UNIVERSITY OF CALCUTTA

SYLLABI

FOR

THREE-YEAR B.Sc. HONOURS & GENERAL COURSES OF STUDIES

STATISTICS

2010
### Course Structure (Statistics Honours) for Annual System

<table>
<thead>
<tr>
<th>Part</th>
<th>Paper</th>
<th>Marks</th>
<th>Topic (as mentioned in Year system)</th>
<th>Topics from the modules</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 1</strong> Total 200</td>
<td>IA</td>
<td>50</td>
<td>Descriptive Statistics</td>
<td>Descriptive Statistics I (101) Descriptive Statistics II (201)</td>
</tr>
<tr>
<td></td>
<td>IB</td>
<td>50</td>
<td>Probability Theory I</td>
<td>Probability Theory I (102) Probability Theory II (202)</td>
</tr>
<tr>
<td></td>
<td>IIA</td>
<td>50</td>
<td>Linear Algebra and Population Statistics</td>
<td>Linear Algebra (103) Population Statistics (203)</td>
</tr>
<tr>
<td></td>
<td>IIB</td>
<td>50</td>
<td>Practical comprising of Papers IA,IB &amp; IIA and use of spreadsheet (EXCEL)</td>
<td>Practical including use of spreadsheet (EXCEL) (104 + 204)</td>
</tr>
<tr>
<td><strong>Part 2</strong> Total 200</td>
<td>IIIA</td>
<td>50</td>
<td>Mathematical Methods and Probability Theory II</td>
<td>Mathematical Methods (301) Probability Theory III (302)</td>
</tr>
<tr>
<td></td>
<td>IIIIB</td>
<td>50</td>
<td>Sampling Distributions and Statistical Inference I</td>
<td>Sampling Distributions (401)</td>
</tr>
<tr>
<td></td>
<td>IVB</td>
<td>50</td>
<td>Practical comprising of Papers IIA,IIB &amp;IIIA and use of MINITAB and C</td>
<td>Practical including use of Statistical software : MINITAB and Programming Language: C (304 + 404)</td>
</tr>
<tr>
<td><strong>Part 3</strong> Total 400</td>
<td>VA</td>
<td>50</td>
<td>Multivariate Analysis and Large Sample Theory</td>
<td>Multivariate Analysis (501) Large Sample Theory (601)</td>
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<td></td>
<td>VB</td>
<td>50</td>
<td>Statistical Inference II</td>
<td>Statistical Inference II (502)</td>
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<tr>
<td></td>
<td>VIA</td>
<td>50</td>
<td>Design of Experiments and Sample Survey Methods I</td>
<td>Design of Experiments and Sample Survey Methods I (503) Design of Experiments (603)</td>
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<tr>
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<td>VIB</td>
<td>50</td>
<td>Time Series Analysis and Sample Survey Methods II</td>
<td>Time Series Analysis (504) Sample Survey Methods (604)</td>
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<tr>
<td></td>
<td>VIIA</td>
<td>50</td>
<td>Practical comprising of Papers VA &amp; VB</td>
<td>505 + 506</td>
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<tr>
<td></td>
<td>VIIB</td>
<td>50</td>
<td>Practical comprising of Papers VIA &amp; VIB</td>
<td>605 + 606</td>
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<tr>
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<td>VIIIA</td>
<td>50</td>
<td>Programming language C (selected features)</td>
<td>Programming language C (selected features) I (507) Programming language C (selected features) II (508)</td>
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<td>VIIIB</td>
<td>50</td>
<td>Computation and Data Analysis</td>
<td>Computation and Data Analysis I (607)</td>
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<td>VIIIIB</td>
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<td></td>
<td>Computation and Data Analysis II (608)</td>
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</tbody>
</table>
HONOURS

101 Descriptive Statistics I

Types of Data: Concepts of population and sample, quantitative and qualitative data, cross-sectional and time-series data, discrete and continuous data, different types of scales. (3L)

Collection of Scrutiny of Data: Primary data – designing a questionnaire and a schedule, checking its consistency. Secondary data – its major sources. Complete enumeration. Controlled experiments, Observational studies and Sample Surveys. Scrutiny of data for internal consistency and detection of errors in recording. Ideas of cross-validation. (3L)

Presentation of data: Construction of Tables with one or more factors of classification, diagrammatic representations, frequency distributions and cumulative frequency distributions and their graphical representations, stem and leaf displays. (4L)

Univariate data – different measures of location, dispersion, relative dispersion, skewness and kurtosis, Moments, Liaponov’s inequality, Quantiles and measures based on them – comparison with moment measures. Box Plot. Outlier Detection. (13L)

