REVISED SYLLABUS
OF
S. Y. B. Sc. STATISTICS
(at subsidiary level)
With Effect from June 2014

STATISTICS

Notes :

1. A student of the three year B.Sc. degree course will not be allowed to offer **Statistics** and **Statistical Techniques** simultaneously in any of the three years of the course.
2. Students offering **Statistics** at the first year of the three year B.Sc. course may be allowed to offer **Statistical Techniques** as one of their subjects in the second year of the three year B.Sc. course in the place of Statistics.
3. Students offering **Statistical Techniques** at the first of the three year B.Sc. course may be allowed to offer **Statistics** as one of their subjects in the second year of the three year B.Sc. course in place of **Statistical Techniques** provided they satisfy other requirements regarding subject combinations, if any.
4. Students must complete all the practicals to the satisfaction of the teacher concerned.
5. At the time of practical examination, a student must produce the laboratory journal along with the completion certificate signed by the Head of the Department.
6. **Structure of evaluation of practical paper at S. Y. B. Sc.**

A)

Continuous internal evaluation	Marks
i) Journal	10
ii) Viva-voce based onproject	10
Total of A	20

B) Annual practical examination

Section	Nature	Marks	Time
I	On line examination: **Note :** Question No.1 is compulsory. Q. 1: Execute the commands and write the same in answer book along with answers using (A) MS-EXCEL (B) R-Software	 10 10	Maximum 30 minutes

II	Using Calculator **Note :** Attempt any two of the **four** questions : Q2 : Q3 : Q4 : Q5 :	50 (25 marks for each question)	2 hours 50 minutes
III	Viva-voce	10	10 minutes
	Total of B	80	3 Hours 30 minutes
	Total of A and B	100	

Preparation by Internal Examiner for Section I (Online examination) :

1. Keep at least 12 **computers** with latest configuration ready with **battery backup** and **necessary software** at the examination laboratory.
2. Trivariate and bivariate data set of 10 to 20 items be fed in computer MS-EXCEL spreadsheet before commencement of examination (Trivariate data set for multiple regression plane). Appropriate data set for time series : linear, quadratic, exponential trend fitting, exponential smoothing be entered in spreadsheet.
3. Any other type of data required also be entered in computer spreadsheet.

Instructions to Examiners :

1. Students are not expected to fill data items at the time of examination. They are expected to use MS-EXCEL and R-commands to operate on the data set which are already fed.
2. The question on section I are compulsory and there is no internal option.
3. The commands of the nature attached in specimen are to be asked, so that the total marks of all asked commands will be exactly 20.

Objectives :

1. To fit various discrete and continuous probability distributions and to study various real life situations.
2. To identify the appropriate probability model that can be used.
3. To use forecasting and data analysis techniques in case of univariate and multivariate data sets.
4. To use statistical software packages.
5. To test the hypotheses particularly about mean, variance, correlation, proportions and goodness of fit.
6. To study applications of statistics in the field of demography etc.

SEMESTER – I, PAPER - I

ST – 211: DISCRETE PROBABILITY DISTRIBUTIONS , TIME SERIES AND R SOFTWARE

1. Standard Discrete Distributions:

1.1 **Negative Binomial Distribution:** Probability mass function (p. m. f.) **(06 L)**

$$P(X=x)=\begin{cases}\binom{x+k-1}{x}p^k q^x , & x=0,1,2,\cdots\cdots;0<p<1;q=1-p\\ 0 & , otherwise\end{cases}$$

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.

1.2 **Multinomial Distribution:** Probability mass function (p. m. f.) **(12 L)**

$$P(X_1=x_1,X_2=x_2,\cdots,X_k=x_k)=\begin{cases}\dfrac{n!\,p_1^{x_1}\;p_2^{x_2}\cdots p_k^{x_k}}{x_1!\;x_2!\cdots x_k!} , & x_i=0,1,2,\cdots n;\; i=1,2,\cdots,k;\\ & x_1+x_2+\cdots+x_k=n;\\ & 0<p_i<1\,;i=1,2,\cdots,k\\ & p_1+p_2+\cdots+p_k=1;\\ 0 & , otherwise\end{cases}$$

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 MGF of $(X_1,X_2,\cdots,X_k)$ use of MGF to obtain means, variances, covariances, total correlation coefficients, multiple and partial correlation coefficients for k= 3, univariate marginal distribution, 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 and real life situations and applications.

