Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA

(AN AUTONOMOUS COLLEGE)

Reaccredited by NAAC with 'A+' Grade

Bachelor of Science

Part - II

STATISTICS

Syllabus

to be implemented w .e. f. June, 2022

Structure of the course:

1) Semester III

Sr. No.	Subject title	Theory					Practical	
		Course No. and Course code	Title of Course	No. of lectures per week	Credits		No. of lectures per week	Credits
1.	Statistics	Course V BST 301	Continuous Probability Distributions	6	2	Statistics practical III BSP 303	8	4
		Course VI BST 302	Statistical Methods	6	2			

2) Semester IV

Sr. No	Subject title	Theory					Practical	
		Course No. and Course Code	Title of Course	No. of lectures per week	Credits		No. of lectures per week	Credits
1.	Statistics	Course VII BST 401	Probability Distributions	6	2	Statistics practical IV BSP 403	8	4
		Course VIII BST 402	Exact Sampling Distributions and Statistical Test	6	2			

B.Sc. II: Evaluation structure

Semester III

	ESE	Internal Exam		Practical			Submission	Total
		ISE-I	ISE-II		Exam	Journal	Seminar + Student Performance	
Course V	30	5	5	Practical-III(A)	25	5	5	150
Course VI	30	5	5	Practical III(B)	25	5	5	

Semester IV

	ESE	Internal Exam		Practical			Submission	Total
		ISE-I	ISE-II		Exam	Journal	Industrial visit/Educational Tour + Student Performance	
Course VII	30	5	5	Practical-IV(A)	25	5	5	150
Course VIII	30	5	5	Practical IV(B)	25	5	5	

Structure and titles of the course of B.Sc. II course

Semester III

Code	Name of Course	Units
BST 301	**COUNTINOUS PROBBAILITY DISTRIBUTION** (CREDITS:02; TOTAL HOURS : 45)	**Unit I:** Continuous Univariate Distributions **Unit II:** Continuous Uniform, Exponential and Normal Distribution **Unit III:** Continuous Bivariate Distributions **Unit IV:** Transformations of Random Variables
BST 302	**STATISTICAL METHODS** (CREDITS:02; TOTAL HOURS : 45)	**Unit I:** Time Series **Unit II**: Demography **Unit III:** Reliability Theory **Unit IV:** Statistical Quality Control

Semester IV

BST 401	**PROBABILITY DISTRIBUTION** (CREDITS:02; TOTAL HOURS: 45)	**Unit I:** Gamma and Beta Distributions **Unit II**: Bivariate Normal distribution **Unit III:** Multinomial Distribution **Unit IV:** Order Statistics and Moment Inequalities
BST 402	**EXACT SAMPLING DISTRIBUTIONS AND STATISTICAL TESTS** (CREDITS:02; TOTAL HOURS: 45)	**Unit I:** Testing of Hypothesis **Unit II:** Exact Sampling Distributions **Unit III**: Tests based on t and F distribution **Unit IV:** Tests based on $\chi 2$ distribution

Semester – III

Course V BST 301 COUNTINOUS PROBBAILITY DISTRIBUTION

Course Objectives: Student will able to

1. Understand fundamental concept of continuous distributions.
2. Explain the relationship among the different distributions.
3. Differentiate between Continuous probability distributions and discrete probability distributions.
4. Apply the concept of transformation on univariate as well as bivariate random variables.