References:
5. Wallis F.E. & Roberts H.V. (1957): Statistics- a new approach, Methuen

102 Probability Theory I
Random Experiment: Trial, Sample point, Sample space, Different types of events. (5L)

Definition of probability: Classical and relative-frequency approach to probability, Kolmogorov’s Axiomatic definition (detailed discussion on discrete space only), limitations of Classical definition. Probability of union and intersection of events, Probability of occurrence of exactly m and atleast m events out of n events. Conditional probability and Independence of events, Bayes’ Theorem and its applications. Examples based on classical approach and repeated trials (20L)

References:

103 Linear Algebra

Vector Algebra: Vector spaces with real field, Basis and dimension of a vector space, Orthogonal vectors, Gram-Schmidt Orthogonalization. (7L)

Matrix Algebra: Linear transformation and Matrices, Matrix operations, Elementary matrices and their uses, Rank of a matrix and related results, Inverse of a matrix, Determinants, the Sweep-out and the Pivotal Condensation methods, Characteristic roots and vectors, Quadratic forms – classification and canonical reduction. (16L)

Systems of Linear Equations: Homogeneous and Non-homogeneous systems – conditions for solvability. (2L)

References:

201 Descriptive Statistics II

Bivariate data – scatter diagram, correlation coefficient and its properties, Correlation ratio, Correlation Index, Intraclass correlation, Concept of Regression, Principles of least squares, Fitting of polynomial and exponential curves. Rank correlation – Spearman’s and Kendall’s measures. (17L)

Analysis of Categorical Data: Consistency of data, independence and association of attributes, measures of association – Pearson’s and Yule’s measures, Goodman-Kruskal’s $\gamma$. Odds Ratio. Fitting of logit model through least squares. (8L)

References:
202 Probability Theory II
Random Variables: Definition of discrete and continuous random variables, cumulative distribution function (c.d.f.) and its properties (with proof), probability mass function (p.m.f.) and probability density function (p.d.f.), Expectation and Moments, Dispersion, Skewness, Kurtosis, Quantiles

The c.d.f., p.m.f. and p.d.f. in bivariate case. Marginal and Conditional distributions, Independence, Conditional Expectation, Correlation and Regression. Theorems on sum and product of expectations of random variables,

Probability Inequalities: Markov’s & Chebyshev’s inequalities.

References:

203 Population Statistics
Introduction: Sources of Population Data – Census data, Registration data and the errors in such data. Rates and ratios of vital events.

Measurements of Mortality: Crude Death rate, Specific Death Rate, Standardized death Rate, Case fatality rate and Cause of Death Rate, Infant Mortality Rate, Neonatal and Perinatal Mortality Rates

Life tables: Descriptions of Complete and Abridged Life Tables and their uses, Cohort vs. Current Life Tables, Stable population and Stationary population, Construction of complete life table from population and death statistics.

Measurements of Fertility: Crude Birth Rate, General Fertility Rate, Age Specific Fertility Rate, Total Fertility Rate.

Measurement of Population Growth: Crude Rate of Natural Increase and Vital Index, Gross and Net Reproduction Rates.
Population Estimation, Projection and Forecasting: Use of A.P. and G.P. methods for population estimates, Fitting of Logistic curve for population forecasting using Rhode’s method.  (5L)

References:

301 Mathematical Methods
Numerical Methods (15 marks):
Approximation of numbers and functions, Absolute and Relative errors.  (1L)

Interpolation: Polynomial approximation, Difference Table, Newton’s Forward and Backward interpolation formulae and Lagrange’s general interpolation formula, Error terms  (5L)

Numerical Differentiation and its applications.  (2L)

Numerical Integration: Trapezoidal and Simpson’s 1/3 rules.  (2L)

Numerical solution of equations: method of fixed point iteration and Newton-Raphson method in one unknown, Conditions of convergence, rates of convergence. Extension of the iteration method to two unknowns (without convergence)  (4L)

Stirling’s approximation to factorial n.  (1L)

Calculus of several variables (10 marks):
Maxima and minima for functions of several variables, Constrained maximization and minimization – use of Lagrange multiplier, Multiple integrals, Transformation of Variables and Jacobian, Polar and Orthogonal transformations  (10L)

References:
6. Apostol T.M. (1968): Calculus (Vols 1 & 2)
302 Probability Theory III

Generating Functions: Probability generating function and moment generating function in the univariate and bivariate cases. (3L)

Univariate Discrete Distributions: Uniform, Bernoulli, Hypergeometric, Binomial, Poisson, Negative Binomial, Geometric distributions and their properties. (7L)

