# Syllabus for Generic Electives in Statistics for Honours Programme


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# Contents

# 1 Generic Elective Courses Offered Under CBCS to Students of Programmes Other than Statistics Honours

| S. No. | Title of the Course | Code | L-T-P-C |
|---|---|---|---|
| 1 | Foundations of Data Analysis | BSTAT-GE-01 | 4-0-2-6 |
| 2 | Quantitative Population Studies | BSTAT-GE-02 | 4-0-2-6 |
| 3 | Probability and Distribution Theory | BSTAT-GE-03 | 4-0-2-6 |
| 4 | Elementary Probability Theory and Probability Samples | BSTAT-GE-04 | 4-0-2-6 |
| 5 | Official Statistics and National Development | BSTAT-GE-05 | 4-0-2-6 |
| 6 | Inferring Populations Through Samples - I | BSTAT-GE-06 | 4-0-2-6 |
| 7 | Ambiance to Research: Statistical Techniques | BSTAT-GE-07 | 4-0-2-6 |
| 8 | Inferring Populations Through Samples - II | BSTAT-GE-08 | 4-0-2-6 |

# 2 Semester - wise distribution of Generic Electives

## 2.1 Semester - I

1. BSTAT-GE-01: Foundations of Data Analysis
2. BSTAT-GE-02: Quantitative Population Studies

## 2.2 Semester - II

1. BSTAT-GE-03: Probability and Distribution Theory
2. BSTAT-GE-04: Elementary Probability Theory and Probability Samples

## 2.3 Semester - III

1. BSTAT-GE-05: Official Statistics and National Development
2. BSTAT-GE-06: Inferring Populations Through Samples - I

## 2.4 Semester - IV

1. BSTAT-GE-07: Ambiance to Research: Statistical Techniques
2. BSTAT-GE-08: Inferring Populations Through Samples - II

# 3 Syllabus: Generic Electives

### 3.0.1 BSTAT-GE-01: Foundations of Data Analysis

**Prerequisite** High School Algebra

**Variables and Data Sets** Scientific studies and variables as means to study a phenomenon, classification of variables based on scale [nominal, ordinal, interval and ratio], based on discreteness and continuity. Linear data and circular data; cross sectional, time series, longitudinal and panel data. Prospective studies and retrospective studies. Primary data and secondary data, cleaning of data.

**Univariate Data** Central tendency and dispersion; numeric measures and graphical methods to describe and summarize univariate frequency distributions of nominal, ordinal, interval and ratio variables; Utility of third and fourth central moments; coefficient of variation; The concept of change in origin and scale; standardization of a variable. Curve of concentration.

**Bivariate Data** Association: The concept of association in simultaneous study of two variable; Various measures of association depending on the nature of the two variables involved; Intraclass correlation, correlation ratio; Contingency tables and association measures for M $\times$ N contingency tables.

**Multivariate Data** multiple correlation, partial correlation; application to the case of three variables.

**Data Analysis Laboratory** Analysis of data using R: descriptive statistics using numeric measures and plots; Association measures of different types.

**Texts**


1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

2. https://www.r-project.org/

### 3.0.2 BSTAT-GE-02: Quantitative Population Studies

**Prerequisite** High School Algebra

**Measures of Population Change and Distribution** Rate of population change, exponential and logistic growth models; population density, population potential; Measures of age distribution: index of relative difference, index of dissimilarity; Measures of ageing.

**Measures of mortality** Crude death rate, age specific death rates, cause specific death rates and ratios, Infant mortality rate, neonatal mortality rate,post-neonatal mortality rate, endogenous and exogenous mortality rates, maternal mortality ratio, standardization of death rates,comparative mortality index.

**Life Tables** Period life table and cohort life table; Components of a life table; Construction of life tables.

**Fertility** Crude birth-rate,general fertility rate, age-specific fertility rates, total fertility rate, age-cumulative fertility rate; Age-sex adjusted birth rates, indices of fertility, fertility rates specific of order of births, net reproduction rate.

**Migration** Definitions, concepts, measures of internal migration and international migration.

**Population Data Laboratory** Exercises on population projection, population growth models, life table construction, measuring fertility, mortality and migration.

**Data Analysis Laboratory** Analysis of Population data using R with excersises based on BSTAT-GE-02.

**Texts**

1. Bhende, A. A., and Kanitkar, T. (2011). Principles of Population Studies. Himalaya Publishing House, Mumbai.

2. Pathak, K. B. and Ram, F. (2013). Techniques of Demographic Analysis. Himalaya Publishing House, Mumbai.

### 3.0.3 BSTAT-GE-03: Probability and Distribution Theory

**Prerequisite** Real Analysis, Elementary Calculus

**Probability** Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes theorem and its applications.

**Random Variables** Discrete and continuous random variables, p.m.f., p.d.f. ,c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.

**Standard Probability Distributions - I** Binomial, Poisson, geometric, negative binomial, hypergeometric.

**Standard Probability Distributions - II** uniform, normal, exponential, beta, gamma.

**Data Science Laboratory** Simulating samples from different probability distributions; study of sampling distributions; modelling with probability distributions.

**Texts**

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.

2. Miller, Irwin and Miller, Marylees (2006): John E. Freunds Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

### 3.0.4 BSTAT-GE-04: Elementary Probability Theory and Probability Samples

**Prerequisite** High School Algebra

**Probability** Uncertainty, randomness and variation; Concepts of experiments: Deterministic and Probabilistic; random experiments, sample space, events and algebra of events; Approaches to Probability classical, statistical, and axiomatic; Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes theorem and its applications.

