Deccan Education Society's

FERGUSSON COLLEGE, PUNE

(AUTONOMOUS)

SYLLABUS UNDER AUTOMONY

SECOND YEAR B.Sc.

SEMESTER - III

SYLLABUS FOR S. Y. B. Sc. STATISTICS

Academic Year 2017-18

S.Y. B.Sc. (Statistics) Semester III
Statistics Paper -1 (STS2301)
Discrete Probability Distributions – II and Introduction to SAS (Software)

[Credits-3]

Objectives:

1. To understand convergence and divergence of infinite series
2. To fit various discrete probability distributions and to study various real life situations.
3. To identify the appropriate probability model that can be used.
4. To use statistical software packages.

Unit I		**Infinite series, convergence and divergence of infinite series**	**(05 L)**
	1.1	Introduction	
	1.2	Partial sums, convergence and divergence	
	1.3	Geometric series, harmonic series	
	1.4	Theorems on convergence and divergence of series (statement only)	
Unit II		**Test for convergence, alternating series, absolute and conditional convergence**	**(05 L)**
	2.1	Definition of alternating series, P series	
	2.2	Theorems on convergence and divergence of series	
	2.3	Absolute and conditional convergence	
	2.4	Ratio test and root test	
Unit III		**Standard discrete distributions**	
	3.1	Motivation for distribution theory - presentation	**(02 L)**
	3.2	Negative binomial distribution: probability mass function (p. m. f.)	**(08 L)**
		$P(X=x)=\begin{cases}\binom{x+k-1}{x}p^k q^x, & x=0,1,2,\ldots, \quad 0<p<1, \; q=1-p \\ 0 & otherwise\end{cases}$	
		Notation: X ~ NB (k, p) Nature of p. m. f., negative binomial distribution as a waiting time distribution, m.g.f., c.g.f., mean, variance, skewness, kurtosis (recurrence relation between moments is not expected). Relation between geometric and negative binomial distribution. Poisson approximation to negative binomial distribution. Real life situations	
	3.3	Multinomial distribution: probability mass function (p. m. f.)	**(12 L)**
		$P(X_1=x_1, X_2=x_2 \cdots X_k=x_k)=\frac{n!}{x_1!, x_2! \cdots x_k!}\; p_1^{x_1} p_2^{x_2} \cdots p_k^{x_k}$	
			$x_1+x_2+\cdots x_k=n, p_1+p_2+\cdots p_k=1,$ $0<p_i<1, x_i=0,1,2\cdots n, i=1,2,\cdots k$

			= 0 otherwise		
		Notation: $(X_1, X_2 \cdots X_k) \sim MD(n , p_1 , p_2 \cdots p_k)$ $\underline{X} \sim MD(n , \underline{p})$ where $\underline{X} = (X_1, X_2 \cdots X_k)$, $\underline{p} = (p_1 , p_2 \cdots p_k)$		
		Joint m.g.f. of $(X_1, X_2 \cdots X_k)$, use of m.g.f. to obtain mean , variance, covariance, total correlation coefficients, multiple and partial correlation coefficients for k = 3. Univariate marginal distribution of X_i, distribution of $X_i + X_j$, conditional distribution of X_i given $X_i + X_j = r$, variance – covariance matrix, rank of variance – covariance matrix and its interpretation , real life situations and applications		
Unit IV		**Truncated distributions**			**(08 L)**
	4.1	Concept of truncated distribution, truncation to the right, left and on both sides			
	4.2	Binomial distribution B(n, p) , left truncated at X=0 (value zero is discarded), its p.m.f., mean, variance			
	4.3	Poisson distribution P(m) left truncated at X=0 (value zero is discarded), its p.m.f. , mean, variance			
	4.4	Real life situations and applications			
Unit V		**Power series distribution**			**(05L)**
	5.1	Introduction to power series			
	5.2	Power series Distribution: probability distribution, distribution function, raw moments, mean and variance, additive property (statement only)			
	5.3	Examples and special cases; binomial distribution , Poisson distribution , geometric distribution , negative binomial distribution, logarithmic distribution			
Unit VI		**Introduction to SAS**			**(03 L)**
	6.1	Exploratory data analysis			
	6.2	Statistical analysis			

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Reference :

1. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), *Fundamentals of Statistics, Vol. 2*, World Press, Kolkata.
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12. Weiss N., *Introductory Statistics*, Pearson education publishers.

