

B.Sc. (Hons.) COURSE IN STATISTICS

THREE-YEAR FULL-TIME PROGRAMME
SEMESTERS I to VI

SCHEME OF EXAMINATION AND COURSE CONTENTS



University of Delhi
Delhi-110007

2011

Syllabus applicable for the students seeking admission to the
B.Sc. (Hons.) Statistics Course in the Academic Year 2011-2012.

B.Sc. (HONOURS) STATISTICS

SCHEME OF EXAMINATION

	Examination 2011 and onwards	Duration (hrs.)	Max. Marks	Internal Assessment*
First Year: Semester I (July to December)				
Paper STH 101:	Technical Writing and Communication in English	3	75	25
Paper STH 102:	Calculus-I	3	75	25
Paper STH 103:	Algebra-I	3	75	25
Paper STH 104:	Probability and Statistical Methods-I	3	75	25
Statistics/ Computer Lab.:				
	Practical-I: comprising the following two parts: Part A: Based on Papers STH 103 and STH 104 Part B: Introduction to Computer fundamentals and Electronic Spread sheet.	4	100	

Examination 2012 and onwards

First Year: Semester II (January to May)

Paper STH 201:	Calculus-II	3	75	25
Paper STH 202:	Algebra-II	3	75	25
Paper STH 203:	Probability and Statistical Methods-II	3	75	25
Paper STH 204:	Applied Statistics-I	3	75	25
Statistics Lab.:				
	Practical-II: Based on Papers STH 202, STH 203 and STH 204	4	100	

Examination 2012 and onwards

Second Year: Semester III (July to December)

Paper STH 301:	Real Analysis	3	75	25
Paper STH 302:	Probability and Statistical Methods-III	3	75	25
Paper STH 303:	Applied Statistics- II	3	75	25
Paper STH 304:	Survey Sampling	3	75	25
Statistics Lab.:				
	Practical-III: Based on Papers STH 302, STH 303 and STH 304	4	100	

Examination 2013 and onwards		Duration (hrs.)	Max. Marks	Internal Assessment*
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Second Year: Semester IV (January to May)

Paper STH 401:	Numerical Analysis	3	75	25
Paper STH 402:	Probability and Statistical Methods-IV	3	75	25
Paper STH 403:	Operational Research	3	75	25
Paper STH 404:	Computer Programming in C	3	75	25
Statistics/ Computer Lab.:				
	Practical-IV:	4	100	
	comprising the following two parts:			
	Part-A: Based on Papers STH 401 and STH 402			
	Part-B: Based on Paper STH 404			

Examination 2013 and onwards

Third Year: Semester V (July to December)

Paper STH 501:	Statistical Inference-I	3	75	25
Paper STH 502:	Applied Statistics-III	3	75	25
Paper STH 503:	Linear Models	3	75	25
Paper STH 504:	Stochastic Processes	3	75	25
Statistics/ Computer Lab.:				
	Practical-V:	4	100	
	comprising the following two parts:			
	Part-A: Based on Papers STH 501, STH 502 and STH 503			
	Part-B: Introduction to Statistical Software/ Packages			

Examination 2014 and onwards

Third Year: Semester VI (January to May)

Paper STH 601:	Statistical Inference-II	3	75	25
Paper STH 602:	Design of Experiments	3	75	25
Paper STH 603:	Econometrics	3	75	25
Paper STH 604:	Bio-Statistics	3	75	25
Statistics/ Computer Lab.:				
	Practical-VI:	4	100	
	comprising the following two parts:			
	Part A: Based on Papers STH 601, STH 602, STH 603 and STH 604			
	Part B: Problem solving using Statistical Software/Packages			

Total Marks for Semester I to Semester VI:

3000

- Note 1:** Each theory paper will carry 100 marks including 25 marks earmarked for Internal Assessment*.
- Note 2:** For each theory paper there shall be 5 lecture periods. Besides, there will be tutorial classes with the tutorial groups of students as per University guidelines.
- Note 3:** Simple Calculator is allowed in the examination of each theory Paper.
- Note 4:** Twelve (12) periods per week will be devoted to Practicals I, II, III, and IV. Sixteen (16) periods per week will be devoted to Practicals V and VI. (The periods to be suitably divided in the case when Practical Paper has been split in Parts A and B).
- Note 5:** There will be one batch of 15 students for practical classes.
- Note 6:** The examination in Part A and Part B of Practicals I, IV, V and VI will be of 50 marks each.
- Note 7:** In respect of Practicals II and III carrying 100 marks each, 15 marks will be allocated to the class record and 10 marks to the oral test.
- Note 8:** In respect of each Part of the Practicals I, IV, V and VI carrying 50 marks (for each part), 10 marks will be allocated to the record book and 5 marks to the oral test.
- Note 9:** The conduct and evaluation in respect of the Examination relating to the Practical Papers would be as per the general guidelines laid down by the University.
- Note 10:** Colleges are advised and encouraged to conduct Practicals on P.C.'s as far as possible.
- Note 11:** For conducting Practical Classes, at least two Laboratories should be provided alongwith qualified Laboratory Staff in each college.
- Note 12:** The 25% marks for Internal Assessment will be distributed in the following manner:
- (a) Attendance: 10%
 - (b) Assignments (at least one): 10%
 - (c) Class Tests/Project Presentation: 5%

DETAILED COURSES OF READING

B.Sc. (HONS.) STATISTICS

Semester I: Examination 2011 and onwards

Paper STH 101: Technical Writing and Communication in English

Unit 1

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

Unit 2

Writing Skills; Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

Unit 3

Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.