Univariate Continuous Distributions: Rectangular, Normal (Normal approximation to the Poisson distribution), Cauchy, Gamma, Beta, Exponential, Laplace, Logistic, Pareto, Log-normal distributions and their properties. Truncated distributions. (9L)

Scaling methods: Z, Percentile, Thurstone, Equivalent scaling procedures (3L)

Bivariate Normal Distribution and its properties. (3L)

References:

303 Official and Economic Statistics

Official Statistics (Marks 10)
The Statistical system in India: The Central and State Government organizations, the functions of the Central Statistical Organization (CSO), the National Sample Survey Organization (NSSO) (4L)

National Income statistics: Income, expenditure and production approaches. Their applications in various sectors in India (6L)

Economic Statistics (Marks 15)
Index Numbers: Price, Quantity and Value indices. (1L)
Price Index Numbers: Construction, Uses, Limitations, Tests for index numbers, Various formulae and their comparisons, Chain Index Number. (7L)

Some Important Indices: Consumer Price Index, Wholesale Price Index and Index of Industrial Production – methods of construction and uses. (3L)
Measurement of income inequality: Gini’s coefficient, Lorenz curves, Application of Pareto and Lognormal as income distributions (4L)

References:

401 Sampling Distributions
Introduction: Concepts of Random Sampling, Statistics and Sampling Distributions of Statistics. Illustrations using different distributions, reproductive properties of the distributions. (7L)

Some Standard Sampling Distributions: $\chi^2$ distribution, distributions of the mean and variance of a random sample from a normal population, $t$ and $F$ distributions, distributions of means, variances and correlation coefficient (null case) of a random sample from a bivariate normal population, distribution of the simple regression coefficient (for both stochastic and non-stochastic independent variable cases). (13L)

Distributions of Order Statistics and Sample Range. (5L)

References:

402 Statistical Inference I
Idea of Inference - Point & Interval Estimations and Testing of Hypothesis (2L)

Point estimation: Requirements of a good estimator – notions of Mean Square Error, Unbiasedness: Minimum Variance Unbiasedness and Best Linear Unbiasedness, Sufficiency, Factorization Theorem (Discrete case only), Properties of minimum variance unbiased estimators, consistent estimators and asymptotic efficiency, Cramer-Rao lower bound, Rao-Blackwell Theorem. (17L)
Methods of Estimation – Moment, Least-square, Maximum Likelihood & Minimum \( \chi^2 \) methods and their properties (excluding proofs of large sample properties). (6L)

References:

403 Statistical Quality Control
Introduction: Concepts of Quality and Quality Control, Process Control and Product Control (5L)

Process Control: Control Charts and their uses, Choice of Subgroup sizes, Construction of control charts by attributes (p, c, np) (including unequal subgroup size) and variables (\( \bar{x} \), R). Interpretation of non-random patterns of points. (10L)

Product Control: Producer’s Risk, Consumer’s Risk, Acceptance Sampling Plan, Single and Double sampling plans by attributes, their OC, ASN (and ATI), LTPD and AOQL. Single sampling plan for inspection by variables (one-sided specification, known and unknown \( \sigma \) cases), Use of IS plans and tables. (10L)

References:
8. IS2500 Part I and Part II

501 Multivariate Analysis
Multivariate data – multiple regression, multiple correlation and partial correlation – their properties and related results. (8L)

Random Vector: Probability mass and density functions, Distribution Function, Mean vector and Dispersion matrix, Marginal and Conditional Distributions, Ellipsoid of Concentration, Multiple Regression, Multiple Correlation, Partial Correlation. (9L)

Multivariate Distributions: Multinomial, Multivariate Normal distributions and their properties. (8L)
**References:**

**502 Statistical Inference II**

**Test of significance (Marks 15)**

Elements of Hypothesis Testing: Null and Alternative hypotheses, Simple and Composite hypotheses, Critical Region, Type I and Type II Errors, Level of Significance and Size, p-value, Power (4L)

Tests of Significance related to a single Binomial proportion and Poisson parameter; two Binomial proportions and Poisson parameters; the mean(s) and variance(s) of a single univariate normal distribution, two independent normal distributions and a single bivariate normal distribution; regression and correlation coefficients of a single bivariate normal distribution, Combination of Probabilities in tests of significance (11L)

**Analysis of Variance (ANOVA) (Marks 10)**

Introduction: Heterogeneity and Analysis of Variance and Covariance, Linear Hypothesis, Orthogonal splitting of total variation, Selection of Valid Error. (3L)

Applications of the ANOVA technique to: one-way classified data, two-way classified data with equal number of observations per cell, testing simple regression coefficients, tests for parallelism and identity, correlation ratio, linearity of simple regression, multiple correlation and partial correlation coefficients. (7L)