**Popular Probability Models** Examples of various phenomena that may be modelled using popular probability distributions like Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, beta and gamma; Distributional properties of random variables discussed above like p.m.f., p.d.f., c.d.f.,expectation, variance, moments and moment generating function.

**Sampling from Finite Population** Basic concepts; types of sampling: non-probability and probability sampling, probability sampling and random experiments, basic principle of sample survey; simple random sampling with and without replacement, stratified random sampling and systematic sampling;

**Basic Designs** Basic concepts; Brief exposure of three basic principles of design of experiments, treatment, plot and block; Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) layout, linear models for data generated out of designed experiments.

**Data Science Laboratory** Fitting probability models to real life random phenomena, sampling under various designs, designing experiments and analysing the data.

**Texts**

1. Miller, Irwin and Miller, Marylees (2006): John E. Freunds Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

2. 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.

### 3.0.5 BSTAT-GE-05: Official Statistics and National Development

**Prerequisite** High School Algebra

**Present official statistical system in India** Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of Indias Principal publications containing data on the topics such as population, industry and finance.

**Index Numbers** Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyres, Paasches, Edgeworth-Marshall and Fishers. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers.

**Economic Time Series** Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential).Measurement of seasonal variations by method of ratio to trend.

**Human Development** Indices of development: Human Development Index, quality of life, multidimensional poverty index, gender inequality in human development.

**Data Analysis Laboratory** Determining various types of index numbers, analysis of time series, calculation HDI using real life data.

**Texts**


1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, 8th Edn. The World Press, Kolkata.

2. Fukuda - PAar and Shiv - Kumar (Eds.). (2011). Handbook of Human Development: Concepts, Measures, and Policies. Oxford University Press.


### 3.0.6 BSTAT-GE-06: Inferring Population through Samples - I

**Prerequisite** BSTAT-GE-04

**Estimating from Sample Surveys** Illustration of popular sampling designs and how these are practically applied in field works. Weighting the observation and using the weights in the analysis of sample based data; estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

**Estimation of Population Parameters** Concept of STATISTIC and Examples on how sampling generates a SAMPLING DISTRIBUTION of a statistic and STANDARD ERROR of the sampling distribution of the STATISTIC. Estimates of population mean, variance, proportion and coefficient of correlation; Determination of sample size for: estimating mean and proportion.

**Estimating Confidence Intervals** the t-distribution, Confidence interval for: population mean / proportion, the difference between two population means / proportions, variance of a normally distributed population.

**Estimating Parameters in Regression Models** Distinction between independent (explanatory) and dependent variables; the linear regression model, parameters of the model, their estimates, interpretation of the estimated parameters, testing the significance of the parameters and fit of the model itself;

**Data Science Laboratory** Regression modelling, analysis of survey data, sample size calculation, estimates of parameters and confidence intervals.

**Texts**


1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

2. Daniel, W. W.(1995).Biostatistics: A foundation for Analysis in the Health Sciences. John Wiley & Sons, Inc.

3. 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.


**References**


1. Miller, Irwin and Miller, Marylees (2006): John E. Freunds Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.


### 3.0.7 BSTAT-GE-07: Ambiance to Research: Statistical Techniques

**Prerequisite** None

**Research Methodology** Introduction to research, meaning of research, role of research in important areas, process of research, types of research, reproducible research; Unit of analysis, characteristics of interest. Research problem as a hypothesis testing; Writing a research proposal.

**Sampling Techniques** Introduction to sampling, advantage of sampling over census, simple random sampling, sampling frame, probabilistic aspects of sampling, stratified random sampling, other methods of sampling, sampling design, non probability sampling methods.

**Format for Documenting Research Findings** Structure of a research report: cover and title page, introductory pages, text, reference section, typing instructions, copy reading, proof reading; Documenting research findings in various forms like review paper, concept note, working paper, policy brief, report, short communication, article in a research journal, books and archives; Presentation of a report: introduction, communication dimensions, presentation package, audio-visual aids, presenter's poise.

**Communicating Research** Types of publications; ISBN; Impact factor, H-index; Citation analysis by Web of Science, Scopus and Google Scholar; Evaluating journal quality and reputation. ORCID ID. Research ethics and intellectual property rights; Patents.

**Computer Skills for Researchers** Emphasis on making effective use of computers, internet and open source statistical software for strengthening research.

**Open Source Applications for Researchers** Versions of Linux OS, LATEX package, SCILAB Package and R Package for Statistical Analysis.

**Data Analysis Laboratory** Practicals on statistical software pertaining to descriptive and inferential statistics

#### 3.0.8 BSTAT-GE-08: Inferring Population through Samples - II

**Prerequisite** BSTAT-GE-04, BSTAT-GE-06

**Testing Hypothesis Pertaining to Population Parameters** Tests of hypothesis: a single population mean/proportion, the difference between two population means/proportions, paired comparisons, a single population variance, ratio of two population variances.

**ANOVA** One / two / three -way classified data; Analysis of data arising out of designed experiments: CRD, RBD and LSD.

**Analysis of Frequencies** The chi-squared distribution: Tests of: goodness of fit, independence and homogenity; Relative risk, odds ratios and Mantel - Haenszel statistics.

**Non-parametric and Distribution Free Statistics** Sign test, Wilcoxon signed - rank test for location, median test, Mann - Whitney test.

**Data Analysis Laboratory** Practicals on testing of hypothesis.

**Texts**


1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

2. Daniel, W. W.(1995). Biostatistics: A foundation for Analysis in the Health Sciences. John Wiley & Sons, Inc.


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2. 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.