Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for S. Y. B. Sc. STATISTICS (2022 Pattern)
(With effect from Academic Year 2023-2024)

Name of the Programme : B.Sc. Statistics

Program Code : USST

Class : S.Y.B.Sc.

Semester : III

Semester	Paper Code	Title of Paper	No. of Credits
III	USST231	Statistical Techniques- I	3
	USST232	Continuous Probability Distributions-I	3
	USST233	Practical Paper –III	2
IV	USST241	Statistical Techniques- II	3
	USST242	Continuous Probability Distributions-II	3
	USST243	Practical Paper-IV	2

SYLLABUS (CBCS) FOR S. Y. B. Sc. STATISTICS

(w. e. from June, 2023)

Name of the Programme	**:** B.Sc. Statistics
Program Code	**:** USST
Class	**:** S.Y.B.Sc.
Semester	**:** III
Course Name	**:** Statistical Techniques – I
Course Code	**:** USST231
No. of Lectures	**:** 48
No of Credits	**:** 3

Course Outcomes:

The students will acquire knowledge about the;

1. the some discrete distributions & truncated distributions and their applications.
2. the various types of index numbers and utilities & their real applications.
3. fitting of the appropriate time series model to time series from real life situations.

TOPICS/CONTENTS:

Unit 1: Standard Discrete Distributions: **(22 L)**

1.1 Negative Binomial Distribution:

Probability mass function (p.m.f.)

$$P(X = x) = \binom{x+k-1}{x} p^k q^x \quad ; x = 0, 1, 2, \ldots$$

$$; \ 0 < p < 1 ; q = 1 - p ; k > 0$$

$$= \quad 0 \quad ; \quad otherwise.$$

Notation: $X \sim NB(k, p)$.

Nature of probability curve, negative binomial distribution as a waiting time distribution, moment generating function (MGF), cumulant generating function (CGF), mean, variance, skewness, kurtosis (recurrence relation between moments is not expected), additive property of NB(k,p). Relation between geometric distribution and negative binomial distribution. Poisson approximation to negative binomial distribution. Real life situations.

1.2 Multinomial Distribution: Probability mass function (p.m.f.)

$$P(X_1 = x_1, X_2 = x_2, \dots, X_k = x_k) = \frac{n!\, {p_1}^{x_1} {p_2}^{x_2} \dots . {p_k}^{x_k}}{x_1!\ x_2! \dots . x_k!} \quad ; x_i = 0, 1, 2, \dots, n - \sum_{1}^{i-1} x_r$$

$$; \ i = 1,2, \dots, k$$

$$; x_1 + x_2 + \cdots + x_k = n$$

$$; 0 < p_i < 1;\ i = 1, 2, \dots, k$$

$$; \ p_1 + p_2 + \cdots + p_k = 1$$

$$= 0 \quad ; \ otherwise$$

$Notation: \ (X_1, X_2, \dots, X_k) \sim MD(n, p_{1,} p_2, \dots, p_k), \qquad \underline{X} \sim MD(n, \underline{p}),$

$where\ \underline{X} = (X_1, X_2, \dots, X_k), \qquad \underline{p} = (p_{1,} p_2, \dots, p_k).$

Joint MGF of $(X_1, X_2, \dots, X_k)$, use of MGF to obtain means, variances, covariances, total correlation coefficients, variance – covariance matrix, rank of variance – covariance matrix and its interpretation, additive property of multinomial distribution, univariate marginal distribution, distribution of $Xi + Xj$, conditional distribution of Xi given $Xj = r$, conditional distribution of Xi given $Xi + Xj = r$, real life situations and applications.

1.3 Truncated Distributions:

Concept of truncated distribution, truncation to the right, left and on both sides. Binomial distribution left truncated at $X = 0$ (value zero is discarded), its p.m.f., mean & variance. Poisson distribution left truncated at $X = 0$ (value zero is discarded), its p.m.f., mean & variance. Real life situations and applications.

Unit 2: Index Numbers: (09L)

2.1 Introduction.

2.2 Definition and Meaning.

2.3 Problems/considerations in the construction of index numbers.

2.4 Simple and weighted price index numbers based on price relatives. **(For practical only)**

2.5 Simple and weighted price index numbers based on aggregates. **(For practical only)**

2.6 Laspeyre's, Paasche's and Fisher's Index numbers.

2.7 Test of adequacy for an Index Number (i) Time Reversal Test (ii) Factor Reversal Test

2.8 Consumer price index number: Considerations in its construction. Methods of construction of consumer price index number - (i) family budget method (ii) aggregate expenditure method.