**References:**
503 Introduction to Designs of Sample Survey and Experiments

Introduction to Sample Survey (Marks 10)

Introduction: Concepts of Finite Population and Sample, Need for Sampling, Complete Enumeration and Sample Surveys. (2L)

General Ideas: Planning and execution of sample surveys, analysis of data and reporting, Biases and Errors. Judgement and probability sampling schemes. Tables of Random Numbers and their uses (3L)

Simple Random Sampling with and without replacement, Determination of sample size in simple random sampling. (5L)

Introduction to Design of Experiments (Marks 15)

Principles of experimental design: Randomization, Replication and Local Control, Uniformity trials, Shapes and Sizes of Plots and Blocks. (4L)

Standard Designs and their Analyses: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), comparison of efficiencies. Applications of the techniques of ANOVA to the analysis of the above designs. (11L)

References:
8. NSSO Publications

504 Time Series Analysis

Introduction: Examples of time series from various fields, Components of a times series, Additive and Multiplicative models. (2L)

Trend and Seasonal Components: Estimation of trend by linear filtering (simple and weighted moving-averages) and curve fitting (polynomial, exponential and Gompertz). Detrending. Estimation of seasonal component by ratio to moving-average method, ratio to trend method, Deseasonalization. (10L)
Stationary Time series: Weak stationarity, Autocorrelation Function and Correlogram (4L)

Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR(1) and AR(2) – Yule-Walker equations (7L)
Exponential smoothing method of forecasting (2L)

References:

601 Large Sample Theory
Convergence in Probability, Weak Law of Large Numbers and its applications, Convergence in Distribution, DeMoivre Laplace limit theorem, Statement of Central Limit Theorem (i.i.d. case) & its applications. (8L)

Delta method, Derivation of large sample standard error of sample moments, standard deviation, coefficient of variation, $b_1$ and $b_2$ measures, and correlation coefficient and their uses in large sample tests under normality assumption, Large sample distribution of sample quantile (8L)

Transformations of Statistics to stabilize variance: derivation and use of Sin$^{-1}$, square root, logarithmic and z-transformations. (3L)

Large sample tests for binomial proportions, Poisson means (single and two independent samples cases) and correlation coefficients. (3L)

Large Sample distribution of Pearsonian $\chi^2$–statistic and its uses. Yate’s correction in a 2 x 2 contingency table. (3L)

References:

602 Statistical Inference III
Theory of Hypothesis Testing: Most Powerful (MP), Uniformly Most Powerful (UMP), Randomized and Nonrandomized tests, Neyman-Pearson Fundamental Lemma (sufficiency part only), and its use in the construction of MP and UMP tests (single parameter with range independent of the), Uniformly Most Powerful Unbiased (UMPU) tests (definition only). (9L)

Likelihood Ratio tests and its applications to tests for the equality of means and variances of several normal populations. (5L)
Interval Estimation: Confidence intervals, Concepts of Uniformly Most Accurate (UMA) confidence sets, relationship with tests of hypotheses.  

Nonparametric Methods: Sign test, Mann-Whitney test, Run test, Test of randomness, Confidence limits for Quantiles based on Sign test statistic.

References:

603 Design of Experiments
Split Plot Design and Strip arrangements.  

Groups of Experiments using RBD and LSD  

Factorial Experiments: 2^n experiments, Advantages, Total and Partial Confounding, Analysis  

Missing Plot Technique: Analysis with one missing plot in a RBD and in a LSD.  

Analysis of Covariance (ANCOVA): Application of the ANCOVA technique to one-way classified data and to two-way classified data with equal number of observations per cell, use in the control of error in CRD, RBD and LSD.

References:

604 Sample Survey Methods
Stratified random sampling, Linear and Circular Systematic Sampling, Cluster sampling, Two-stage (with equal-sized first stage units) sampling with equal selection probabilities at each stage. Associated unbiased estimators of population total, mean, and proportion, their variances and unbiased variance estimators. Allocation problem in stratified random sampling and optimum choice of sampling and sub-sampling fractions in two-stage sampling, Interpenetrating sub-sampling technique for unbiased variance estimation in systematic sampling.
Ratio and Regression methods of estimation in simple random sampling. Double sampling for ratio and regression estimators. (5L)

Randomized Response Techniques: Warner’s Model. (2L)