S.Y. B.Sc. (Statistics) Semester III

Statistics Paper -2 (STS2302)

Continuous Probability Distributions – I

[Credits-3]

Objectives:

1. To understand the concept of continuous random variable and probability distributions
2. To fit various continuous probability distributions and to study various real life situations.
3. To identify the appropriate probability model that can be used.

Unit I		**Continuous univariate distributions**	**(13 L)**
	1.1	Continuous sample space: Definition, illustrations Continuous random variable: Definition, probability density function (p.d.f.), distribution function (d.f.), properties of d.f. (without proof), probabilities of events related to random variable	
	1.2	Expectation of continuous r.v., expectation of function of r.v. E[g(X)], variance, geometric mean, harmonic mean, raw and central moments, skewness, kurtosis	
	1.3	Moment generating function (m.g.f.): Definition and properties, Cumulant generating function (c.g.f.): Definition, properties	
	1.4	Mode, median, quartiles	
	1.5	Probability distribution of function of a r. v. : Y = g(X) using i) Jacobian of transformation for g(.) monotonic function and one-to-one, on to functions, ii) Distribution function for $Y = X^2$, Y = |X| etc., iii) m.g.f. of g(X)	
Unit II		**Continuous bivariate distributions**	**(14 L)**
	2.1	Continuous bivariate random vector or variable (X, Y): Joint p.d.f. , joint d.f. , properties (without proof), probabilities of events related to r.v. (events in terms of regions bounded by regular curves, circles, straight lines) Marginal and conditional distributions	
	2.2	Expectation of r.v., expectation of function of r.v. E[g(X, Y)], joint moments, Cov (X,Y), Corr (X, Y), conditional mean, conditional variance, E[E(X|Y = y)] = E(X), regression as a conditional expectation	
	2.3	Independence of r. v. (X, Y) and its extension to k dimensional r.v. Theorems on expectation: i) E(X + Y) = E(X) + E(Y),	

		(ii) $E(XY) = E(X) E(Y)$, if X and Y are independent r.v.s , generalization to k variables $E(aX + bY + c)$, $Var(aX + bY + c)$	
	2.4	Joint m.g.f. $M_{X,Y}(t_1, t_2)$, m.g.f. of marginal distribution of r.v.s., and following properties (i) $M_{X,Y}(t_1,t_2) = M_X(t_1,0)\, M_Y(0, t_2)$, if X and Y are independent r.v.s (ii) $M_{X+Y}(t) = M_{X,Y}(t, t)$, (iii) $M_{X+Y}(t) = M_X(t)\, M_Y(t)$ if X and Y are independent r.v.s	
	2.5	Probability distribution of transformation of bivariate r. v. $U = \phi_1(X, Y)$, $V = \phi_2(X, Y)$	
Unit III		**Standard Continuous Probability Distributions**	
	3.1	Motivation for distribution theory - Presentation	**(02 L)**
	3.2	Uniform or rectangular distribution: probability density function (p.d.f.)	**(04 L)**
		$f(x) = \begin{cases} \frac{1}{b-a}, & a \le x \le b \\ 0, & \text{otherwise} \end{cases}$ Notation : $X \sim U[a, b]$	
		Sketch of p. d. f., Nature of p.d.f., d. f., mean, variance Distribution of i) $\frac{X-a}{b-a}$, ii) $\frac{b-X}{b-a}$ iii) $Y = F(x)$ where $F(x)$ is distribution function of a continuous r.v., applications of the result for model sampling.	
	3.3	Normal distribution: probability density function (p. d. f.) $f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-1}{2\sigma^2}(x-\mu)^2\right)$, $-\infty < x < \infty$, $-\infty < \mu < \infty$; $\sigma > 0$ Notation: $X \sim N(\mu, \sigma^2)$ identification of location and scale parameters, nature of probability curve, mean , variance, m.g.f., c.g.f., central moment , cumulants, β_1 , β_2 , γ_1, γ_2 , median, mode, quartiles, mean deviation, additive property, computations of normal probabilities using normal probability integral tables, probability distribution of : i) $\frac{X-\mu}{\sigma}$, standard normal variable (S.N.V.), ii) $aX + b$, iii) $aX + bY + c$, iv) X^2 , where X and Y are independent normal variables.	**(11 L)**