1.3 Truncated Distributions: **(06 L)**

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

2. Time Series: **(18 L)**

2.1 Meaning and utility of time series, Components of time series**:** trend, seasonal variations, cyclical variations, irregular (error) fluctuations or noise.
2.2 Exploratory data analysis: Time series plot to (i) check any trend, seasonality in the time series (ii) learn how to capture trend.
2.3 Methods of trend estimation and smoothing: (i) moving average, (ii) curve fitting by least square principle, (iii) exponential smoothing.
2.4 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.
2.5 Choosing parameters for smoothing and forecasting.
2.6 Forecasting based on exponential smoothing.
2.7 Double exponential smoothing i.e. Holt-Winters method
2.8 Fitting of autoregressive model AR (1), plotting of residuals.
2.9 Data Analysis of Real Life Time Series:
price index series, share price series, economic time series, sales tax series, market price of daily consumables, weather related time series: temperature and rainfall time series, wind speed time series, pollution levels.

3. Fundamentals of R-Software: (6L)

3.1 Introduction to R, features of R, starting and ending R session, getting help in R, R commands and case sensitivity.
3.2 Vectors and vector arithmetic
a) creation of vectors using functions c, seq, rep
b) Arithmetic operations on vectors using operators +, - , * , / , ^ .
c) Numerical functions: log10, log, sort, max, min, unique, range, length, var, prod, sum, summary, fivenum etc.
d) accessing vectors
3.3 Data frames : creation using data.frame, subset and transform commands.
3.4 Resident data sets : Accession and summary
3.5 p, q, d, r functions.

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SEMESTER – I, PAPER – II
ST 212 : CONTINUOUS PROBABILITY DISTRIBUTIONS

1. Continuous Univariate Distributions: (12 L)

1.1 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.
1.2 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.
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 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).

2. Continuous Bivariate Distributions: (12 L)

2.1 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.

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

2.4 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.

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

3. Standard Univariate Continuous Distributions:

3.1 **Uniform or Rectangular Distribution:** Probability density function (p.d.f.) **(03 L)**

$$f(x) = \begin{cases} \dfrac{1}{b-a}, & a \le x \le b \\ 0, & otherwise \end{cases}$$

Notation **:** X ~ U[a, b] .

p. d. f., sketch of p. d. f., c. d. f., mean, variance, symmetry. Distribution of i) $\dfrac{X-a}{b-a}$, ii) $\dfrac{b-X}{b-a}$, 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.)

3.2 **Normal Distribution:** Probability density function (p. d. f.) **(12 L)**

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

Notation: $X \sim N(\mu,\sigma^2)$.

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, $\beta_1,\beta_2,\gamma_1,\gamma_2$, median, mode, quartiles, mean deviation, additive property, computations of normal probabilities using normal probability integral tables, probability distribution of : i) $\dfrac{X-\mu}{\sigma}$, 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 $\bar{X}$, the mean of n i. i. d. $N(\mu,\sigma^2)$ 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.

3.3 **Exponential Distribution:** Probability density function (p. d. f.) **(04 L)**

$$f(x)=\begin{cases}\alpha e^{-\alpha x} & , \quad x\ge 0;\ \alpha>0\\[2ex] 0 & , \quad otherwise\end{cases}$$

Notation **:** $X \sim E(\alpha)$.

Nature of p. d. f., density curve, interpretation of α as rate and $1/\alpha$ as mean, 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.

3.4 **Gamma Distribution:** Probability density function (p. d. f.) **(05 L)**

$$f(x)=\begin{cases}\dfrac{\alpha^\lambda}{\Gamma\lambda}x^{\lambda-1}e^{-\alpha x}, & x\ge 0;\alpha>0\\[2ex] 0 & , otherwise\end{cases}$$

Notation : $X \sim G(\alpha,\lambda)$.