2.9 Base Shifting, splicing, deflating, and purchasing power. **(For practical only)**

2.10 Description of the BSE sensitivity and similar index numbers.

Unit 3: Time Series: (12L)

3.1 Meaning and utility of time series, components of time series: trend, seasonal variations, cyclical variations, irregular (error) fluctuations.

3.2 Exploratory data analysis: Time series plot to (i) check any trend & seasonality in the time series (ii) capture trend.

3.3 Methods of trend estimation and smoothing: (i) moving average, (ii) curve fitting by least square principle, (iii) exponential smoothing.

3.4 Choosing parameters for smoothing and forecasting.

3.5 Forecasting based on exponential smoothing.

3.6 Measurement of seasonal variations: i) simple average method, ii) ratio to moving average method, iii) ratio to trend where trend is calculated by method of least squares. **(For practical only)**

3.7 Fitting of autoregressive model $AR\ (p)$, where $p\ =\ 1,2$.

3.8 Case studies of real life Time Series: Price index series, share price index series, economic time series: temperature and rainfall time series, wind speed time series, pollution levels.

Unit 4: Chebychev's Inequality: (5L)

4.1 For discrete and continuous distribution.

4.2 Examples and problems on Binomial, Normal and Exponential distributions.

Reference Books:

1. Brockwell P. J. and Davis R. A. (2003), Introduction to Time Series and Forecasting (Second Edition), Springer Texts in Statistics
2. Chatfield C. (2001), The Analysis of Time Series An Introduction, Chapman and Hall / CRC, Texts in Statistical Science .
3. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
4. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
5. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
6. Gupta, S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
7. Mukhopadhya Parimal (1999), Applied Statistics, New Central Book Agency, Pvt. Ltd. Kolkata

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SYLLABUS (CBCS) FOR S. Y. B. Sc. STATISTICS

(w. e. from June, 2023)

Name of the Programme : B.Sc. Statistics

Program Code : USST

Class : S.Y.B.Sc.

Semester : III

Course Name : CONTINUOUS PROBABILITY DISTRIBUTIONS – I

Course Code : USST232

No. of lectures : 48

No. of Credits : 3

Course Outcomes:

Students should be able to:

1. understand continuous distributions with real life situations.
2. learn uniform, Normal, exponential and Gamma distributions.
3. learn Bivariate distributions
4. learn the relations among the different distributions
5. learn the concept of transformation of continuous random variables which help to study derived distributions.

TOPICS/CONTENTS:

UNIT 1: Functions and Properties of functions (04 L)

Definition of function, Continuous function, Monotonic function, One to one function, Onto function, Inverse function.

UNIT 2: Continuous Univariate Distributions (10 L)

2.1 Continuous sample space: Definition, illustrations.

Continuous random variable: Definition, probability density function (p.d.f.), cumulative distribution function (c.d.f.), properties of c.d.f. (without proof), probabilities of events related to random variable.

2.2 Expectation of continuous r.v., expectation of function of r.v. E[g(X)], mean, variance, geometric mean, harmonic mean, raw and central moments, skewness, kurtosis.

2.3 Moment generating function (M.G.F.): Definition and properties, cumulant generating function (C. G. F.): definition, properties.

2.4 Mode, median, quartiles.

2.5 Probability distribution of function of 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 3: Continuous Bivariate Distributions: **(12 L)**

3.1 Continuous bivariate random vector or variable (X, Y): Joint p. d. f. , joint c. 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

3.2 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.

3.3 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, generalization to k variables. E(aX + bY + c), Var (aX + bY + c).

3.4 M.G.F. : $M_{X,Y}(t_1, t_2)$, properties, M.G.F. of marginal distribution of r. v.s., 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.

3.5 Probability distribution of transformation of bivariate r. v. $U = \phi_1(X, Y)$, $V = \phi_2(X, Y)$

UNIT 4: Standard Univariate Continuous Distributions: **(22 L)**

4.1 Uniform or Rectangular Distribution:

Probability density function (p.d.f.) $f(x) = \begin{cases} \frac{1}{b-a} & ;\ a \le x \le b \\ 0 & ;\ \text{Otherwise} \end{cases}$

Notation : X ~ U[a, b], sketch of p. d. f., c. d. f., mean, variance, symmetry.