References:
## Practical (Honours) Course Structure

<table>
<thead>
<tr>
<th>Paper</th>
<th>Course structure</th>
</tr>
</thead>
</table>
| 1; 104 (Paper IIB in annual system) | 1. Respective practical problems (without using computer) covering papers - Descriptive Statistics I (101) and Linear Algebra (103) – 20 marks  
2. Computer course – 5 marks  
   (a) Number system – Binary, Octal, Hexadecimal; Binary arithmetic  
   (b) Use of EXCEL:  
      (i) Workbook and worksheets; working with worksheets to calculate different order moments etc.  
      (ii) Use of functions- Some Statistical and mathematical functions, (iii) Creating easy to understand charts |
| 2; 204 (Paper IIB in annual system) | 1. Respective practical problems (without using computer) covering papers - Descriptive Statistics II (201) and Population Statistics (203) – 20 marks  
2. Computer course – 5 marks  
   (a) Use of EXCEL:  
   (b) (i) Worksheet  
   (ii) Use of functions |
| 3; 304 (Paper IVB in annual system) | 1. Respective practical problems (without using computer) covering papers – Mathematical Methods (301) and Official & Economic Statistics (303) – 20 marks  
2. Computer course – 5 marks  
   (a) MINITAB syllabus  
      Use of different menus- manipulation, calculation, statistics, graph, editor  
      Practical Exercises using data:  
      (i) Drawing of different charts and graphs (Histogram, Stem and leaf, box, Scatter, matrix plot)  
      (ii) Computation and interpretation of mean, median, mode, SD, Mean deviation and quartiles.  
      (iii) Computation and interpretation of correlation coefficient, regression line  
      (iv) Matrix addition, multiplication, Diagonalisation, Inversion. |
| 4; 404 (Paper IVB in annual system) | 1. Respective practical problems (without using computer) covering papers – Statistical Inference I (402) and Statistical Quality Control (403)– 20 marks  
2. Computer course – 5 marks  
   (a) Computer software- operating system, computer languages- machine language, high level language, statistical packages.  
   (b) Algorithm and flow charts  
   (c) Introduction to C programming-  
      (i) Basic structure of a C program (explanation with a simple program)  
      (ii) Constants, variables and declarations  
      (iii) Selected library functions  
      (iv) Simple input-output statements  
      (v) Operators – arithmetic, increment and decrement  
      (vi) Looping structure: “for” loop  
      (vii) Some selected C programs: addition, multiplication, calculation of mean, computation of different order moments, correlation, and fitting straight line to a given }
<table>
<thead>
<tr>
<th>5; 505</th>
<th>Respective practical problems (without using computer) covering papers – Multivariate Analysis (501), Statistical Inference II (502)</th>
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<tbody>
<tr>
<td>5; 506</td>
<td>Respective practical problems (without using computer) covering papers – Introduction to Designs of Sample Survey and Experiments (503), Time Series Analysis (504)</td>
</tr>
</tbody>
</table>
| 5; 507  | **Computer Programming:**
|         | 1. More on input-output statements  
|         | 2. Operator - relational and logical, conditional operator  
|         | 3. More on library functions  
|         | 4. Data type  
|         | 5. Decision making and branching- If, If-else, Nesting of if statement, go to statement  
|         | 6. Arrays  
|         | 7. Some selected C programs:
|         | (i) Selection and Bubble sort, Computation of quantiles, Computation of Spearman's rank correlation coefficient (no tie case)  
|         | (ii) Fitting of Binomial and Poisson distributions  
|         | (iii) Interpolation by Lagrange's formula. |
| 5; 508  | **Computer Programming:**
|         | 1. More on looping structure (control statement) – while, do while  
|         | 2. Use of Functions  
|         | 3. File structure  
|         | 4. Some suggested C programs:
|         | (i) Numerical integration (Trapezoidal and Simpson's 1/3 rule) with convergence;  
|         | (ii) Solution of numerical equations by Newton Raphson and iterative method (single variable);  
|         | (iii) Addition, multiplication, transpose of matrices  
|         | (iv) Trace, determinant and inverse of square matrices  
|         | (v) Generation of random samples from Normal, Chi-square, t and F distributions. |
| 6; 605  | Respective practical problems (without using computer) covering papers – Large Sample Theory (601), Statistical Inference III (602) |
| 6; 606  | Respective practical problems (without using computer) covering papers – Design of Experiments (603), Sample Survey Methods (604) |
| 6; 607  | Computation and Data Analysis encompassing all topics taught in the six semesters. Use may be made of all computational methods taught in all the semesters along with analysis tool pack of EXCEL (not covered in Paper 204) and modules of MINITAB (not covered in Paper 304) |
| 6; 608  | Computation and Data Analysis encompassing all topics taught in the six semesters. Use may be made of all computational methods taught in all the semesters along with analysis tool pack of EXCEL (not covered in Paper 204) and modules of MINITAB (not covered in Paper 304) |
Rules for the Practical Examinations

For the Part I examination, the Practical Examination (for Paper IIB) will be of 5 (FIVE) hours duration including problems to be solved with EXCEL. The Notebooks need to be submitted during the course of the examination. The Viva-Voce will either be held concurrently with the examination or a separate day may be allotted for it depending on the discretion of the examiners and to be decided in the meeting of the UG Board of Studies.

