Department of Statistics
Gauhati University
B.Sc. Major Syllabus: Statistics
(SEMESTER SCHEME)

SEMESTER - I

Two theory papers each of 75 marks and one practical paper of 50 marks.
Total marks: - 75 X 2 + 50 =200

Paper M 101: Descriptive Statistics –I: 75 Marks (Internal 20%)
Credit = 6

Paper 1.1 : Descriptive Statistics –1:

Unit 1:   **25 Marks**
Types of data: Concepts of a statistical population and sample from a population; qualitative and quantitative data; nominal and ordinal data; cross sectional and time series data; discrete and continuous data; frequency and non-frequency data.

Collection and Scrutiny of Data: Primary data-designing a questionnaire and a schedule; checking their consistency; Secondary data-their major sources including some government publications. Complete enumeration, controlled experiments, observational studies and sample surveys. Scrutiny of data for internal consistency and detection of errors of recording. Ideas of cross-validation.

Unit 2:   **25 Marks**
Presentation of Data and Statistical Graphics: Construction of tables with one or more factors of classification. Diagrammatic and graphical representation of non-frequency data. Frequency distributions, cumulative frequency distributions and their graphical and diagrammatic representation-column diagram, histogram, frequency polygon and ogives. Stem and leaf chart. Box plot, scatter diagram for bivariate data.

Analysis of Quantitative Data: Univariate data. Concepts of central tendency or location, dispersion and relative dispersion, skewness and kurtosis and their measures including those based on quantiles and moments, Absolute moments, factorial moments, cumulants, Sheppard's corrections for moments for grouped data.

Unit 3:   **25 Marks**

Analysis of bivariate data: Preparation of bivariate frequency table, Product moment correlation coefficient and its properties, Spearman's rank correlation co-efficient, Concepts of regression, Principle of least squares and orthogonal polynomial, Fitting of linear regression and related results. Correlation index, Fitting of curves reducible to polynomials by log and inverse transformation, Correlation ratio, and Intra-class correlation, Partial and Multiple correlation and regression.

PAPER M102: PROBABILITY – 1: 75 Marks   Credit 6   (Internal 20%)

Unit 1:   **35 Marks**

Random experiment: trial, sample point and sample space, event, operations of events, and concepts of mutually exclusive and exhaustive events.

Definition of probability: classical and relative frequency approach. Axiomatic approach, Discrete probability space, Properties of probability, Independence of events, Conditional probability, total and compound probability rules, Baye's theorem and its applications, Geometrical interpretation.

Unit 2:   **40 Marks**

Random variable (rv); its probability mass function (pmf) and probability density function (pdf) and cumulative distribution function (cdf), Joint pmf and pdf of several discrete and continuous rv's. Marginal and conditional pmf and pdf. Functions of rv, linear combination of rv's. Independence of rv's. Expectation of a rv and its properties; Moments, measures of location and dispersion of a rv; Probability generating function (pgf), convolution and moment generating function (mgf) of a rv, their properties and uses, factorial moments and their properties, cumulant generating function and its properties, characteristic function and its simple properties.

<u>Paper M103:Practical: 50 Marks</u> (Internal 20%) Credit 4
Practical from topics in Paper M101 & M102

<u>Reference books for Semester I :</u>

1. A M Goon , M K Gupta, B Dasgupta . Fundamental of Statistics, Vol 1 World Press
2. F E Croxton, D J Cowden, S Klein. Applied General Statistics, Prentice Hall.
3. M R Spiegel. Theory and Problems of Statistics
4. P Mukhopadhyay. Mathematical Statistics, New Central Book Agency.
5. K L Chung. Elementary Probability Theory with Stochastic Process, Springer
6. W Feller. An Introduction to Probability Theory and its Applications, Wiley
7. Bhattacharjee, D. and Das, K.K., Statistical Graphics for everyone, South Asian Publishers Pvt. Ltd., New Delhi.
8. Das, K.K., and Bhattacharjee, D. 101 Graphical Techniques, Asian Books Private Limited, New Delhi.