		Probability distribution of $\overline{X}$, the mean of n i. i. d. N (μ, σ^2) r. v s. Normal probability plot, q-q plot to test normality. Model sampling from Normal distribution using (i) Distribution function method and (ii) Box-Muller transformation as an application of simulation. Statement and proof of central limit theorem (CLT) for i. i. d. r. v. s with finite positive variance.(Proof should be using m.g.f.) Its illustration for Poisson and binomial distributions	
	3.4	Exponential distribution: probability density function (p. d. f.) $f(x) = \begin{cases} \alpha e^{-\alpha x}, & x > 0, \alpha > 0 \\ 0 & \text{otherwise} \end{cases}$ Notation : $X \sim Exp(\alpha)$	**(04 L)**
		Nature of p.d.f., mean, variance, m.g.f., c.g.f., d. f., graph of d. f., lack of memory property, median, quartiles. Distribution of min(X, Y) where X and Y are i. i. d. exponential r.v.s	

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Reference :

1. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), *Fundamentals of Statistics, Vol. 2*, World Press, Kolkata.
2. Gupta, S. C. and Kapoor, V. K. (2002), *Fundamentals of Mathematical Statistics*, (*Eleventh Edition*), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
3. Gupta, S. C. and Kapoor V. K. (2007), *Fundamentals of Applied Statistics* (*Fourth Edition*), Sultan Chand and Sons, New Delhi.
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7. 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
8. Mukhopadhya Parimal (1999), *Applied Statistics*, New Central Book Agency, Pvt. Ltd. Kolkata
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11. Weiss N., *Introductory Statistics*, Pearson education publishers.

S.Y. B.Sc. (Statistics) Semester III

Statistics Paper -3 (STS2303): Statistics Practical-III

[Credits-2]

Objectives

1. To fit various discrete and continuous distributions, to draw model samples (using calculators , MSEXCEL and R software)
2. To fit discrete truncated distributions
3. To compute probabilities using R-software

Sr. No.	Title of the experiment
1.	Fitting of negative binomial distribution, plot of observed and expected frequencies
2.	Fitting of normal and exponential distributions, plot of observed and expected frequencies
3.	Applications of negative binomial and multinomial distributions
4.	Applications of normal and exponential distributions
5.	Model sampling from (i) exponential distribution using distribution function, (ii) normal distribution using Box-Muller transformation
6.	Fitting of truncated binomial distribution and truncated Poisson distribution
7.	Fitting of negative binomial, normal and exponential distributions using SAS
8.	Computation of probabilities for negative binomial, multinomial, normal , exponential, truncated probability distributions using R software
9. 10.	} Statistical analysis of primary/secondary data using SAS and R-software

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SYLLABUS UNDER AUTOMONY

SECOND YEAR B. Sc.

SEMESTER - IV

SYLLABUS FOR S. Y. B. Sc. STATISTICS

Academic Year 2017-18

S.Y. B.Sc. (Statistics) Semester IV

Statistics Paper -1 (STS2401)
Statistical and Inferential Methods, related Computing Tool (R-Software)

[Credits-3]

Objectives:

1. To use forecasting and data analysis techniques in case of univariate and multivariate data sets.
2. To test the hypotheses particularly about mean, variance, correlation, proportions and goodness of fit.
3. To use statistical software packages.

Unit I		**Multiple Linear Regression Model (trivariate case)**	**(08 L)**
	1.1	Definition of multiple correlation coefficient. $R_{Y.X_1X_2}$	
		Derivation of the expression for the multiple correlation coefficient. Properties of multiple correlation coefficient (statement only) $0 \le R_{Y.X_1X_2} \le 1$	
		(ii) $R_{Y.X_1X_2} > \min\{r_{YX_1}, r_{YX_2}\}$	
	1.2	Interpretation of coefficient of multiple determination $R^2_{Y.X_1X_2}$ (i) $R^2_{Y.X_1X_2} = 1$ (ii) $R^2_{Y.X_1X_2} = 0$	
	1.3	Definition of partial correlation coefficient $r_{YX_1.X_2}$ $r_{YX_2.X_1}$	
	1.4	Notion of multiple linear regression	
	1.5	Multiple linear regression model $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \epsilon$, assumptions on error random variable ϵ	
	1.6	Fitting of regression plane of Y on X_1 and X_2, $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \epsilon$, by the method of least squares; obtaining normal equations, solutions of normal equations	
	1.7	Residuals: definition, derivation of variance of residual , properties of residuals (statement only)	
	1.8	Definition and interpretation of partial regression coefficients $b_{YX_1.X_2}$ $b_{YX_2.X_1}$	
	1.9	Properties of partial regression coefficient (statement only) (i) $-1 \le b_{YX_1.X_2} \le 1$ and $-1 \le b_{YX_2.X_1} \le 1$ (ii) $b_{YX_1.X_2} * b_{YX_2.X_1} = r^2_{YX_1.X_2}$	
Unit II		**Tests of Hypotheses**	
	2.1	Statistics and parameters, statistical inference : problem of estimation and	**(08 L)**