SUGGESTED READINGS:

1. M. Frank. Writing as thinking: *A guided process approach, Englewood Cliffs*, Prentice Hall Regents.
2. L. Hamp-Lyons and B. Heasley: Study Writing; *A course in written English*. For academic and professional purposes, Cambridge Univ. Press.
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik: *A comprehensive grammar of the English language*, Longman, London.
4. Daniel G. Riordan & Steven A. Panley: "*Technical Report Writing Today*" - Biztantra.

ADDITIONAL REFERENCE BOOKS:

5. Daniel G. Riordan, Steven E. Pauley, Biztantra: *Technical Report Writing Today*, 8th Edition (2004).
6. *Contemporary Business Communication*, Scot Ober, Biztantra, 5th Edition (2004)

Paper STH 102: Calculus-I

Differential Calculus: Limits of functions, continuous functions (ϵ and δ notations), properties of continuous functions, review of results on differentiation, Successive differentiation, Leibnitz rule, partial differentiation, Euler's theorem on homogeneous functions; maxima and minima of functions of one and two variables, Constrained Optimisation techniques (with and without Lagrange multiplier) along with few problems. Jacobians, point of inflexion; asymptotes; concavity and convexity of functions, singular points, tracing of curves in Cartesian and polar forms.

Review of Differential Equations, equations reducible to linear forms and homogenous forms, exact differential equations, Integrating Factor, Equations of first order but not of the first degree, Equations solvable for p, y and x , Clairut's Equation. Linear differential equations with constant coefficients, Operators, solution of n th order differential equation, Inverse operators, homogeneous linear equations, equations reducible to homogeneous form

SUGGESTED READINGS:

1. Anton, H., Biven, I., Davis, S.(2002) : Calculus, J. Wiley & Sons.
2. Apostol, Tom. M. (2002): *Calculus, Vol. I*. John Wiley & Sons.
3. Ross, S.L. (1984): Differential Equations, John Wiley and Sons (Student Edition).
4. Shanti Narain (2009): Differential Calculus. (Reprint). S. Chand and Co.
5. Simmons, G. F. (1972): Differential Equations, Tata McGraw Hill.

Paper STH 103: Algebra-I

Demoivre's theorem (both integral and rational index). Expansion for $\cos n\theta$, $\sin n\theta$, $\tan n\theta$ in terms of powers of $\sin\theta$, $\cos\theta$ and $\tan\theta$. Expansion of $\sin^n\theta$, $\cos^n\theta$ in terms of sine and cosine of multiples of θ . Expansion of $\tan(\theta_1 + \dots + \theta_n)$ in terms of elementary symmetric functions of $\tan\theta_1, \dots, \tan\theta_n$. Summation of series and complex roots of unity.

Theory of equations, statement of the fundamental theorem of algebra and its consequences. Relation between roots and coefficients or any polynomial equations. Solutions of cubic and biquadratic equations when some conditions on roots of equations are given. Evaluation of the symmetric polynomials and roots of cubic and biquadratic equations.

Inequalities: Inequality of means, Holder's inequality, Cauchy-Schwartz Inequality, Triangle inequality, Tchebychef inequality, Weierstrass Inequality.

Algebra of matrices-a review. Theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties.

Determinants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew-symmetric determinants, Circulant determinants and Vandermonde determinants for nth order, Jacobi's Theorem, product of determinants. Use of determinants in solution to the system of linear equations.

SUGGESTED READINGS:

1. Beachy, J. A and Blair, W. D (1990): Abstract Algebra with a concrete introduction, Prentice Hall
2. Biswas, S. (1997) :A Textbook of Matrix Algebra, New Age International.
3. Gupta, S.C. (2008): An Introduction to Matrices. (Reprint). Sultan Chand & Sons.
4. Hall, H.S. and Knight, S. R. (1994) : Higher Algebra, H.M. Publications.
5. Lay, David C. (2007): Linear Algebra and its Applications (3rd Edition), Pearson Education Asia, Indian Reprint.
6. Singhal, M.K. and Singhal, A.R.(1980) : Algebra, 10th edition. R. Chand & Co.

Paper STH 104: Probability and Statistical Methods-I

Statistical Methods: Concepts of statistical population and sample from a population, quantitative and qualitative data, Nominal, ordinal and time series data, discrete and continuous data. Presentation of data by table and by diagrams, frequency distributions by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods) and ogive. Bivariate data-scatter diagram, principle of least squares and fitting of polynomials and exponential curves.

Measures of location (or central tendency) and dispersion. moments, measures of skewness and kurtosis, absolute moments and factorial moments, Inequalities concerning moments, Sheppard's corrections. Theory of attributes: Consistency of data, conditions for consistency, independence and association of attributes, measures of association and contingency.