For the Part II examination, the Practical Examination (for Paper IVB) will be of 5 (FIVE) hours duration including problems to be solved with MINITAB and C. The Notebooks need to be submitted during the course of the examination. The Viva-Voce will either be held concurrently with the examination or a separate day may be allotted for it depending on the discretion of the examiners and to be decided in the meeting of the UG Board of Studies.

For the Part III examination, the Practical Examination for the two papers viz. Papers VIIA and VIIB will be held on two separate days each of 5 (FIVE) hours duration. The Notebooks need to be submitted during the course of the examination. The Viva-Voce will either be held concurrently with the examination or on a separate day depending on the discretion of the examiners and to be decided in the meeting of the UG Board of Studies.

The examination for Papers VIIIA and VIIIB will be held on two separate days each of 5 (FIVE) hours duration. This examinations may be held in batches (on the same or on separate days) or simultaneously for all students depending on the availability of computers. The Viva-Voce will be held during the course of the examination. A Practical Notebook, comprising of the exercises pertaining to Computer Programming corresponding to Paper VIIIA done during the year, will need to be submitted during the course of the examination for evaluation. For these two practical papers it is imperative that the respective colleges arrange for their own computers and printers and allow the students sufficient time to practice on them so that they are able to compile their Practical Notebook as also to ready themselves for the examination. If necessary, the examination for this paper may also be held in the colleges which must make sure of the availability of sufficient computers and printers for the purpose for the benefit of their students. The Viva-Voce will either be held concurrently with the examination or on a separate day depending on the discretion of the examiners and to be decided in the meeting of the UG Board of Studies.
GENERAL

101 Descriptive Statistics I
Types of statistical data, Compilation, Classification, Tabulation and Diagrammatic representation of data, Frequency Distribution, Cumulative Distribution and their graphical representation, Histogram, Frequency Polygon, Frequency Curve and Ogive. (11L)

Analysis of Univariate Quantitative Data – concepts of central tendency, dispersion, relative dispersion, skewness and kurtosis and their measures based on quantiles and moments. (14L)

References:

102 Probability I
Random Experiments and Random Events, Statistical regularity and meaning of Probability, Classical and Axiomatic definitions of Probability (discrete sample space only), Conditional Probability, Independence of Events, Principal Theorems including union and intersection of events and Bayes Theorem. (13L)


References:
8. Rathie and Mathai: Probability and Statistics
201 Descriptive Statistics II

Fitting of Binomial, Poisson and Normal distributions (2L)

Analysis of Bivariate Quantitative Data – Scatter Diagram, Product Moment Correlation Coefficient and its properties, Regression Analysis, Fitting of Linear and Polynomial equations by the principle of Least Squares, Correlation Index, Spearman’s Rank Correlation Coefficient. (15L)

Analysis of Multivariate Quantitative Data – Multiple Regression, Multiple Correlation and Partial Correlation in three variables, their measures and related results. (8L)

References:

202 Probability II

Standard Univariate Discrete Distributions and their properties – Discrete Uniform, Binomial, Poisson, Hypergeometric, Geometric and Negative Binomial distributions (10L)

Standard Univariate Continuous Distributions – Uniform, Normal, Exponential, Gamma, Beta and Lognormal distributions, Bivariate Normal distribution and statement of its general properties (10L)

Chebychev’s Inequality, Weak Law of Large Numbers, Statement of Central Limit Theorem (i.i.d. case) and its uses. (5L)

References:
8. Rathie and Mathai: Probability and Statistics
301 Sampling Distributions and Point Estimation

Concepts of Population and sample, Random Sampling and Sampling Distributions of Statistics, sampling distribution of sum of independent Binomial and Poisson variables, $\chi^2$, t and F distributions (derivations excluded), sampling distribution of mean and variance of independent Normal variables.

Point Estimation of a population parameter – concepts of Bias and Standard Error of an estimator, concepts of Unbiasedness, Minimum Variance, Consistency and Efficiency of an estimator, Method of Moments, Maximum Likelihood Method of estimation, Method of Least Squares, Point estimators of the parameters of Binomial, Poisson, and univariate Normal distributions.

References:

302 Economic Statistics, Time Series Analysis

Economic Statistics: Index Number – construction and use of price index numbers and tests in connection with them, Consumer and Wholesale price index numbers, their uses and major steps in their construction.


