10**

1.1 Meaning and need of time series analysis, components of times (i) Secular trend (ii) Seasonal Variation (iii) Cyclical Variation (iv) Irregular Variation, Additive and Multiplicative model, Utility of time series.

1.2 Measurement of trend: (i) Moving averages method (ii) Progressive average method (iii) Least square method. (iv)Measurement of seasonal indices by simple average method.

Unit-2: Demography **10**

2.1 Introduction and need of vital statistics

2.2 Mortality rates: Crude death rate (CDR), Specific Death Rate (SDR), Standarized Death Rate (STDR).

2.3 Fertility Rates: Crude Birth Rate (CBR), Age Specific Fertility Rate (ASFR), General Fertility Rate (GFR), Total Fertility Rate (TFR).

2.4 Reproduction Rate: Gross Reproduction rate (GRR), Net Reproduction Rate (NRR).

Unit-3: Reliability Theory **15**

3.1 Binary Systems: Block diagrams, definition of binary coherent structure and illustrations. Coherent system of component at most three, (a) Series, (b) Parallel, (c) 2 out of 3: Minimal cut, minimal path representation of system.

3.2 Reliability of binary System: reliability of above systems h(p), when components are independent and identically distributed with common probability p of operating.

3.3 Ageing Properties: definitions: Hazard rate, hazard function, survival function, concept of distributions with increasing and decreasing failure rate (IFR, DFR). relationship between survival function and hazard function, density function and hazard rate, derivations results (1) Hazard rate of a series system of components having independent life times is summation of component hazard rates.
(2) Life time of series system of independent components with independent IFR life times is IFR.

Unit-4: Order Statistics **10**

4.1 Order statistics for a random sample of size n from a continuous distribution, definition, derivation of distribution function and density function of the i-th order statistic , particular cases for i =1 and i = n.

4.2 Derivation of joint p. d. f. of i -th and j- th order statistics, statement of distribution of the sample range.

4.3 Distribution of the sample median when n is odd.

4.4 Examples

Books Recommended :

1. Statistical Theory of Reliability and Life Testing,Barlow R. E. and Proschan Frank: Holt Rinebart and Winston Inc., New Yark, 1981
2. Reliability and Life Testing: Sinha S. K.,Wiley Eastern Publishers, New Delhi, Second Edition, 1987
3. An Introduction to the Theory of Probability, Parimal Mukhopadhyaya, World Scientific Publishing,2011
4. Introduction to Mathematical Statistics, Hogg R.V. and Criag A.T., Macmillan Publishing, New York:Seventh Edition,2013.
5. Applied Statistics, Gupta S. C. &Kapoor V.K., Sultan Chand & sons, New Delhi. 2018

Course Outcomes: Students are able to -

Unit 1: Time Series

1. Learn the Meaning and need of time series analysis.
2. Measurement of trend value

Unit 2: Demography

1. Understand the need of vital statistics and concept of mortality and fertility
2. Solve examples on Demography

Unit-3: Reliability Theory

1. Learn Binary Systems Reliability of binary System and Ageing Properties
2. Learn Order statistics for a random sample of size n from a continuous distribution

Unit-4: Order Statistics

1. Learn order statistics
2. Solve the examples on order statistics

BSP 303: B.Sc.II : Semester III : Practical (Credit 2)

(Practical: 80 lectures, 64 hours)

Course Objectives: Students should to

1. Understand the applications of Poisson, Geometric, Negative Binomial distribution, Hypergeometric distributions.
2. Compute the expected frequencies and test the goodness of fit.
3. Understand how to obtain random sample from standard probability distribution.
4. Apply time series, reliability, and order statistics in real life situations.
5. Sketch time series plots using MS-EXCEL.

Practical – III(A)

1. Fitting of Discrete Uniform Distribution
2. Fitting of Binomial Distribution.
3. Fitting of Hypergeometric distribution.
4. Fitting of Poisson and Geometric distribution.
5. Fitting of Negative Binomial distribution.
6. Model sampling from Discrete Uniform distribution.
7. Model sampling from Binomial distribution.
8. Model sampling from Hypergeometric distribution.
9. Model sampling from Poisson and Geometric distribution.
10. Model sampling from Negative Binomial distribution.
    (Distributions for various parameters using MS-EXCEL.)