Probability Theory: Random experiments, sample point and sample space, event, algebra of events. Definition of Probability – classical and relative frequency approach to probability; Richard Von-Mises, and Kolmogorov's approach to probability, merits and demerits of these approaches (only general ideas to be given), theorems on probability, conditional probability, independent events, Bayes theorem and its applications.

SUGGESTED READINGS:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
4. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
5. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
6. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.

STATISTICS/ COMPUTER LAB.:

Practical-I:

comprising the following two parts:

Part A: Based on Papers STH 103 and STH 104

Part B: Introduction to Computer fundamentals and Electronic Spread sheet.

Semester II: Examination 2012 and onwards

Paper STH 201: Calculus-II

Review of integration and definite integrals, integration of irrational functions. Reduction formulae, application of integration: Rectification and quadrature, volumes and surfaces of revolution for cartesian and polar curves, differentiation under integral sign.

Double Integrals, change of order of integration, transformation of variables, Beta and Gamma integrals and relationship between them.

Geometry: Pair of straight lines, Circle, derivation of equation of tangent, normal, polar and length of tangent from any external point. Conic sections: Equation of Parabola and associated theorems, Ellipse, eccentric angle, equation of Ellipse and its tangents and normal in terms of eccentric angle, Hyperbola in standard forms and their properties, real, conjugate and rectangular Hyperbola.

SUGGESTED READINGS:

1. Gorakh Prasad and Gupta, H. C. (1994): Text Book on Coordinate Geometry, Pothishala 'Pvt. Ltd., Allahabad.
2. Shanti Narain and Mittal, P.K. (2007): Integral Calculus. (Reprint). S. Chand and Co.
3. Strauss, M. J., Bradley, G. L. and Smith, K. J. (2007): *Calculus* (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Paper STH 202: Algebra-II

System of linear equations, row reduction and echelon forms, the matrix equations $AX=B$, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix. Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Generalized inverse (concept with illustrations). Partitioning of matrices and simple properties. Homogeneous and non-homogeneous system of linear equations- their consistency and general solutions. Introduction to matrix polynomial. Characteristic roots and characteristic vectors of a matrix, Cayley-Hamilton theorem. Quadratic forms, linear orthogonal transformation and their diagonalisation.

Sets ,binary relations. Definitions and examples of groups,abelian-groups, rings, integral domain, skew-field and fields ,vector spaces with illustrations, vector space with real scalars, linear combination of vectors, sub-spaces, linear span, bases and change of bases, dimensions, orthogonal vectors, orthogonal basis, Gram-Schmidt orthogonalisation process. Matrix differentiation.

SUGGESTED READINGS:

1. Artin, M. (1994): Algebra. Prentice Hall of India.
2. Datta, K.B. (2002) : Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd.
3. Graybill, F.E.(1961) :Introduction to Matrices with Applications in Statistics. Wadsworth Pub. Co.
4. Gupta, S.C. (2008): An Introduction to Matrices. (Reprint). Sultan Chand & Sons.
5. Hadley, G. (2002) : Linear Algebra. Narosa Publishing House Reprint.
6. Searle, S. R. (1982) : Matrix Algebra Useful for Statistics. John Wiley & Sons.

Paper STH 203: Probability and Statistical Methods-II

Random Variables: Discrete and continuous random variables, p.m.f. , p.d.f. , c.d.f. illustrations of random variables and its properties. Univariate transformations.

Expectation of random variable and its properties. Moments and cumulants, moment generating function. Cumulant generation function and characteristic function.

Standard discrete probability distributions: Degenerate, Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric.

Standard continuous probability distributions: Normal, uniform, exponential, beta, gamma, Cauchy, Laplace.

SUGGESTED READINGS:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
3. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.
4. Johnson, N.L., Kotz, S. and Balakrishnan, N. (1994): Discrete Univariate Distributions, John Wiley.
5. Johnson, N.L., Kotz, S. and Balakrishnan, N. (1994): Continuous Univariate Distributions, Vol. I & Vol. II, 2nd Edn., John Wiley.

6. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
7. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.
8. Ross, S. M. (2007): Introduction to Probability Models, 9th Edn., Indian Reprint, Academic Press.

Paper STH 204: Applied Statistics-I

Index Numbers: Definition, construction of index numbers by different methods, Problems faced in their construction, criterion of a good index number-Test Theory-unit, time reversal, factor reversal and circular tests. Errors in the construction of index numbers. Chain and Fixed base index numbers. Base Shifting, Splicing and Deflating of index numbers. Cost of Living Index numbers- construction and uses. Wholesale Price Index and Index of Industrial Production.

Demand Analysis: Demand function, price and income elasticity of demand, nature of commodities, laws of supply and demand, Income distributions, Pareto – curves of concentration.

Utility and Production Functions: utility function, constrained utility maximisation, indifference curves, derivation of demand curve, production function, homogeneous production functions, Isoquant and Isocost curves, Elasticity of substitution, C.E.S. functions, Multiple production by monopolist, discriminating monopolistic form, multiplant form.

Application of integration in Economics: Given Elasticity of any function then how to find function, consumer surplus, producer surplus, learning curves, finding consumption function from M.P.C, finding profit function from M.R and M.C.