Credits (Total Credits 2)	SEMESTER-III BST 301 COUNTINOUS PROBBAILITY DISTRIBUTION	No. of hours per unit/credits
UNIT - I	**Continuous Univariate Distributions**	**(10)**
	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, Cumulants, 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 property of m.g.f., (statement only).Generation of raw and central moments. 1.4: Cumulant generating function (c.g.f.): definition, relations between cumulants and central moments (up to order four). Examples.	
UNIT - II	**Continuous Uniform, Exponential and Normal Distribution**	**(15)**
	2.1: Uniform distribution: Definition of Uniform distribution over (a, b) c.d.f., m.g.f., mean, variance, moments. Symmetry of Uniform Distribution, U(0, Θ) as Scale Family of distributions. 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, Skewness and Kurtosis, median, quartiles, lack of memory property, distribution of $-(1/\theta)\log X$ where X~U (0, 1) 2.3 Normal distribution with parameters μ & σ^2 , Definition of standard normal distribution, 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. Normal family as a location and scale family.	
UNIT - III	**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± Y) = E(X) ± E(Y) ii) E [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) Mx+y (t)=Mx(t)My (t) 3.4: Examples.	
UNIT - IV	**Transformations of Random Variables**	**(10)**
	4.1 Transformation of univariate Discrete r.v. 4.2 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. 4.3: Transformation of continuous bivariate r.v.s : Distribution of bivariate r.v.s. using Jacobin of transformation. 4.4: Examples	

Course outcomes: Student should be able to

1. Understand concept of continuous distributions with real life situations
2. Determine the probabilities of normal distributed random variables.
3. Solve examples on Bivariate distributions.
4. Apply different distribution on real life data.

References:

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

Course VI BST 302 STATISTICAL METHODS

Course Objectives: Student will able to

1. Understand concept of Time Series.
2. Describe different birth rate and death rate.
3. Outline reliability block diagram of various system and compute it's reliability
4. Construct different variable and attribute control Charts.

Credits (Total Credits 2)	**SEMESTER-III BST 302 Statistical Methods**	**No. of hours per unit/credits**
UNIT - I	**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 - II	**Demography**	**(10)**
	2.1: Introduction and need of vital statistics 2.2: Mortality rates: Crude death rate (CDR), Specific Death Rate (SDR), Standardized 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 - III	**Reliability Theory**	**(15)**
	3.1: Binary Systems: Block diagrams, definition of binary coherent structure and illustrations. Coherent systems of at most three components (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 - IV	**Statistical Quality Control**	**(10)**
	4.1: 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. 4.2: 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. 4.3: 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.	

Course outcomes: Students should be able to

1. Understand the need of vital statistics and concept of mortality and fertility
2. Measure trend and seasonality of time series.
3. Compute reliability of various types of systems.
4. Identify whether production process is in control or not.

References:

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

BSP 303 STATISTICS Practical III

Course Objectives: Student will able to

1. Identify the distribution of a discrete data using the goodness of fit.
2. Compute expected frequency for given frequency distribution and asses the fit of distribution.
3. Obtain random samples from discrete probability distributions and compute the probabilities.

4. Apply different statistical methods such as time series, reliability and S. Q. C for real life data.

Credits (Total Credit 04)	SEMESTER-III BSP 303 Statistics Practical III	No. of hours per unit/credits
	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.	
	Practical – III(B)	
	1. Time Series-I Trend by Progressive averages, Moving average 2. Time Series-II Trend by least square methods 3. Demography I Mortality rates 4. Demography II (Fertility and Reproduction rates). 5. Reliability Theory-I 6. Reliability Theory-II 7. Fitting of Straight line / Parabola / Exponential curves. 8. Construction of R and X charts. 9. Construcion of P and C charts. 10. Time Series (Trend by Progressive averages, Moving average, least square methods) using MSEXCEL	

Course outcomes-Students should be able to

1. Understand the applications of Reliability theory in real life.
2. Compute the different vital statistics.
3. Fit different discrete distribution on real life data
4. Sketch time series plots using MS-EXCEL.