Practical – III (B)

1. Time Series.-I (Trend by Progressive averages, Moving average)
2. Time Series.-I (least square methods)
3. Demography I (Mortality rates).
4. Demography II (Fertility and Reproduction rates).
5. Reliability Theory-I
6. Reliability Theory-II
7. Applications of Order Statistics.
8. Fitting of Straight line / Parabola / Exponential curves.
9. Time Series (Trend by Progressive averages, Moving average, least square methods) using MS- EXCEL
10. Sketch of gamma and beta distributions for various parameters using MS-EXCEL.

Books Recommended:

1. Statistical Theory of Reliability and Life Testing, Barlow R. E. and Proschan Frank, Holt Rinebart and Winston Inc., New Yark, 1981
2. An Introduction to the Theory of Probability ,Parimal Mukhopadhyaya, World Scientific Publishing, 2011
3. Introduction to Mathematical Statistics**,** Hogg R.V. and Criag A.T., Macmillan Publishing, New York, Seventh Edition, 2013
4. Fundamentals of Mathematical Statistics, Gupta S. C. &Kapoor V.K.,Sultan Chand & sons, New Delhi, 2014
5. Applied Statistics, Gupta S. C. &Kapoor V.K., Sultan Chand & sons, New Delhi.,2018
6. Statistical Methods ,Gupta S.P, Sultan Chand and Sons, New Delhi, 2019

Course Outcomes: Students are able to

Practical – III(A):

i) Solve the applications of Poisson, Geometric, Negative Binomial distribution, Hypergeometric distributions.

i) Compute the expected frequencies and test the goodness of fit

iii) Compute the expected frequencies and test the goodness of fit.

Practical – III (B):

i) Sketch time series plots using MS-EXCEL.

i) Compute the vital statistics

iii) Solve the applications of Reliability problems.

B. Sc. –II: Statistics Semester – IV
BST-401: Continuous Probability Distributions- II (Credits: 2)

Course Objectives: Students should to

1. Find various measures of r.v. and probabilities using its probability distributions
2. Know the relations among the different distributions
3. Understand the concept of Normal distribution, Chi-Square distribution , Student's t- distribution, Snedecor's F distribution, Bivariate Normal Distribution

Unit-1: Gamma and Beta Distributions: **15**

1.1 Gamma distribution: Gamma distribution with scale parameter θ and shape parameter n, special case $\theta = 1$, n =1, m.g.f., c.g.f., mean, mode, variance, moments, cumulants, $\beta_1, \beta_2, \gamma_1$ *and* γ_2 coefficients, additive property: distribution of sum of i.i.d. exponential variates.

1.2 Beta distribution of first kind: Beta distribution of first kind with parameters m & n. mean, mode, variance, symmetric when m = n, Uniform distribution as a particular case when m = n = 1, distribution of (1-X).

1.3 Beta distribution of second kind: Beta distribution of second kind with parameters m & n. mean, mode, variance, 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 variate.

Unit-2: Normal distribution **10**

2.1 Normal distribution with parameters μ & σ^2, Definition of standard normal distribution,

2.2 Properties of normal curve, m.g.f., c.g.f., mean, variance, median, mode, mean deviation, moments, cumulants, measures of skewness & kurtosis, distribution of linear combination of variates.

2.3 Distribution of X^2 if X~N (0, 1).

Unit-3: Exact Sampling Distributions **10**

3.1 Chi-Square distribution: Definition of chi square, derivation of p.d.f. of chi square distribution with n degrees of freedom using m.g.f..c.g.f., mean, variance, moments, cumulants, mode, skewness and kurtosis, additive property.

3.2 Student's t- distribution: Definition of student's t variate. Derivation of p.d.f., mean, mode, variance, moments, β_1, β_2, γ_1 and γ_2 coefficients.

3.3 Snedecor's F distribution: Definition of F variate, derivation of p.d.f., mean, variance and mode. Distribution of 1/F. Inter relation between t, F and χ^2 (Without Proof).