Mathematical Finance: Compound Interest, Discount and present value, Different types of annuities.

SUGGESTED READINGS:

1. Allen, R.G.D. (1975): Index Numbers in Theory and Practice. Macmillan.
2. Allen, R.G.D. (1995): Mathematical Analysis for Economist. Macmillan.
3. Ayer, Frank. (1983): Theory and Problems of Mathematics of Finance (Schaum's Outline Series), Mc Graw Hill Book Company, Singapore
4. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall of India (P) Ltd.
5. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
6. Soni, R.S. (1996): Business Mathematics with Application in Business and Economics. Pitamber Publishing Co.

STATISTICS LAB.:

Practical-II:

Based on Papers STH 202, STH 203 and STH 204.

Semester III: Examination 2012 and onwards

Paper STH 301: Real Analysis

Real Analysis: Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets, neighborhoods and limit points, supremum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as r^n , $\left(1 + \frac{1}{n}\right)^n$ and $n^{\frac{1}{n}}$ and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.

Infinite series, positive term series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Raabe's test. Gauss test and Maclaurin's integral test. Leibnitz's test for the convergence of alternating series, Absolute convergence and Conditional convergence of series.

Continuous functions, algebra of continuous functions, continuous functions and boundedness. Differentiability, Rolle's theorem, Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder. Taylor's and Maclaurin's series expansions of $\sin x$, $\cos x$, e^x , $(1+x)^n$, $\log(1+x)$. Indeterminate form, L'Hospital's rule.

SUGGESTED READINGS:

1. Apostol, T.M. (1985): Mathematical Analysis, Narosa Publishing House, New Delhi.
2. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
3. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
4. Ross, K. A. (2004): Elementary analysis: the theory of calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
5. Rudin, W. (1976): Principles of Mathematical Analysis, Tata McGraw-Hill.
6. Singhal, M.K. and Singhal, A.R. (1992): A First course in Real Analysis. R. Chand & Co.

Paper STH 302: Probability and Statistical Methods – III

Bivariate and Multivariate Distributions : Discrete and continuous type, c.d.f., p.d.f., marginal and conditional distributions, independence, expectation and conditional expectation, characteristic function and its properties, Inversion Theorem (without proof). Multinomial Distribution.

Bivariate Transformations-concept and examples in uniform, normal, exponential, beta, gamma and Cauchy distributions.

Variance stabilizing transformations- \sin^{-1} , square root, log and Fisher's z. Bivariate normal distribution and its properties. Multivariate normal distribution, its marginal and conditional distributions.

Correlation and regression: Karl Pearson's Coefficient of Correlation, lines of regression, Spearman's Rank Correlation Coefficient. Intraclass correlation coefficient, Correlation Ratio. Multiple and partial correlation coefficients (for three variates only).

Limit Laws: Convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution. Chebyshev's inequality, WLLN, SLLN applications, De-Moivre-Laplace theorem, central limit theorem (C.L.T.) for i.i.d. variates, Liapunov theorem (without proof) and applications of C.L.T.

SUGGESTED READINGS:

1. Anderson, T.W. (2003): Introduction to Multivariate Statistical Analysis, (3rd Edition). John Wiley and Sons.

2. Hogg, R.V., Craig, A.T. and McKeon, J.W. (2009): Introduction to Mathematical Statistics, 6th Edn., (6th Impression). Pearson Education.
3. Goon, A.M., Gupta, M.K. and Dasgupta. B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
4. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
5. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.
6. Parzen, E. (1992): Modern Probability Theory and its Applications. Wiley-Inter Science (Paper back Wiley Classic).

Paper STH 303: Applied Statistics-II

Time Series: Introduction, decomposition of a time series, different components with illustrations. Measurement of trend-Graphical Method, Method of Semi-averages, Method of fitting curves (straight line, polynomials, growth curves-modified exponential curve, Gompertz curve and logistic curve). Method of Moving Averages. Measurement of seasonal variation- Method of Simple Averages, Ratio to Trend Method, Ratio to Moving Average Method and Link Relative Method. Measurement of cyclical variation-residual method. Random component-estimation of its variance by Variate Difference Method.

Statistical Quality Control (S.Q.C.): Its concept, application and importance. Process and Product Controls, causes of variations in quality, 3σ -control limits and their justification. Theory of control charts for variables and attributes: \bar{x} , R, s, p, np, c and u-charts. Natural Tolerance Limits. Specification Control Limits and Modified Control Limits.

Sampling Inspection Plans- Acceptance-Rejection and Acceptance-Rectification plans, concepts, Acceptance Quality level (AQL), Lot Tolerance Percent Defective (LTPD), Process Average Fraction Defective, Producer's Risk, Consumer's Risk, Average Outgoing Quality (AOQ), Average Outgoing Quality Limit (AOQL), Operating Characteristic (OC) curve, Average Sample Number (ASN) Curve and Average Amount of Total Inspection (ATI) Curve. Single Sampling Plan- Probability of Acceptance using hypergeometric distribution and its approximation to Poisson and binomial distributions, its OC, AOQ, ASN and ATI functions. Determination of n and c using different approaches.