References-

1. Boes D.C and Mood A. M., Introduction to theory of Statistics, Tata, McGrawHill, New Delhi. Third Edition,1973
2. Gupta S. C. &Kapoor V.K.: Applied Statistics, Sultan Chand &Sons, New Delhi, 2018
3. Gupta S.C.& Kapoor V.K., Fundamentals of Mathematical Statistics Sultan Chand& sons, New Delhi, 2014
4. Gupta S.P, Statistical Methods, Sultan Chand and Sons, New Delhi, 2019
5. Hogg R.V. and Criag A.T, Introduction to Mathematical Statistics, Macmillan Publishing, New York, Seventh Edidtion,2013
6. Parimal Mukhopadhyaya, An Introduction to the Theory of Probability, World Scientific Publishing, 2011

SEMESTER- IV

Course VII MST401 PROBABILITY DISTRIBUTIONS

Course Objectives: Student will able to

1. Understand the concept of gamma and beta distributions.
2. Differentiate between Univariate and bivariate normal distribution
3. Evaluate probabilities of multinomial random variables.
4. Demonstrate use of different moment inequalities.

Credits (Total Credits 2)	SEMESTER-IV BST401 Probability Distributions	No. of hours per unit/credits
UNIT - I	**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, $\beta1,\beta2$, $\gamma1$ and $\gamma2$ 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 - II	**Bivariate Normal Distribution**	**(11)**
	2.1 : P.d.f. of bivariate Normal Distribution, BN($\mu1,\mu2,\sigma12$,$\sigma22$,ρ), marginal and conditional distributions,	

	identifications of parameters, conditional expectation and conditional variance, regression of Y on X and of X on Independence and uncorrelated –ness imply each other, m.g.f. and moments. Distribution of aX+bY+c, where a, b, and c are real numbers. 2.2 : Examples.	
UNIT - III	**Multinomial Distribution**	**(10)**
	3.1. Probability mass function (p.m.f.), Joint MGF of (X1,X2, ….Xk), use of MGF to obtain means, variances, covariances, total correlation coefficients, variance – covariance matrix, rank of variance – covariance matrix and its interpretation. 3.2. Additive property of multinomial distribution, univariate marginal distribution, distribution of Xi + Xj, conditional distribution of Xi g iven Xj =r, conditional distribution of Xi given Xi + Xj = r, real life situations and applications.	
UNIT - IV	**Order Statistics and Moment Inequalities**	**(10)**
	4.1. Basic Concepts, definitions- Missense , nonsense, 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 Chebychev's inequality for discrete and continuous distributions (Without Proof) 4.5 Markov Inequality, Chuchy-Schwarz Inequality, Jensen's Inequality, Lyapunov's Inequality.	

Course outcomes: Student should able to

1. Understand Gamma and Beta Distributions.
2. Solve examples on bivariate Normal Distribution.
3. Compute probabilities of multivariate random variable.
4. Apply Chebychev's inequality to compute upper and lower probability bounds of R.V.

References:

1. Goon, A.M., Gupta M.K. and Dasgupta B, Fundamentals of Statistics Vol. I and Vol. II, World Press, Calcutta, 2016
2. Gupta S. C. & Kapoor V. K., Applied Statistics, Sultan Chand & Sons, New Delhi,2018
3. Gupta S. C. & Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2014
4. Hogg R.V. and Criag A.T., Introduction to Mathematical Statistics, Macmillan Publishing, New York, Seventh Edition, 2013
5. Parimal Mukhopadhyaya, An Introduction to the Theory of Probability, World Scientific Publishing, 2011

Course VIII BST 402 EXACT SAMPLING DISTRIBUTIONS AND STATISTICAL TESTS

Course Objectives: Student will able to

1. Understand the concept of testing of hypothesis.
2. Identify relation between the t, f and $\chi 2$ distribution
3. Perform small sample tests on real life data.
4. Identify association between the two categorical variables.

Credits (Total Credits 2)	SEMESTER-IV BST402 **Exact Sampling Distributions and Statistical Tests**	No. of hours per unit/credits
UNIT - I	**Testing of Hypothesis**	**(10)**
	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; H0: $\mu = \mu 0$ ii) testing equality of population means; H0: $\mu 1 = \mu 2$ b) Tests for Proportion: i) testing of population Proportion; H0: P = P0 ii) testing equality of population Proportion; H0:P1 = P2 c) test for population correlation: i) H0: $\rho = \rho 0$ ii) H0: $\rho 1 = \rho 2$ (by Z-transformation)	
UNIT - II	**Exact Sampling Distributions**	**(15)**
	2.1: 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.	