Unit -4 Bivariate Normal Distribution **10**

4.1 P.d.f. of bivariate Normal Distribution, BN($\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \rho$), marginal and conditional distributions, identifications of parameters, conditional expectation and conditional variance, regression of Y on X and of X on Independence and uncorrelated simply each other, m.g.f and moments. Distribution of aX+bY+c, where a, b, and c are real numbers.

4.2 Examples.

Books Recommended:

1. Statistical Theory of Reliability and Life Testing, Barlow R. E. and Proschan Frank, Holt Rinebart and Winston Inc., New Yark, 1971
2. Reliability and Life Testing, Sinha S. K ,Wiley Eastern Publishers, New Delhi, Second Edition, 1987
3. Probability and Statistics with Reliability, Queuing and Computer Science Application, Trivedi R. S., John Wiley&Sons, Second edition, 2016
4. An Introduction to the Theory of Probability,Parimal Mukhopadhyaya,World Scientific Publishing, 2011
5. Introduction to Mathematical Statistics, Hogg R.V. and Criag A.T., MacmillanPublishing, New York, Seventh Edition , 2013
6. Fundamentals of Mathematical Statistics, Gupta S. C. & Kapoor V.K.,Sultan Chand& sons, New Delhi, 2014
7. Applied Statistics, Gupta S. C. & Kapoor V.K., Sultan Chand & sons, New Delhi, 2018

Course Outcomes: Students are able to

Unit-1: Gamma and Beta Distributions:

1. Learn Gamma and Beta Distributions
2. Compute mean, mode, variance, moments, cumulants for Gamma and Beta Distributions

Unit-2: Normal distribution

1. Learn Normal distribution with parameters μ & σ^2
2. Learn properties of normal curve
3. Compute Distribution of χ^2

Unit-3: Exact Sampling Distributions

1. Learn Exact Sampling Distributions
2. Understand Chi-Square distribution, Student's t- distribution, Snedecor's F distribution
3. Know the relations among the different distributions

Unit -4 Bivariate Normal Distribution

1. Learn bivariate Normal Distribution
2. Solve examples on bivariate Normal Distribution

BST402: Statistical Methods – II (Credits: 2)

Course Objectives: Students should to

1. Understand the small sample tests and large sample tests in various situations
2. Use Chebyshev's inequality for various distributions to find probabilities.
3. Understand the meaning, purpose and use of SQC , construction and working ofcontrol charts for variables and attributes.

Unit 1: Testing of Hypothesis - I **12**

1.1 Notion of Population, Sample, Parameter, Statistic, Sampling distribution of Statistic, hypothesis, Simple and composite hypothesis, Null and alternative hypothesis, type I and type II errors, Critical region, level of significance, p-value.one and two tailed test, power of test.

1.2. Large Sample Tests: General procedure of testing of hypothesis.

a) Tests for means: i) testing of population mean; $H_0: \mu = \mu_0$

ii) Testing equality of population means; H_0: $\mu_1 = \mu_2$

b) Tests for Proportion: i) testing of population Proportion; H_0: $P = P_0$

ii) Testing equality of population Proportion; H_0: $P_1 = P_2$

c) test for population correlation: i) H_0: $\rho = \rho_0$ ii) H0: $\rho_1 = \rho_2$ (by Z-transformation)

Unit 2: Testing of Hypothesis – II **15**

2.1 **:** Definition of Fisher's t- variate

t- test: a) test for means: i) H0: $\mu = \mu_0$

,ii) H0: $\mu_1 = \mu_2$, $(\sigma_1^2 = \sigma_2^2)$

iii) Paired t- test

2.2 : $\chi 2$ – test: i) test for population variance H0: $\sigma^2 = \sigma_0^2$,

ii) test for goodness of fit

iii) test for independence of attributes;

a) m x n contingency table

b) 2 x 2 contingency table, Yate's correction for continuity.

2.3 : F – test: test for equality of two population variances H0: $\sigma_1^2 = \sigma_2^2$

Unit 3: Statistical Quality Control **13**

3.1 : 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.

3.2 : 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.

3.3 : 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.