Indian official Statistics: Present official statistical system in India relating to census and population; methods of collection of official statistics. Various agencies responsible for the data collection- C.S.O., N.S.S.O., office of Registrar General, their main functions and important publications.

SUGGESTED READINGS:

1. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall of India (P) Ltd.
2. Duncan, A.J. and Erwin, R.D. (1974): Quality Control and Industrial Statistics, 4th Edn. Taraporewala and Sons.
3. Elhance, D. N. and Elhance, V. (1996): Fundamentals of Statistics. D.K. Publishers.
4. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
5. Grant, E.L. (1999): Statistical Quality Control. Tata McGraw-Hill.
6. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
7. Montgomery, D.C. (2007): Introduction to Statistical Quality Control. Wiley India.
8. Mukhopadhyay, P. (1999): Applied Statistics. Books and Allied (P) Ltd.

Paper STH 304: Survey Sampling

Sample Surveys: Concepts of Population and sample. Complete enumeration vs sampling. Need for sampling. Principal and organisational aspects in the conduct of a sample survey. Probability sampling design. Properties of a good estimator. Sampling errors.

Basic sampling methods: Simple random sampling with or without replacement for the estimation of mean, total, proportion and ratio. T_1 and T_2 classes of Linear estimators and minimum variance. Determination of sample size. Probability proportional to size sampling (with replacement).

Stratified random sampling: Different allocations. Post-stratification, Method of collapsed strata. Ratio method of estimation, optimality of ratio estimator. Difference and Regression methods of estimation, optimality of regression estimator. Linear and circular systematic sampling, performance of systematic sampling in populations with linear trend. Cluster sampling with equal size of clusters. Two-stage sampling (Sub-sampling) with equal first stage units.

Non sampling errors. Sources, Hansen and Hurwitz technique .

SUGGESTED READINGS:

1. Cochran, W.G. (1977): Sampling Techniques. John Wiley and Sons, N.Y.
2. Murthy, M.N. (1967): Sampling Theory and Methods. Statistical Publishing Society, Kolkata.
3. Raj, D. and Chandhoke, P. (1998): Sample Survey Theory. Narosa Publishing house.
4. Singh, D. and Chaudhary, F.S. (1995): Theory and Analysis of Sample Survey Designs. New Age International (P) Ltd.
5. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984): Sampling Theory of Surveys with Applications. Iowa State University Press, Iowa, USA.

STATISTICS LAB.:

Practical III:

Based on Papers STH 302, STH 303 and STH 304.

Semester IV: Examination 2013 and onwards

Paper STH 401: Numerical Analysis

Numerical Analysis: Factorial with positive and negative index. Operators: Shift operator (E), forward difference (Δ), backward difference (∇), central difference (δ), average (μ), differential (D) and inter-relations between them. Finite differences of order n, divided differences of order n and interpolation. Newton's forward, backward and divided difference interpolation formulae with error term. Lagrange's interpolation formula. Central difference formulae: Gauss and Stirling's formulae.

Inverse interpolation: Lagrange's inverse interpolation formula, Method of successive approximation and method of reversion of series. Summation of finite series. Numerical differentiation.

Numerical integration: Newton-Cote's integration formula, Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule and Weddle's rule with error term. Euler-Maclaurin's summation formula. Stirling's approximation to factorial n.

Solution of difference equations of first order with variable coefficients and linear difference equations with constant coefficients.

SUGGESTED READINGS:

1. Bradie, B. (2006): A friendly introduction to Numerical Analysis, Pearson Education, India.
2. Gerald, C. F. and Wheatly, P. O. (2005): Applied Numerical Analysis, Pearson Education, India.
3. Hilderbrand, F.B. (1974): Introduction to Numerical Analysis. Tata McGraw Hill.
4. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Saxena, H.C. (2005): Finite Differences and Numerical Analysis, 15th Revised Edn. (Reprint). S. Chand and Co.
6. Scarborough, J.B. (1966): Numerical Mathematical Analysis, 6th Edition. Oxford and IBH.

Paper STH 402: Probability and Statistical Methods- IV

Order Statistics: Introduction, distribution of r^{th} order statistic, joint distribution of r^{th} and s^{th} order statistics.

Sampling Distribution: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean and sample proportion. Sampling distributions of chi-square, t and F statistics. Distribution of sample correlation coefficient r when $\rho = 0$.

Tests of significance: Null and alternative hypotheses, level of significance and probabilities of Type I and Type II errors, critical region and p-value. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations. Tests of significance based on t, F and Chi-square distributions.

SUGGESTED READINGS:

1. David, H.A. and Nagaraja, H.N. (2003): Order statistics, 3rd Edition, John Wiley and sons.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint). Sultan Chand and Sons.
4. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.
5. Johnson, N.L., Kotz, S. and Balakrishnan, N. (1994): Continuous Univariate Distributions, Vol. II, 2nd Edn. John Wiley.
6. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4th Edn. John Wiley and Sons.
7. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint). Tata McGraw-Hill Pub. Co. Ltd.

Paper STH 403: Operational Research

Introduction to OR: Phases of OR, model building and various types of OR Problems, Linear Programming: Models, graphical solution, simplex method and M-technique. Concept of duality, dual simplex method, post-optimality analysis.