Nature of probability curve, special cases: i) $\alpha=1$, ii) $\lambda=1$, M. G. F., C. G. F., moments, cumulants, $\beta_1,\beta_2,\gamma_1,\gamma_2$, mode, additive property. Distribution of sum of n i. i. d. exponential variables. Relation between distribution function of Poisson and Gamma variates.

SEMESTER – II, PAPER – I
ST-221 : STATISTICAL METHODS AND USE OF R-SOFTWARE

1. Multiple Linear Regression Model: (12 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

i) $0 \le R_{Y.X_1X_2} \le 1$, ii) $R_{Y.X_1X_2} \ge \min\{r_{YX_1}, r_{YX_2}\}$.

1.2 Interpretation of coefficient of multiple determination $R^2_{Y.X_1X_2}$ as i) proportion of variation explained by the linear regression ii) $R^2_{Y.X_1X_2} = 1$, iii) $R^2_{Y.X_1X_2} = 0$.

1.3 Definition of partial correlation coefficient $r_{YX_1.X_2}$ and $r_{YX_2.X_1}$.

1.4 Notion of multiple linear regression, Yule's notation (trivariate case).

1.5 Fitting of regression plane of Y on X_1 and X_2, $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \varepsilon$, by the method of least squares; obtaining normal equations, solutions of normal equations.

1.6 Residuals : Definition, order, derivation of variance, properties.

1.7 Definition and interpretation of partial regression coefficient**s** $b_{YX_1.X_2}$ and $b_{YX_2.X_1}$

1.8 Properties of partial correlation coefficient: i) $-1 \le r_{YX_1.X_2} \le 1$ and $-1 \le r_{YX_2.X_1} \le 1$, ii) $b_{YX_1.X_2} b_{YX_2.X_1} = r^2_{YX_1.X_2}$

2. Tests of Hypotheses: (18L)

2.1 Statistics and parameters, statistical inference : problem of estimation and 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. Two sided confidence interval, finding probabilities of type I error and type II error when critical regions are specified .

2.2 Tests for mean of $N(\mu, \sigma^2)$ known, using critical region approach

i) $H_0 : \mu = \mu_0$ against $H_1 : \mu \ne \mu_0$, $H_1 : \mu > \mu_0$, $H_1 : \mu < \mu_0$, ii) $H_0 : \mu_1 = \mu_2$ against $H_1 : \mu_1 \ne \mu_2$, $H_1 : \mu_1 > \mu_2$, $H_1 : \mu_1 < \mu_2$. Two sided 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 P :

i) $H_0 : P = P_0$ against $H_1 : P \ne P_0$, $H_1 : P > P_0$, $H_1 : P < P_0$

ii) $H_0 : P_1 = P_2$ against $H_1 : P_1 \neq P_2$, $H_1 : P_1 > P_2$, $H_1 : P_1 < P_2$.
Two sided confidence intervals for P and $P_1 - P_2$.

3. Tests of hypothesis using R-Software: (6 L)

2.1 Drawing a sample from population using SRSWR, SRSWOR.
2.2 Tests: Z test, t test, F test and tests for proportions.

4. Demography: (6 L)

4.1 Vital events, vital statistics, methods of obtaining vital statistics, rates of vital events, sex ratios, dependency ratio.
4.2 Death/Mortality rates: Crude death rate, specific (age, sex etc.) death rate, standardized death rate (direct and indirect), infant mortality rate.
4.3 Fertility/Birth rate: Crude birth rate, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rate.
4.4 Growth/Reproduction rates : Gross reproduction rate, net reproduction rate.
4.5 Interpretations of different rates, uses and applications.
4.6 Trends in vital rates as revealed in the latest census.