Unit- 4: Chebychev's Inequality. **05**

4.1 Chebychev's inequality for discrete and continuous distributions.

4.2 Examples and problems on standard distributions (Binomial, Normal, Exponential etc.

Books Recommended:

1. Reliability and Life Testing, Sinha S. K., Wiley Eastern Publishers, New Delhi, Second Edition, 1987
2. Fundamentals of Mathematical Statistics, Gupta S. C. &Kapoor V.K.,Sultan Chand & sons, New Delhi, 2014
3. Applied Statistics, Gupta S. C. &Kapoor V.K., Sultan Chand & sons, New Delhi, 2018

Course Outcomes: Students are able to

Unit 1: Testing of Hypothesis - I

1. Learn Testing of Hypothesis
2. Understand Large Sample Tests

Unit 2: Testing of Hypothesis - I

1. Learn Testing of Hypothesis
2. Understand Small Sample Tests

Unit 3: Statistical Quality Control

1. Learn Meaning and purpose of S.Q.C
2. Draw Control charts for Attributes
3. Draw Control charts for variables

Unit- 4: Chebychev's Inequality

1. Learn Chebychev's inequality for discrete and continuous distributions
2. Solve examples on Chebychev's inequality

BSP 403: B.Sc.II : Semester IV : Practical
Practical: 80 lectures, 64 hours(Credits:4)

Course Objectives: students should to

1. Understand the applications of Continuous uniform distribution, Exponential distribution, Normal distribution, Bivariate Normal distribution.
2. Compute the expected frequencies and test the goodness of fit.
3. Apply Chebychev's Inequality for various distributions
4. Construct various control charts
5. Apply large and small sample tests.

Practical – IV(A)

1. Fitting of Continuous Uniform distribution
2. Fitting of Exponential distribution
3. Fitting of Normal distribution.
4. Model sampling from Continuous Uniform and Exponential distribution
5. Model sampling from Normal distribution using: (i) Normal table and ii) Box-Muller transformation.
6. Application of Exponential distribution.
7. Application of Normal distribution.
8. Application of Bivariate Normal distribution.
9. Fitting of binomial, Poisson & Negative Binomial distribution using MS-EXCEL.
10. Fitting of Exponential & Normal distribution using MS-EXCEL.

Practical –IV(B)

1. Large sample tests for means.
2. Large sample tests for proportions.
3. Tests for population correlation coefficients. (Using Fisher's Z transformation.)
4. Tests based on Chi square distribution.(Test for population variance, Test for goodness of fit.)Tests for independence.
5. Tests based on t distribution ($\mu=\mu_0$, $\mu_1 = \mu_2$; paired t test)
6. Tests based on F distribution. ($\sigma_1^2= \sigma_2^2$)
7. Applications of Chebychev's Inequality

8. Construction of R and *X* charts.
9. Construction of P and C charts.
10. Single Sampling Plan (OC, AOQ and ATI using Hypergeometric / Binomial / Poisson distribution)

Books Recommended:

1. An Introduction to the Theory of Probability, Parimal Mukhopadhyaya: World Scientific Publishing, 2011
2. Introduction to Mathematical Statistics, Hogg R.V. and Criag A.T.:, MacmillanPublishing, New York, Seventh Ediction,2013
3. Fundamentals of Mathematical Statistics, Gupta S. C. & Kapoor V.K., Sultan Chand& sons, New Delhi, 2014
4. Applied Statistics, Gupta S. C. &Kapoor V.K.: Sultan Chand & sons, New Delhi, 2018
5. Introduction to theory of Statistics**,**(Chapter II, IV, V,VII) and Boes D.C, MoodA.M., Graybill F.A.: Tata, McGraw Hill, New Delhi.,Third Edition,1973
6. Statistical Methods, Gupta S.P, Sultan Chand and Sons, New Delhi, 2019

Course outcomes: students are able to

Practical –IV(A)

1. Learn the applications of Continuous Uniform distribution, Exponential distribution, Normal distribution, Bivariate Normal distribution.
2. Compute the expected frequencies and test the goodness of fit.
3. Apply Chebychev's Inequality for various distributions

Practical –IV(B)

1. Construct various control charts
2. Apply large and small sample tests.