The transportation problems: North-West corner rule, Least cost method, Vogel's approximation method and MODI's method to find the optimal solution. The assignment problem. Networking problems. Individual replacement model.

Game Theory: Rectangular games; methods of solution: dominance method, modified dominance, Graphical solution and algebraic technique solution by L.P. Method.

Simulations: Simulation models, event-type simulation, generation of random phenomena, steps in simulation, application of simulation techniques.

SUGGESTED READINGS:

1. Gass, S.I. (1985): Linear Programming: Methods and Applications. Boyd Fraser Publishing Co., Danvers.
2. Hadley, G. (2002): Linear Programming (Reprint). Narosa Publishing House.
3. Hillier, F.S. and Lieberman, G. J. (2001): Introduction to Operational Research, 7th Edn. Irwin.
4. Kantiswarup, Gupta, P.K. and Manmohan (2008): Operations Research, 13th Edn. Sultan Chand and Sons.
5. Sharma, S.D. (2009): Operations Research-Theory, Methods and Applications, 16th Revised Edn., Kedar Nath Ram Nath.
6. Taha, H.A. (2007): Operations Research: An Introduction, 8th Edn. Prentice Hall of India.

Paper STH 404: Computer programming in C

History and features of C language. Components of C language, Structure of a C Program. Data type: Basic data types, Enumerated data types, Derived data types. Variable Declaration : Local, Global, Parametric Variables, Assignment of variables. Numeric, Character, real and string constants. Arithmetic, Relation and logical operators. Assignment operators. Increment and Decrement operators, conditional operators. Type modifiers and expressions, Writing and interpreting expressions, using expressions in statements. Basic input/output.

Control Statements, conditional statements, if .. else, Nesting of if else, else if ladder, switch statements. Loops in C : for, while, do ... while loops. break, continue, exit(), goto and label declarations. One dimensional, two dimensional and multidimensional arrays.

Functions, classification of functions, functions definition and declaration, accessing a function, return statement. Operations using string functions. Parameter passing in functions, recursion in Functions.

Storage classes: Automatic variables, External variables, static variables, register variables, Scope and lifetime of variables.

Pointers; Pointer Notation: and * operators. Pointer declaration and Initialization, Accessing a variable through pointer, pointer expressions, pointer arithmetic. Pointers and Arrays: Pointers and one dimensional arrays, dynamic memory allocation. Function returning pointers (single variable and one-dimensional arrays).

Files in C: Defining and opening a file, closing a file, input-output operation on file. Creating a file, reading a file.

Preprocessors: Introduction to preprocessors, #define and #include.

SUGGESTED READINGS:

1. Balagurusamy, E. (2008): Programming in ANSI C, 4th Edn. Tata McGraw Hill.
2. Forouzan, B.A. and Gilberg, R.F. (2007): Computer Science – A Structured Programming Approach Using C. (Third Edn.). Thompson Course Technology.
3. Gottfried, B.S. (1996): Schaum's Outline of Programming with C, 2nd Edn. McGraw Hill.
4. Kanetakar, Y. (2008): Let us C. BPB Publications.

STATISTICS/ COMPUTER LAB.:

Practical-IV:

comprising the following two parts:

Part-A: Based on Papers STH 401 and STH 402

Part-B: Based on Paper STH 404

Semester V: Examination 2013 and onwards

Paper STH 501: Statistical Inference-I

Estimation: Parametric space, sample space, point estimation. Requirements of good estimator: Consistency, unbiasedness, efficiency, sufficiency and completeness. Minimum variance unbiased (MVU) estimators. Cramer-Rao inequality. Minimum Variance Bound (MVB) estimators, Rao-Blackwell theorem, Lehmann-Scheffe theorem. Methods of estimation: Maximum likelihood, moments, minimum chi-square, least squares and minimum variance. Properties of maximum likelihood estimators (without proof).

Interval estimation: Confidence intervals for the parameters of various distributions. Confidence intervals for difference of means and for ratio of variances. Confidence interval for binomial proportion and population correlation coefficient when population is normal. Pivotal quantity method of constructing confidence interval. Large sample confidence intervals.

SUGGESTED READINGS:

1. Casella, G. and Berger, R.L. (2002): Statistical Inference, Second Edn. Thomson Duxbury.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): An Outline of Statistical Theory, Vol. II, 3rd Edn. World Press, Kolkata.
3. Hogg, R.V., Craig, A.T. and Mckean, J.W. (2009): Introduction to Mathematical Statistics, 6th Edn., (6th Impression). Pearson Education.
4. Hogg, R.V. and Tanis, E.A. (1988): Probability and statistical inference, 3rd Edn. Macmillan Publishing Co., Inc.
5. Rohatgi, V. K. (1984): Statistical Inference. John Wiley and Sons.
6. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.

Paper STH 502: Applied Statistics-III

Vital Statistics: Sources of collecting data on vital statistics and errors encountered therein- Census, Registration, Adhoc surveys, hospital records. Mortality- CDR, SDR, STDR, IMR, along with their merits and demerits, Life Tables- construction of a complete life table along with assumptions and uses. Concept of an Abridged Life Table. Measurements of Fertility- CBR, GFR, SFR, TFR (merits and demerits). Measures of Population growth- Crude Rate of Natural Growth, GRR and NRR.