Distribution of i) $\frac{X-a}{b-a}$ ii) $\frac{b-X}{b-a}$ iii) Y=F(X), where F(X) is the c.d.f. of continuous r.v. X.

Application of the result to model sampling. (Distributions of X + Y, X – Y, XY and X/Y are not expected.)

4.2 Normal Distribution:

Probability density function (p. d. f.)

$$f(x) = \begin{cases} \dfrac{1}{\sigma\sqrt{2\pi}} e^{\frac{1}{-2\sigma^2}(x-\mu)^2} & ; -\infty < x < \infty; -\infty < \mu < \infty; \sigma > 0 \\ 0 & ; \quad otherwise \end{cases}$$

p. d. f. curve, identification of scale and location parameters, nature of probability curve, mean, variance, M.G.F., C.G.F., central moments, 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 variates. Probability distribution of $\overline{X}$, the mean of n i.i.d. $N(\mu, \sigma^2)$ r.v.s. 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.

4.3 Exponential Distribution

Probability density function (p. d. f.) $f(x) = \begin{cases} \alpha e^{-\alpha x}; x \geq 0; \alpha > 0 \\ 0 \quad ; \quad otherwise \end{cases}$

Notation : X ~ Exp(α) .

Nature of p. d. f., density curve, interpretation of α as rate and 1/α as mean, variance, M.G.F., C.G.F., c.d.f., graph of c.d.f., lack of memory property, median, quartiles. Distribution of min(X, Y) with X, Y i. i. d. exponential r. v. s.

4.4 Gamma Distribution:

Probability density function (p. d. f.) $f(x) = \begin{cases} \dfrac{\alpha^\lambda}{\Gamma\lambda} x^{\lambda-1} e^{-\alpha x}; x \geq 0; \alpha > 0, \lambda > 0 \\ 0 \quad ; \quad otherwise \end{cases}$

Notation : $X \sim G(\alpha, \lambda)$. Nature of probability curve, special cases: i) α=1 , ii) λ= 1, M.G.F., C.G.F., moments, cumulants, β_1, β_2, γ_1, γ_2, mode, additive property. Distribution of sum of n i.i.d. Gamma variates.

Reference Books:

1. **1.** Mukhopadhya Parimal (1999), Applied Statistics, New Central Book Agency, Pvt. Ltd. Kolkata
2. **2.** Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.

3. Gupta S. C. &Kapoor V.K.: (2002), Fundamentals of Mathematical Statistics. Sultan Chand & sons, New Delhi.
4. Gupta S. C. &Kapoor V.K.: Applied Statistics. Sultan Chand & sons, New Delhi.
5. Walpole R.E. & Mayer R.H.: Probability & Statistics. (Chapter 4, 5, 6, 8, 10) MacMillan Publishing Co. Inc, New York
6. Goon, A.M., Gupta M.K. and Dasgupta B: (1986), Fundamentals of Statistics Vol. I and Vol. II World Press, Calcutta.
7. Meyer, P. L., Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.
8. 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
9. Ross, S. (2003), A first course in probability (Sixth Edition), Pearson Education publishers, Delhi, India.

SYLLABUS (CBCS) FOR S. Y. B. Sc. STATISTICS
(w. e. from June, 2023)

Name of the Programme : B.Sc. Statistics
Program Code : USST
Class : S.Y.B.Sc.
Semester : III
Course Name : Practical Paper – III
Course Code : USST233
No. of lectures : 48
No. of Credits : 2

Course Outcomes:

The students will acquire practical knowledge about the;

1. to fit various discrete and continuous distributions, to draw model samples (using R software)
2. understand the applications of Continuous Uniform distribution, Exponential distribution, Normal distribution, Bivariate Normal distribution.
3. distributions and their applications
4. concept and use of time series

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
7.	Fitting of Negative Binomial, Normal and Exponential Distributions using R software
8.	Index Numbers
9.	Time series : Estimation and forecasting of trend by fitting of AR (1) model, exponential smoothing, moving averages.
10.	Estimation of seasonal indices by ratio to trend