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In the 1st semester in Major

Total Marks – 200

Total Credit -   16

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SEMESTER – II
Two theory papers each of 75 marks and one Practical paper of 50 marks
Total Marks : 75X2 + 50 = 200

Paper M201 : Numerical and Computational Techniques –I   75 Marks (Internal 20%)
                                                              Credit - 6

Unit 1:   **25Marks**
Δ & E operators, Fundamental theorem, zero differences, Interpolation formulae; Newton's forward, backward with remainder terms, Divided differences: Properties, Newton's Divided difference formula, Lagrange's formulae

Unit 2:   **25 Marks**
Central Difference: Idea, Operator's, Gauss's forward, backward, Bessel, Everret and Stirling formulae
Inverse Interpolation, Numerical Differentiation.

Numerical Integration: Trapezoidal Rule, Simpson's 1/3 rd and 3/8 th rule, Weddle's rule, Euler-Maclaurin's formula [Proof of all the formulae will be required].

Unit 3:   **25 Marks**
General properties of linear difference equation, linear difference equation with constant co-efficient, roots of polynomial equations, and solution of simple problems by Newton-Raphson method, Bisection method, and Graphical method, Regula Falsi Method, Method of Iteration.

Paper M202 Mathematical Method –I   **75 Marks (Internal 20%)**

(Recap: Limit, continuity and differentiability of functions of one variable, sequences and series of real numbers; Convergence, Cauchy criterion and tests for convergence. No questions to be set from recoys)

Roll's theorm Mean value theorems, Taylor's expansion, maxima and minima, Point wise and uniform convergence, necessary and sufficient conditions for uniform convergence, Functions of several variables- limit, continuity and differentiability, Taylor's expansion for two variables; Partial derivatives-basic idea and simple examples; Applications of Lagrange's multipliers, Riemann Internal.
Infinite and Improper integrals; Gamma and Beta integrals and their properties, Jacobian transformation.

Paper M203: Practical: 50 Marks   **(Internal 20%)**

Practical from Paper M201   Credit - 4

Reference books for Semester 2 :

1. Shanti Narayan . Mathematical Analysis, S Chand and Co
2. W Rudin. Principles of Mathematical Analysis, Mc Graw Hill
3. T M Apostol. Mathematical Analysis, Narosa Publishing House
4. S C Malik. Mathematical Analysis
5. J V Deshpande. Text Book of Mathematical Analysis, Tata Mc Graw Hill
6. H C Saxena. Calculus of Finite Difference
7. Shanti Narayan. Matrix Algebra, S Chand and Co
8. S R Searle. Matrix Algebra Useful for Statistics, Wiley

In the 2nd semester Major course

Total Marks – 200
Total Credit -   16

Two theory papers each of 75 marks and one practical paper of 50 marks.
Total marks: - 75 X 2 + 50 = 200

Paper M301: Mathematical Methods – II   **75 Marks**
Credit -6   (Internal 20%)

Matrices:
Recap (Inverse of a matrix-definition and related theorems, idempotent and unitary matrices).
Orthogonal matrix and its properties, Adjoint of a square matrix and related theorems, Rank of a matrix: submatrix of a matrix, minors of a matrix, definition of rank, Theorems on rank, Elementary transformation of a matrix, elementary matrices and related theorem, echelon and normal form, invariance of rank under elementary transformation, rank of product, Linear equations, homogenous and non homogenous system of equations , consistency and general solution, Quadratic forms: definition , Matrix of a Quadratic form- definition, Idea of a Positive definite, negative definite and semi-positive definite with simple examples.

Paper M302 : Distribution – 1   **75 Marks (Internal 20%)**
        Credit - 6

Unit 1:   **40 Marks**
Standard distributions:
Discrete distributions: Bernoulli, Binomial, Poisson, Hypergeometric, Negative Binomial, Geometric, Uniform distributions, their properties and applications.