References:
401 Statistical Inference

Statistical tests of Hypotheses – Null and Alternative hypotheses, Types of Errors, Critical Region, Level of Significance, Power and p-values, Exact tests of hypotheses under Normal set-up for a single mean, the equality of two means, a single variance and the equality of two variances, Test of Significance of sample correlation coefficient (null case) and tests of hypotheses for the equality of means and equality of variances of a bivariate Normal distribution. (13L)

Interval Estimation – Confidence Interval and Confidence Coefficient, Exact confidence interval under Normal set-up for a single mean, single variance, the difference of two means and the ratio of two variances. (5L)

Large Sample Tests and related Interval Estimates of a single mean and a single proportion and difference of two means & two proportions, Pearsonian $\chi^2$ tests for goodness of fit & for homogeneity and independence in a contingency table. (7L)

References:

402 Population Statistics and Statistical Quality Control

*Population Statistics:*
Vital events, Rates and Ratios, Measurement of Mortality – Crude, Specific and Standardized death rates, Complete Life Table, Measurement of Fertility and Reproduction – Crude Birth Rate, General, Specific and Total fertility rates, Gross and Net reproduction rates. (14L)

*Statistical Quality Control:*
Advantages of statistical quality control, Construction of control charts by attributes (p, c, np) and variables ($x$, R). (7L)

Sampling Inspection Plan by attributes, OC, ASN (and ATI), LTPD and AOQL for single sampling plan (4L)

References:
501 Sample Survey Methods:

Concepts of population and sample, Need for sampling, Stages in the design and conduct of sample surveys. Concept of probability sampling, Random Number tables. Simple random sampling with and without replacement

Stratified random sampling – associated unbiased estimators of population mean, total and proportion, their variances and unbiased variance estimators, Linear Systematic sampling, Two-stage sampling (with primary units of equal size and equal selection probability at each stage) – unbiased estimation of population mean and total.

References:

601 Design & Analysis of Experiments

Analysis of Variance in one-way classified data and two-way classified data with equal number of observations in each cell.

Basic principles of design – Randomization, Replication and Local Control, Completely Randomized design, Randomized Block design and Latin Square design, applications of the technique of Analysis of Variance for the analysis of data collected under these designs.

References:
Question Pattern for B.Sc. Honours Examinations in Statistics (1+1+1) - 2010

**Theoretical**

**Part I**

**Paper IA:**
- Short Questions of 5 marks each: No. of questions to be given = 8
  No. of questions to be answered = 4
  Total marks = 5 x 4 = 20
- Broad Questions of 15 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 15 x 2 = 30

**Paper IB:**
- Short Questions of 5 marks each: No. of questions to be given = 8
  No. of questions to be answered = 4
  Total marks = 5 x 4 = 20
- Broad Questions of 15 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 15 x 2 = 30

**Paper IIA:**

**Group A (25 marks)**
- Short Questions of 5 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 5 x 2 = 10
- Broad Questions of 15 marks each: No. of questions to be given = 2
  No. of questions to be answered = 1
  Total marks = 15 x 1 = 15

**Group B (25 marks)**
- Short Questions of 5 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 5 x 2 = 10
- Broad Questions of 15 marks each: No. of questions to be given = 2
  No. of questions to be answered = 1
  Total marks = 15 x 1 = 15
**Part II**

*Paper IIIA:*

**Group A (25 marks)**
- Short Questions of 5 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 5 x 2 = 10
- Broad Questions of 15 marks each: No. of questions to be given = 2
  No. of questions to be answered = 1
  Total marks = 15 x 1 = 15

**Group B (25 marks)**
- Short Questions of 5 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 5 x 2 = 10
- Broad Questions of 15 marks each: No. of questions to be given = 2
  No. of questions to be answered = 1
  Total marks = 15 x 1 = 15

*Paper IIIB:*

**Group A (25 marks)**
- Short Questions of 5 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 5 x 2 = 10
- Broad Questions of 15 marks each: No. of questions to be given = 2
  No. of questions to be answered = 1
  Total marks = 15 x 1 = 15

**Group B (25 marks)**
- Short Questions of 5 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 5 x 2 = 10
- Broad Questions of 15 marks each: No. of questions to be given = 2
  No. of questions to be answered = 1
  Total marks = 15 x 1 = 15
Paper IVA:

Group A (25 marks)

- Short Questions of 5 marks each:  
  No. of questions to be given = 4  
  No. of questions to be answered = 2  
  Total marks = 5 x 2 = 10

- Broad Questions of 15 marks each:  
  No. of questions to be given = 2  
  No. of questions to be answered = 1  
  Total marks = 15 x 1 = 15