5.Queueing Model: (6 L)

M/M/1: FIFO as an application of exponential distribution, Poisson distribution and geometric distribution : Inter arrival rate (λ), service rate (μ), traffic intensity ($\rho = \lambda / \mu < 1$), queue discipline, probability distribution of number of customers in queue, average queue length, average waiting time in: i) queue, ii) system.

SEMESTER – II, PAPER - II
ST 222: SAMPLING DISTRIBUTIONS AND INFERENCE

1.Chi-square (χ_n^2) Distribution: (10 L)

1.1 Definition of χ^2 r. v. as sum of squares of i. i. d. standard normal variables, derivation of p. d. f. of χ^2 with n degrees of freedom (d. f.) using M. G. F., nature of p. d. f. curve, computations of probabilities using tables of χ^2 distribution. mean, variance, M. G. F., C. G. F., central moments, $\beta_1, \beta_2, \gamma_1, \gamma_2$, mode, additive property.

1.2 Normal approximation: $\frac{\chi_n^2 - n}{\sqrt{2n}}$ with proof .

1.3 Distribution of $\frac{X}{X+Y}$ and $\frac{X}{Y}$, where X and Y are two independent chi-square random variables.

2. Student's t-distribution: (06 L)

2.1 Definition of T r. v. with n d. f. in the form $T = \frac{U}{\sqrt{\chi_n^2 / n}}$, where U ~ N(0, 1) and χ_n^2 is a χ^2 r. v. with n d. f. and U and χ_n^2 are independent r. v. s.

2.2 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.

3. Snedecore's F-distribution: (06L)

3.1 Definition of F r. v. with n_1 and n_2 d. f. as $F_{n_1, n_2} = \frac{\chi_{n_1}^2 / n_1}{\chi_{n_2}^2 / n_2}$ where χ_{n1}^2 and $\chi_{n_2}^2$ are independent chi-square r.v.s with n_1 and n_2 d.f. respectively .

3.2 Derivation of p. d. f., nature of probability curve, mean, variance, moments, mode.

3.3 Distribution of $1/F_{n_1, n_2}$, use of tables of F-distribution for calculation of probabilities.

3.4 Interrelations among, χ^2 , t and F variates.

4. Sampling Distributions: (08 L)

4.1 Random sample from a distribution as i. i. d. r. v.s. $X_1, X_2, \cdots, X_n$.

4.2 Notion of a statistic as function of $X_1, X_2, \cdots, X_n$ with illustrations.

4.3 Sampling distribution of a statistic. Distribution of sample mean $\overline{X}$ from normal, exponential and gamma distribution, Notion of standard error of a statistic.

4.5 Distribution of $\frac{nS^2}{\sigma^2} = \frac{1}{\sigma^2} \sum_{i=1}^{n} \left(X_i - \overline{X}\right)^2$ for a sample from a normal distribution using orthogonal transformation. Independence of $\overline{X}$ and S^2.

5. Test of Hypothesis:

(18 L)

5.1 Tests based on chi-square distribution:

a) Test for independence of two attributes arranged in 2 X2 contingency table. (With Yates' correction).

b) Test for independence of two attributes arranged in r X s contingency table, McNemar’s test

c) Test for 'Goodness of Fit'. (Without rounding-off the expected frequencies).

d) 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.

5.2 Test**s** 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) $100(1-\alpha)\%$ two sided confidence interval for population mean (μ) and difference of means $(\mu_1 - \mu_2)$ of two independent normal population**s.**

b) Paired t-test for one-sided and two-sided alternatives.

5.3 Test based on F-distribution:

a) 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.

PAPER - III
ST 223 : PRACTICALS (Annual Examination)

Pre-requisites : Knowledge of the topics in theory.

Equipments : At least **12** computers, P4 with 32 bit, 1GB RAM, 160GB hard disk, with necessary software, battery backup, printers, scientific calculators, necessary statistical tables.

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 calculators and MSEXCEL).
2. To fit various discrete and continuous distributions, to test the goodness of fit, to draw model samples (using calculators , MSEXCEL and R software).
3. To test various hypotheses included in theory.
4. To analyze time series data.