Unit 2:   **35 Marks**
Continuous distributions: Uniform, Normal, Beta, Gamma (one and two parameter), Laplace Cauchy, Exponential, Weibell, Lognormal,

Paper M303 Practical :   50 Marks (Internal 20%)   Credit - 4
Practical from topics in Paper M301 & M302

References for Semester III

1. J E Freund. Mathematical Statistics, Prentice Hall
2. A M Mood, F A Graybill, D C Boes. Introduction to the Theory of Statistics, McGraw Hill
3. R V Hogg, A T Craig. Introduction to Mathematical Statistics, Collier Macmillan
4. Das, K.K., and Bhattacharjee, D. A Treatise on Statistical Inference and Distributions, Asian Books Private Limited, New Delhi.
5. Fundamental of Statistics, Vol 1, Goon, Gupta, & Das Gupta.

Total Marks
Major – 200
Credit -   16

SEMESTER – IV

Two theory papers each of 75 marks and one practical paper of 50 marks.
Total marks: - 75 X 2 + 50 = 200

Paper M401:Mathematical Methods – 3 & OR – I :   75 Marks

Credit - 6   **(Internal 20%)**

Unit 1:   **40 Marks**

Definition of vectors, Algebra of vectors, Linear dependence and linear independence of vectors, A vector as a linear combination of vectors, Eigen values and Eigen vectors and their related theorems, Cayley-Hamilton theorem,

Vectors: Linear combination of vectors - their independence and dependence, hyperplanes, basis, dimension, properties of convex sets.

Unit 2:   **35 Marks**

Optimization:
Linear Programming problem (LPP):- Problem formulation and solution using graphical and simplex method –No derivation.

Transportation Problem:
Definition and its solution using north west corner rule and Vogel's method.

Paper M402 : Descriptive Statistics 2 & Probability – 2   75Marks

Credit - 6   **(Internal 20%)**

Unit 1:   **30 Marks**

Theory of sampling and large sample tests, standard error of means, proportion, moments (raw and central moments), standard error of simple function of moments.

Unit 2:   **30 Marks**

Characteristic for and it properties (without prof)
Central Limit Theorem: De – Moivre's and Levy Lindeberg (with proof), Chebyshev's lemma, WLLN with proof and applications, Bernoulli's law of large Numbers. Liaponenef's

Unit 3 :   **15 Marks**

Definitions and examples of stochastic processes (Its applications in various fields – other than mathematical applications), classification of general stochastic process into discrete / continuous time, discrete / continuous state space, elementary problems, definition and examples of Markov chain, transition probability matrix- its construction and applications, Chappman Kolmogorov equation, classification of states.

Paper M 403: Practical   - 50 Marks (Internal 20%)
Practical from paper M401 and M402

Credit -4

References for Semester – IV

1. H A Taha. Operations Research, Macmillan Publishing
2. F S Hiller , G J Libermann. Introduction to Operations Research, Mc Graw Hill
3. J Medhi. Stochastic Process, Wiley
4. P G Hoel , S C Port, C J Stone. Introduction to Stochastic Process, Universal Book Stall
5. S Karlin, H M Taylor. A First Course in Stochastic Process, Academic Press
6. Feller, W., An Introduction to Probability Theory and is Applications, Wiley.

Total Marks
Major – 200
Credit -   16

SEMESTER – V

Four theory papers each of 75 marks and two practical paper of 75 marks each
Total marks: - 75 X 6 = 450

Credit – 6 (Paper 501)
Paper M501 : Sampling Distribution and Statistical Inference – I   **75 Marks**
(Internal 20% ie 15 Marks)

Unit 1:   **40 Marks**

Sampling Distribution: - $\chi^2, \overline{x}, s^2, t, r, \text{and}, F -$ Their derivation, properties, inter-relationship and applications (null case only)

Order Statistics :- Definition and uses of order Statistics, derivation of the distribution of rth ordered statistic, joint distribution of the rth & s^{th} order statistics, distribution of sample range and sample median.