		testing of hypothesis. Estimator and estimate. Unbiased estimator (definition and illustrations only). Statistical hypothesis, null and alternative hypothesis, simple and composite hypothesis, one sided and two sided alternative hypothesis, critical region, type I error, type II error, power of the test, level of significance, p-value. Confidence interval, finding probabilities of type I error and type II error when critical regions are specified	
	2.2	Tests for mean based on normal distribution (population variance σ^2 known and unknown), using critical region approach and p value approach	**(04 L)**
		(i) $H_o: \mu = \mu_0$ against $H_1 : \mu > \mu_0$, $H_1 : \mu < \mu_0$, $H_1 : \mu \neq \mu_0$	
		(ii) $H_o: \mu_1 = \mu_2$ against $H_1 : \mu_1 > \mu_2$, $H_1 : \mu_1 < \mu_2$ $H_1 : \mu_1 \neq \mu_2$	
		Confidence intervals for μ and $\mu_1 - \mu_2$	
	2.3	Tests Based on normal approximation : Using central limit theorem (using critical region approach and p value approach). Tests for population proportion (i) $H_0 : P = P_0$ against $H_1 : P > P_0$, $H_1 : P < P_0$, $H_1 : P \neq P_0$ (ii) $H_0 : P_1 = P_2$ against $H_1 : P_1 > P_2$, $H_1: P_1 < P_2$, $H_1: P_1 \neq P_2$ Confidence intervals for P and $P_1 - P_2$	**(04 L)**
	2.4	Tests based on chi-square distribution a) Test for independence of two attributes arranged in $r \times s$ contingency table. (With Yates' correction) b) Test for 'Goodness of Fit'. (Without rounding off the expected frequencies) c) Test for $H_0 : \sigma^2 = \sigma_0^2$ against one-sided and two-sided alternatives when i) mean is known , ii) mean is unknown.	**(06 L)**
	2.5	Tests based on t-distribution a) t-tests for population means i) one sample and two sample tests for one-sided and two-sided alternatives, ii) 100(1 –α)% confidence interval for population mean (μ) and difference of means ($\mu_1 - \mu_2$) of two independent normal populations b) Paired t-test for one-sided and two-sided alternatives	**(06 L)**
	2.6	Test based on F-distribution Test for $H_0 : \sigma_1^2 = \sigma_2^2$ against one-sided and two-sided alternatives when i) means are known, ii) means are unknown	**(04 L)**
Unit III		**Use of SAS and R-Software for Statistical Analysis**	**(8L)**
	3.1 **3.2** **3.3**	Computation of probabilities for different probability distributions Computation of multiple correlation coefficients, fitting of regression plane Testing of hypothesis using SAS and R-software	

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Reference :

1. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), *Fundamentals of Statistics, Vol. 2*, World Press, Kolkata.
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14. Weiss N., *Introductory Statistics*, Pearson education publishers.

S.Y. B.Sc. (Statistics) Semester IV

Statistics Paper -2 (STS2402)

Continuous Probability Distributions – II

[Credits-3]

Objectives :

1. To study gamma beta functions
2. To study derived distributions and their applications

Unit I		**Introduction to Gamma and Beta Functions**	**(04L)**
		1.1 Gamma function and properties	
		1.2 Beta functions and properties	
		1.3 Interrelations between beta and gamma functions	
Unit II		**Gamma Distribution:**	**(06L)**
		Probability density function (p. d. f.)	
		$f(x) = \frac{\alpha^{\lambda}}{\Gamma\lambda} e^{-\alpha x} x^{\lambda-1}$, $x \geq 0$, $\lambda>0$, $\alpha>0$	
		= 0 otherwise	
		Notation : $X \sim G(\alpha , \lambda)$ α : scale parameter, λ : shape parameter Nature of probability curve for various values of shape parameter , m.g.f., c.g.f., moments, cumulants, β_1 , β_2 , γ_1, γ_2 , mode, additive property Erlang distribution as a special case of gamma distribution Distribution of sum of n iid exponential variables with same scale parameter Relation between distribution function of Poisson and gamma variates.	
Unit III		**Truncated Normal Distribution**	**(05 L)**
	3.1	Normal distribution N (μ , σ^2) truncated i. to the left below a ii. to the right above b iii. to the left below a and to the right above b, (a < b) Its p.d.f, derivation of mean and statement of variance (without derivation)	
	3.2	Real life situations and applications	
Unit IV		**Sampling Distributions**	**(09 L)**
	4.1	Random sample from a distribution of r.v. X as i. i. d. r. v.s. $X_1 , X_2 , \ldots , X_n$	
	4.2	Notion of a statistic as function of $X_1 , X_2 , \ldots , X_n$ with illustrations	