Sr. No.	**Title of the experiment**	**No. of practicals**
1	Fitting of negative binomial distribution, testing goodness of fit.	**1**
2	Fitting of normal distribution, testing goodness of fit (also using qq-plot).	**1**
3	Applications of normal, negative binomial and multinomial distribution.	**2**
4	Model sampling from exponential, normal distribution using (i) distribution function, (ii) Box-Muller transformation.	**1**
5	Time series : Estimation and forecasting of trend by fitting of AR (1) model, exponential smoothing, moving averages.	**1**
6	Estimation of seasonal indices by ratio to trend	**1**
7	Test for means and construction of confidence interval . (Also using MSEXCEL) (i) H0 : □□= □0, □□known and □□unknown (ii) H0 : $□_1 = □_2$, $□_1$, $□_2$ known (iii) H0 : $□_1 = □_2$, $□_1 = □_2$ = □□unknown (iv) H0 : $□_1 = □_2$, paired t test	**2**
8	Tests for proportions and construction of confidence interval for H0 : P = P_0, H0 : P1 = P2	**1**
9	Tests based on $□^2$ distribution (i) goodness of fit (ii) independence of attributes (2 □□2, m □□n contingency table), (iii)Mc Nemar's test, (iv) $H_0 : \sigma^2 = \sigma_0^2$, □□unknown, confidence interval for $□^2$	**2**
10	Tests based on F distribution $H_0 : \sigma_1^2 = \sigma_2^2$ (i) means known, (ii) means unknown	**1**
11	Fitting of multiple regression plane using MSEXCEL.	**1**
12	Fitting of normal distribution using MSEXCEL.	**1**
13	Exponential smoothing using MSEXCEL.	**1**

14	Computations of probabilities of Normal, Exponential gamma, □2, t, F using R.	**1**
15	Use of basic R software commands, finding summary statistics using R software	**1**
16	Tests using R software	**1**
17	**Project :** Project based on analysis of data collected by students in groups maximum 6 students. (**Project is equivalent to five practicals**)	**5**

Books Recommended:

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. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), *Introduction to Mathematical Statistics (Tenth Impression*), Pearson Prentice Hall.
8. Kulkarni, M. B., Ghatpande, S. B. and Gore, S. D. (1999), *Common Statistical Tests,* Satyajeet Prakashan, Pune 411029
9. Medhi, J., *Statistical Methods*, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002.
10. Meyer, P. L., *Introductory Probability and Statistical Applications*, Oxford and IBH Publishing Co. New Delhi.
11. 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
12. Mukhopadhya Parimal (1999), *Applied Statistics*, New Central Book Agency, Pvt. Ltd. Kolkata
13. Purohit S. G., Gore S. D. and Deshmukh S. R. (2008), *Statistics using R,* Narosa Publishing House, New Delhi.
14. Ross, S. (2003), *A first course in probability (Sixth Edition*), Pearson Education publishers , Delhi, India.
15. Walpole R. E., Myers R. H. and Myers S. L. (1985), *Probability and Statistics for Engineers and Scientists (Third Edition, Chapters 4, 5, 6, 8, 10)*, Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022.
16. Weiss N., *Introductory Statistics*, Pearson education publishers.

S. Y. B. Sc. Statistics

Equivalence of old and new papers

Paper code	Old paper (2009 pattern)	New paper (2014 pattern)
ST: 211	DISCRETE PROBABILITY DISTRIBUTIONS AND TIME SERIES	PROBABILITY DISTRIBUTIONS , TIME SERIES AND R SOFTWARE
ST: 212	CONTINUOUS PROBABILITY DISTRIBUTIONS-I	CONTINUOUS PROBABILITY DISTRIBUTIONS
ST: 221	STATISTICAL METHODS AND NATIONAL INCOME	STATISTICAL METHODS AND USE OF R-SOFTWARE
ST: 222	CONTINUOUS PROBABILITY DISTRIBUTIONS-II AND DEMOGRAPHY	SAMPLING DISTRIBUTIONS AND INFERENCE