Demography: Vital index, graduation of mortality rates by Gompertz and Makehm's laws, Logistic curve, its fitting by the methods of (i) three selected points,(ii) Pearl and Reeds and (iii) Rhodes, its uses in population projection

Educational and Psychological Statistics: Scaling individual test items in terms of difficulties, Z-scores, Standard scores, Normalized score, T-scores, percentile scores. Scaling of rankings and ratings in

terms of Normal probability, Methods for determining test reliability, Validity of test scores and its determination. IQ-its measurement and uses.

SUGGESTED READINGS:

1. Benjamin, B. (1968): Health and Vital Statistics. G. Allen and Unwin.
2. Cox, P.R. (1970): Demography. Cambridge University Press.
3. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall of India (P) Ltd.
4. Garrett, H.E. (1966): Statistics in Psychology and Education. Longmans, Green.
5. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
6. Guilford, J.P. (1956): Fundamental Statistics in Psychology and Education. McGraw-Hill Book Company, New York.
7. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
8. Mukhopadhyay, P. (1999): Applied Statistics. Books and Allied (P) Ltd.

Paper STH 503: Linear Models

General Linear models, estimability and BLUE, method of least squares, Gauss- Markoff theorem, estimation of error variance, distribution of quadratic forms for standard normal variates, tests of linear hypothesis.

Analysis of variance: One-way and two-way classified data with $m (\geq 1)$ observations per cell for fixed effects models. Analysis of Covariance: One-way and two-way classified data with one concomitant variable.

Straight Line relationship between two variables, precision of the estimated regression. Examination of the regression equation. Lack of fit and pure error. Fitting a straight line in matrix form. variance and covariance of b_0 and b_1 from the matrix calculation. Variance of Y using the matrix development. Orthogonal columns in the X-matrix. partial F-Test and Sequential F-Tests. Selection of best regression equations by step wise procedure. Bias in regression estimates. Residuals, Polynomial models. orthogonal polynomials.

SUGGESTED READINGS:

1. Bapat, R.B. (1999): Linear Algebra and Linear Models, 2nd Edn. Hindustan Book Agency.
2. Draper, N.R. and Smith, H. (1998): Applied Regression Analysis, 2nd Edn. John Wiley & Sons.
3. Montgomery, D.C. (2001): Design and Analysis of Experiments, 2nd Edn. John Wiley & Sons.
4. Montgomery, D.C., Peck, E.A. and Vining, G.G. (2006): Introduction to Linear Regression Analysis, 4th Edn. John Wiley & Sons.
5. Rencher, A.C. and Scaalje, G.B. (2008): Linear Models in Statistics, 2nd Edn. John Wiley & Sons.
6. Searle, S.R. (1997): Linear Models. Wiley Classic Library. Wiley-Interscience.

Paper STH 504: Stochastic Processes

Definition, classification and illustrative examples of stochastic processes, Mean value function and covariance Kernel, Probability generating function, Bivariate probability generating function, Convolution

and compound distribution, recurrent events, random walk model, absorbing and reflecting barriers, first passage probabilities and Gambler's ruin problem, Discrete branching process, extinction probabilities,

Markov chain-definition and examples, Chapman Kolmogorov's equations and m-step transition probabilities, classification of states, closures and closed sets.

Poisson process and its applications- Pure Birth Process, Pure Death Process, Birth and Death process, Introduction to queuing theory, M/M/1 Queue with infinite waiting space. Yule Furry Process and Linear growth process.

SUGGESTED READINGS:

1. Bhat, B.R. (2000): Stochastic Models-Analysis and Applications. New Age International Publishers.
2. Feller, W. (1993): An Introduction to Probability Theory and its Applications, Vol. I, 9th Wiley Eastern (Reprint).
3. Karlin, S. and Taylor, H.M. (1975): A First Course in Stochastic Processes, 2nd Edn. Academic Press.
4. Medhi, J. (2008): Stochastic Processes, 2nd Edn. (Reprint). New Age International.
5. Ross, S. M. (1996): Stochastic Processes, 2nd Edn. John Wiley and Sons.
6. Taha, H.A. (2007): Operations Research: An Introduction, 8th Edn. Prentice Hall of India.

STATISTICS/ COMPUTER LAB.:

Practical-V

comprising the following two parts:

Part-A: Based on Papers STH 501, STH 502 and STH 503

Part-B: Introduction to Statistical Software/ Packages

Semester VI: Examination 2014 and onwards

Paper STH 601: Statistical Inference-II

Testing of Hypothesis: Statistical hypothesis, simple and composite hypotheses. Test of statistical hypotheses, null and alternative hypotheses. Critical region. Two kinds of errors. Level of significance and power of a test. Consistency and relative efficiency of tests. MP test and region. Neyman-Pearson Lemma, critical regions for simple hypotheses, for one parameter. Randomized test. UMPU Test and region. Likelihood ratio test, properties of LR tests (without proof). Sequential Probability Ratio Test. Determination of stopping bounds A and B, OC and ASN functions of SPRT. Non-Parametric tests. Empirical distribution function, one sample and two-sample sign test. Wald-Wolfowitz run test. Run test for randomness, Median test, Wilcoxon-Mann-Whitney U-test. Kolmogorov-Smirnov one-sample test, Kruskal-Wallis test.