Group B (25 marks)

- Short Questions of 5 marks each:  
  No. of questions to be given = 4  
  No. of questions to be answered = 2  
  Total marks = 5 x 2 = 10

- Broad Questions of 15 marks each:  
  No. of questions to be given = 2  
  No. of questions to be answered = 1  
  Total marks = 15 x 1 = 15

Part III

Paper VA:

Group A (25 marks)

- Short Questions of 5 marks each:  
  No. of questions to be given = 4  
  No. of questions to be answered = 2  
  Total marks = 5 x 2 = 10

- Broad Questions of 15 marks each:  
  No. of questions to be given = 2  
  No. of questions to be answered = 1  
  Total marks = 15 x 1 = 15

Group B (25 marks)

- Short Questions of 5 marks each:  
  No. of questions to be given = 4  
  No. of questions to be answered = 2  
  Total marks = 5 x 2 = 10

- Broad Questions of 15 marks each:  
  No. of questions to be given = 2  
  No. of questions to be answered = 1  
  Total marks = 15 x 1 = 15
Paper VB:

- Short Questions of 5 marks each: No. of questions to be given = 8
  No. of questions to be answered = 4
  Total marks = 5 x 4 = 20

- Broad Questions of 15 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 15 x 2 = 30

Paper VIA:

- Short Questions of 5 marks each: No. of questions to be given = 8
  No. of questions to be answered = 4
  Total marks = 5 x 4 = 20

- Broad Questions of 15 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 15 x 2 = 30

Paper VIB:

Group A (25 marks)

- Short Questions of 5 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 5 x 2 = 10

- Broad Questions of 15 marks each: No. of questions to be given = 2
  No. of questions to be answered = 1
  Total marks = 15 x 1 = 15

Group B (25 marks)

- Short Questions of 5 marks each: No. of questions to be given = 4
  No. of questions to be answered = 2
  Total marks = 5 x 2 = 10

- Broad Questions of 15 marks each: No. of questions to be given = 2
  No. of questions to be answered = 1
  Total marks = 15 x 1 = 15
Note:

1. There will be no choices among questions in the Practical Papers. The candidates will be required to answer all the questions.

2. The practical examination of Paper IIB in Part 1, Paper IVB in Part 2 and Papers VIIA and VIIB in Part 3 will be held simultaneously in all the centers on the basis of single question paper in respective papers. Papers VIIIA and VIIIB in Part 3 may be held in groups on different dates. However, the final modality will be decided in the UG Board of Studies meeting.

3. The division of marks for each subsection of all the questions in the Theoretical papers is to be given alongside. No such division need to be given for the questions in the Practical papers.

**Question Pattern for B.Sc. General Examinations in Statistics (1+1+1) - 2010**

**Theoretical**

**Part I**

**Paper IA:**
- Short Questions of 2 marks each: No. of questions to be given = 8  
  No. of questions to be answered = 4  
  Total marks = 2 x 4 = 8
- Broad Questions of 14 marks each: No. of questions to be given = 6  
  No. of questions to be answered = 3  
  Total marks = 14 x 3 = 42

**Paper IB:**
- Short Questions of 2 marks each: No. of questions to be given = 8  
  No. of questions to be answered = 4  
  Total marks = 2 x 4 = 8
- Broad Questions of 14 marks each: No. of questions to be given = 6  
  No. of questions to be answered = 3  
  Total marks = 14 x 3 = 42
Part II

Paper IIB:
- Short Questions of 2 marks each:  
  No. of questions to be given = 8  
  No. of questions to be answered = 4  
  Total marks = 2 x 4 = 8
- Broad Questions of 14 marks each:  
  No. of questions to be given = 6  
  No. of questions to be answered = 3  
  Total marks = 14 x 3 = 42

Paper IIIA:
- Short Questions of 2 marks each:  
  No. of questions to be given = 8  
  No. of questions to be answered = 4  
  Total marks = 2 x 4 = 8
- Broad Questions of 14 marks each:  
  No. of questions to be given = 6  
  No. of questions to be answered = 3  
  Total marks = 14 x 3 = 42

Paper IVA:
- Short Questions of 2 marks each:  
  No. of questions to be given = 8  
  No. of questions to be answered = 4  
  Total marks = 2 x 4 = 8
- Broad Questions of 14 marks each:  
  No. of questions to be given = 6  
  No. of questions to be answered = 3  
  Total marks = 14 x 3 = 42

Part III

Note:
1. There will be no choices among questions in the Practical Papers. The candidates will be required to answer all the questions.
2. The division of marks for each subsection of all the questions in the Theoretical papers is to be given alongside. No such division need to be given for the questions in the Practical papers.