

## 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  $r^n$ ,  $(1 + \frac{1}{n})^n$  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 termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's  $n^{\text{th}}$  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, (3<sup>rd</sup> Edition). John Wiley and Sons.

2. Hogg, R.V., Craig, A.T. and McKean, J.W. (2009): Introduction to Mathematical Statistics, 6<sup>th</sup> Impression). Pearson Education.
3. Goon, A.M., Gupta, M.K. and Dasgupta. B. (2003): An Outline of Statistical Theory, Vol. I. Edn. World Press, Kolkata.
4. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11<sup>th</sup> Edn. (Reprint), Sultan Chand and Sons.
5. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2<sup>nd</sup> 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,  $3\sigma$ -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, 3<sup>rd</sup> Edn. Prentice Hall of India (P) Ltd.
2. Duncan, A.J. and Erwin, R.D. (1974): Quality Control and Industrial Statistics, 4<sup>th</sup> 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, 8<sup>th</sup> 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, 4<sup>th</sup> 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 ( $\Delta$ ), backward difference ( $\nabla$ ), central difference ( $\delta$ ), average ( $\mu$ ), 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 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, 15<sup>th</sup> Revised Edn. (Reprint) S. Chand and Co.
6. Scarborough, J.B. (1966): Numerical Mathematical Analysis, 6<sup>th</sup> Edition. Oxford and IBH.

**Paper STH 402: Probability and Statistical Methods- IV**

Order Statistics: Introduction, distribution of  $r^{\text{th}}$  order statistic, joint distribution of  $r^{\text{th}}$  and  $s^{\text{th}}$  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 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, 3<sup>rd</sup> Edition, John Wiley and sons.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4<sup>th</sup> Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11<sup>th</sup> 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. I 2<sup>nd</sup> Edn. John Wiley.
6. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4<sup>th</sup> Edn. John Wiley and Sons.
7. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3<sup>rd</sup> 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, 7<sup>th</sup> Edn. Irwin.
4. Kantiswarup, Gupta, P.K. and Manmohan (2008): Operations Research, 13<sup>th</sup> Edn. Sultan Chand and Sons.
5. Sharma, S.D. (2009): Operations Research-Theory, Methods and Applications, 16<sup>th</sup> Revised Edn., Kedar Nath Ram Nath.
6. Taha, H.A. (2007): Operations Research: An Introduction, 8<sup>th</sup> 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, 4<sup>th</sup> 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, 2<sup>nd</sup> 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, 3<sup>rd</sup> Edn. World Press, Kolkata.
3. Hogg, R.V., Craig, A.T. and Mckean, J.W. (2009): Introduction to Mathematical Statistics, 6<sup>th</sup> Edn., (6<sup>th</sup> Impression). Pearson Education.
4. Hogg, R.V. and Tanis, E.A. (1988): Probability and statistical inference, 3<sup>rd</sup> 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, 2<sup>nd</sup> 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, 3<sup>rd</sup> 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, 8<sup>th</sup> 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, 4<sup>th</sup> 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, 2<sup>nd</sup> Edn. Hindustan Book Agency.
2. Draper, N.R. and Smith, H. (1998): Applied Regression Analysis, 2<sup>nd</sup> Edn. John Wiley & Sons.
3. Montgomery, D.C. (2001): Design and Analysis of Experiments, 2<sup>nd</sup> Edn. John Wiley & Sons.
4. Montgomery, D.C., Peck, E.A. and Vining, G.G. (2006): Introduction to Linear Regression Analysis, 4<sup>th</sup> Edn. John Wiley & Sons.
5. Rencher, A.C. and Schaalje, G.B. (2008): Linear Models in Statistics, 2<sup>nd</sup> 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, passage probabilities and Gambler's ruin problem, Discrete branching process, extinction probabilities.

Markov chain-definition and examples, Chapman Kolmogorov's equations and  $n$ -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 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, 9<sup>th</sup> Wiley Eastern (Reprint).
3. Karlin, S. and Taylor, H.M. (1975): A First Course in Stochastic Processes, 2<sup>nd</sup> Edn. Academic Press.
4. Medhi, J. (2008): Stochastic Processes, 2<sup>nd</sup> Edn. (Reprint). New Age International.
5. Ross, S. M. (1996): Stochastic Processes, 2<sup>nd</sup> Edn. John Wiley and Sons.
6. Taha, H.A. (2007): Operations Research: An Introduction, 8<sup>th</sup> 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 test 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, 4<sup>th</sup> Edition, Marcel Dekker, CRC.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): An Outline of Statistical Theory, Vol. II, 1<sup>st</sup> Edn. World Press, Kolkata.

4. Das, A. K. and Pauls, B.A. (1988): Probability and statistical inference, 5<sup>th</sup> Edn. Macmillan Publishing Co., Inc.
5. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2<sup>nd</sup> 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, 8<sup>th</sup> 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, 3<sup>rd</sup> Edn. John Wiley and Sons.
2. Gujarati, D.N. (2006): Essentials of Econometrics, 3<sup>rd</sup> Edn., McGraw-Hill.
3. Johnston, J. (1991): Econometric Methods, 3<sup>rd</sup> Edn. McGraw-Hill Kogakusha Ltd.

4. Koutsoyiannis, A. (1984): Theory of Econometrics: An introductory Exposition of Econometric Methods, 2<sup>nd</sup> Edn. Macmillan.
5. Maddala, G.S. (2002): Introduction to Econometrics, 3<sup>rd</sup> Edn. John Wiley and Sons.
6. Madhani, G.M.K. (2008): Introduction to Econometrics-Principles and Application, 8<sup>th</sup> 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, 2<sup>nd</sup> 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, 2<sup>nd</sup> 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, 2<sup>nd</sup> 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