SUGGESTED READINGS:

1. Dudewicz, E.J., and Mishra, S.N. (1988): Modern Mathematical Statistics, John Wiley & Sons.
2. Gibbons, J. D. and Chakraborty, S. (2003): Non parametric Statistical Inference, 4th Edition, Marcel Dekker, CRC.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): An Outline of Statistical Theory, Vol. II, 3rd Edn. World Press, Kolkata.

4. Hogg, R.V. and Tanis, E.A. (1988): Probability and statistical inference, 3rd Edn. Macmillan Publishing Co., Inc.
5. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.
6. Sigel, S. (1956): Nonparametric Statistics for the Behavioural Sciences. McGraw Hill, N.Y.

Paper STH 602: Design of Experiments

Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks.

Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations.

Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties, Symmetric BIBD, Resolvable BIBD, Affine Resolvable BIBD, Intra Block analysis, complimentary BIBD, Residual BIBD, Dual BIBD, Derived BIBD.

Factorial experiments: advantages, notations and concepts, 2^2 , $2^3 \dots 2^n$ and 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$), 3^2 and 3^3 . Factorial experiments in a single replicate.

Fractional factorial experiments: Construction of one-half and one-quarter fractions of 2^n ($n \leq 5$) factorial experiments, Alias structure, Resolution of a design.

SUGGESTED READINGS:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asis Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.
4. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
5. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

Paper STH 603: Econometrics

Objectives behind econometric models, General Linear Model: assumptions, least-squares estimation. BLUE, analysis of variance, tests of significance, confidence intervals for the parameters, Prediction, Estimation under linear restrictions. Multicollinearity, concept, detection of multicollinearity, consequences and solutions of multicollinearity. Generalized least squares estimation, Aitken estimators, Heteroscedastic disturbances, efficiency of Aitken estimator with OLS estimator under heteroscedasticity. Autocorrelation: concept, consequences of autocorrelated disturbances, detection of autocorrelation, their estimation and testing, estimation using Durbin-Watson statistic. Forecasting: exponential smoothing for linear trend model.

SUGGESTED READINGS:

1. Draper, N.R. and Smith, H. (1998): Applied Regression Analysis, 3rd Edn. John Wiley and Sons.
2. Gujarati, D.N. (2006): Essentials of Econometrics, 3rd Edn., McGraw-Hill.
3. Johnston, J. (1991): Econometric Methods, 3rd Edn. McGraw-Hill Kogakusha Ltd.

4. Koutsoyiannis, A. (1984): Theory of Econometrics: An Introductory Exposition of Econometric Methods, 2nd Edn. Macmillan.
5. Maddala, G.S. (2002): Introduction to Econometrics, 3rd Edn. John Wiley and Sons.
6. Madnani, G.M.K. (2008): Introduction to Econometrics-Principles and Application, 8th Edn. Oxford & IBH Publishing House.
7. Montgomery, D.C. and Johnson, L.A. (1976): Forecasting and Time Series Analysis, Mc Graw Hill, New York.

Paper STH 604: Bio-Statistics

Functions of survival time, survival distributions and their applications viz. exponential, gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shape hazard function.

Type I, Type II and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator for type I and type II censored data with numerical examples. Non-parametric methods for estimating survival function and variance of the estimator viz. Actuarial and Kaplan-Meier methods.

Competing risk theory, Indices for measurement of probability of death under competing risks and their inter-relations. Estimation of probabilities of death under competing risks by maximum likelihood and modified minimum Chi-square methods. Theory of independent and dependent risks. Bivariate normal dependent risk model. Conditional death density functions.

Stochastic epidemic models: Simple and general epidemic models (by use of random variable technique). Duration of an epidemic.

Planning and design of clinical trials, Phase I, II and III trials. Blindings single, double and triple. Consideration in planning a clinical trial.

SUGGESTED READINGS:

1. Biswas, S. (2004): Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, 2nd Central Edn. New Central Book Agency.
2. Chiang, C.L. (1968): Introduction to Stochastic Processes in Bio Statistics. John Wiley and Sons.
3. Gross, A.J. and Clark, V.A. (1975): Survival Distributions: Reliability Applications in Biomedical Sciences. John Wiley, N.Y.
4. Indrayan, A. (2008): Medical Biostatistics, 2nd Edn. Chapman and Hall/CRC.
5. Jain, J.P. and Prabhakaran, V.T. (1992): Genetics of Population. South Asian Publishers Pvt. Ltd.
6. Lee, E.T. and Wang, J.W. (2003): Statistical Methods for Survival data Analysis, 2nd Edn. John Wiley and Sons.
7. Miller, R.G. (1981): Survival Analysis. John Wiley and Sons.

STATISTICS/ COMPUTER LAB.:

Practical-VI

comprising the following two parts:

Part A: Based on Papers STH 601, STH 602, STH 603 and STH 604

Part B: Problem solving using Statistical Software/Packages