	4.3	Sampling distribution of a statistic. concept of sampling variation illustration (using R-software and SAS). Distribution of sample mean $\overline{X}$ of a random sample from normal population, exponential and gamma distribution Notion of standard error of a statistic, illustration using (R-software and SAS)	
		Distribution of $\frac{nS^2}{\sigma^2} = \frac{1}{\sigma^2}\sum_{i=1}^{n}(X_i - \overline{X})^2$ for a sample from a normal distribution using orthogonal transformation. Independence of $\overline{X}$ and S^2	
Unit V		**Chi-square (χ_n^2) Distribution**	**(10 L)**
	5.1	Definition of chi-square (χ^2) r. v. as sum of squares of i. i. d. standard normal variates, derivation of p.d.f. of χ^2 with n degrees of freedom using m.g.f., nature of probability. curve with the help of SAS and R software, computations of probabilities using tables of χ^2 distribution mean, variance, m.g.f., c.g.f., central moments, β_1, β_2 , γ_1, γ_2 , mode, additive property	
	5.2	Normal approximation: $\frac{\chi_n^2 - n}{\sqrt{2n}}$ with proof using m.g.f	
	5.3	Distribution of $\frac{X}{X+Y}$ and $\frac{X}{Y}$ where X and Y are two independent chi-square random variables	
Unit VI		**Student's t distribution**	**(8 L)**
	6.1	Definition of student's t distribution with n d. f. where $t = \frac{U}{\sqrt{V/n}}$, U and V are independent random variables such that U ~ N(0, 1) , V ~ χ_n^2	
	6.2	Derivation of p.d.f., nature of probability curve, mean, variance, moments, mode, use of tables of t-distribution for calculation of probabilities, statement of normal approximation	
Unit VII		**Snedecor's F-distribution**	**(6 L)**
	7.1	Definition of F r.v. with n_1 and n_2 d.f. as $F_{n_1, n_2} = \frac{U/n_1}{V/n_2}$ where U and V are independent chi square random variables with n_1 and n_2 d.f. respectively	
	7.2	Derivation of p.d.f., nature of probability curve, mean, variance, moments, mode	

	7.3	Distribution of 1/ F_{n_1, n_2} , use of tables of F-distribution for calculation of probabilities	
	7.4	Interrelations among, χ^2 , t and F variates	
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Reference :

1. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), *Fundamentals of Statistics, Vol. 2*, World Press, Kolkata.
2. Gupta, S. C. and Kapoor, V. K. (2002), *Fundamentals of Mathematical Statistics*, (*Eleventh Edition*), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
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S.Y. B.Sc. (Statistics) Semester III

Statistics Paper - 3 (STS2403): Statistics Practical-IV

[Credits-2]

Objectives

1. To compute multiple and partial correlation coefficients, to fit trivariate multiple regression plane, to find residual s. s. and adjusted residual s. s. (using calculator, SAS, MS-Excel and R-software)
2. To fit continuous truncated distribution
3. To test various hypotheses included in theory
4. To compute probabilities for the events related to different probability distributions and testing of hypotheses using R-software

Sr. No.	**Title of the experiment**
1.	Fitting of truncated normal distribution
2.	Test for means and construction of confidence interval based on normal distribution
3.	Test for proportions and construction of confidence interval based on normal distribution
4.	Test for means and construction of confidence interval based on t distribution
5.	Tests based on chi-square distribution (Independence of attributes)
6.	Tests based on chi-square distribution (Goodness of fit test, test of variance for $H_0 : \sigma^2 = \sigma_0^2$)
7.	Tests based on F distribution (Test for equality of variances and global F test)
8.	Fitting of multiple regression plane and computation of multiple and partial correlation coefficients (Also using SAS &R)
9.	Computations of probabilities of truncated normal distribution , gamma distribution , χ^2 , t , F distributions using SAS and R- software
10.	Testing of hypotheses using SAS and R- software