	2.2: Student's t- distribution: Definition of student's t variate. Derivation of p.d.f., mean, mode, variance, moments, $\beta 1$, $\beta 2$, $\gamma 1$ and $\gamma 2$ coefficients. 2.3: 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 $\chi 2$ (Without Proof).	
UNIT - III	**Tests based on t and F distribution**	**(10)**
	3.1. Test for means: i) H0: $\mu = \mu 0$ ii) H0: $\mu 1 = \mu 2$, $(\sigma_1^2 = \sigma_2^2)$ iii) Paired t- test 3.2. Test for variance: Test for Ho: $\sigma_1^2 = \sigma_2^2$ against one-sided and two-sided alternatives when i) means are known and ii) means are unknown.	
UNIT - IV	**Tests based on $\chi 2$ distribution**	**(10)**
	4.1. Test for population variance Ho: $\sigma^2 = \sigma_0^2$ 4.2. Test for goodness of fit 4.3. Test for independence of attributes; a) m x n contingency table b) 2 x 2 contingency table, Yate's correction for continuity	

Course outcomes: Student should be able to

1. Understand fundamental concept of hypothesis testing.
2. Frame simple hypothesis and alternative hypothesis.
3. Differentiate between small sample test and large sample tests.
4. Apply various parametric tests on real life data.

References:

1. E. L. Lehmann, Joseph P. Romano, Testing Statistical Hypotheses, Springer New York, Third Edition, 2005
2. Gupta S. C. & Kapoor V.K., Applied Statistics, Sultan Chand & Sons, New Delhi, 2018
3. Gupta S.C. & Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2014

4. Hogg R.V. and Criag A.T., Introduction to Mathematical Statistics, Macmillan Publishing, New York, Seventh Edition, 2013
5. Parimal Mukhopadhyaya, An Introduction to the Theory of Probability, World Scientific Publishing, 2011

BSP 403 Statistics Practical –IV

Course objectives: Student will able to

1. Understand use of R software to perform procedures of the inferential statistics.
2. Apply normal distribution on real life data
3. Asses the fit of continuous distribution on given data
4. Compute probabilities for the continuous distribution using R – software

Credits (Total Credit 04)	**SEMESTER-IV BSP - 403 Statistics Practical - IV**	**No. of hours per unit/credits**
	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. Use of basic R software commands c( ), scan( ), rep( ), seq( ), min, max, sort, extract, data. frame, matrix, accessing resident data sets etc 8. Computation of probabilities of negative binomial, multinomial, normal, exponential, gamma, t, F, $\chi 2$ distribution using R software. 9. Small Sample tests using R Software 10. Large Sample test using R Software	

Course Outcomes- Students should be able to

1. Understand applications of Continuous Uniform distribution, Exponential distribution, Normal distribution, Bivariate Normal distribution.
2. Understand use of R- software for different statistical procedure.
3. Asses the fit of continuous distribution.
4. Simulate data from various continuous distributions.

References:

1. Boes D.C and Mood A. M., Introduction to theory of Statistics, Tata, McGrawHill, New Delhi. Third Edition,1973
2. Gupta S. C. &Kapoor V.K.: Applied Statistics, Sultan Chand &Sons, New Delhi, 2018
3. Gupta S.C.& Kapoor V.K., Fundamentals of Mathematical Statistics Sultan Chand& sons, New Delhi, 2014
4. Gupta S.P, Statistical Methods, Sultan Chand and Sons, New Delhi, 2019
5. Hogg R.V. and Criag A.T, Introduction to Mathematical Statistics, Macmillan Publishing, New York, Seventh Edidtion,2013
6. Parimal Mukhopadhyaya, An Introduction to the Theory of Probability, World Scientific Publishing, 2011