Unit 2:   **35 Marks**

Point estimation: - Properties of good estimators- unbiasedness, consistency, efficiency, sufficiency. Mean square error, Minimum Variance Unbiased Estimator, Crammer Rao lower bound (with proof) and related results.

Methods of estimation: - Methods of maximum likelihood, Method of Moments, Method of Minimum chi-square—Statement of properties of these methods (without proof).

Paper M502 : Sample Survey   75 Marks (Internal 20%)
                    Credit -6

Place of Sampling. Census and survey work. Concept of sampling frame and sampling unit.

Sampling Techniques: - Simple Random Sampling. Stratified Random Sampling, Cluster Sampling, Systematic Sampling, Double sampling, sampling with probability proportional to size.

Estimation procedures: - Estimates of population total and mean, bias in estimates, standard error of estimates, Ratio, regression and product estimates.

Optimum design: - Cost and variance functions. Use of pilot survey. Optimum size and structure of sampling units. Proportional and optimum allocation in stratified random sampling. Non sampling errors and their control.

Paper M503: Applied Statistics–I Credit-6 75 Marks
                        (Internal 20%)

Unit 1: Index number: **15 Marks**

Different types of index numbers e.g. index numbers of wholesale prices, cost of living index numbers (CLIN) and index of production (agricultural and industrial) numbers. Comparison of CLIN over time.

Unit 2: Applied Economics: **45Marks**

Income distributions. Pareto's curve, Measures of inequality-Gini's coefficient and Lorenz curve, and concentration curve. Elements of Econometrics: Definition and scope of Econometrics. Relation between variables, Linear model: two or more variables. Least square assumptions Estimation of regression parameters, Test of significance and confidence interval of parameters. Problem of single equation, model, multicollinearity, autocorrelation & Heteroscedasticity (brief idea of why it occur – violation of Least square assumptions). Theory of consumption and Demand, Demand function, elasticity of demand,

statistical analysis of demand with the help of time series and family budget data. Engel curve.

Unit 3: Time Series: 15 Marks

Economic time series, Multiplicative and additive models, trend determination by curve fitting and moving average methods, determination of seasonal indices, idea of correlogram and periodogram; Concepts of forecasting and its applications, Methods of forecasting MA, exponential smoothing.

Paper M504 : Operations Research – II   75 Marks   (Internal 20%)
Credit - 6

Unit 1: Replacement and Maintenance: **20 Marks**

Replacement of items with deterministic deterioration (items that deteriorate with time), group replacement policy.

Unit 2: Inventory Models: **20 Marks**

Concept of planned inventory policies, ABC Analysis, Deterministic model policy when inventory levels are reviewed continuously and demand occurs uniformly with and without shortage cost, Economic order quantity for production planning when inventory models are reviewed periodically(with and without shortage). (Multi item models, uncertain and stochastic demand models are not required)

Unit 3: Network + C.P.M. + PERT: **35 Marks**

Network: Idea of Network node, activities, dummy activity, construction of network diagram.

C.P.M: Network scheduling using C.P.M: determination of different types of floats and slacks, determination of Critical path.

PERT: Basic definition of PERT and its usefulness; brief idea of optimistic time, pessimistic time and most likely time (PERT calculations are not required)

Paper M505 : Practical from paper M501 & M502 75 Marks (Internal 20%) Credit - 6

Paper M506: Practical from paper M503 & M504   75 Marks (Internal 20%) Credit - 6

References for Semester 5

1. A M Goon , M K Gupta, B Dasgupta . Fundamental of Statistics, Vol & 2, World Press
2. A M Goon , M K Gupta, B Dasgupta . Outllines of Statistics, Vol 1& 2, World Press
3. E J Dudewicz, S N Mishra. Modern Mathematical Statistics, John Wiley
4. P Mukhopadhyay. Applied Statistics, New Central Book Agency
5. A J Duncan. Statistical Theory with Engineering Application, John Wiley
6. C Chatfield. The Analysis of Time Series – An Introduction , Chapman and Hall
7. Sukhatme et al . Sampling theory and methods
8. P Mukhopadhyay.Theory and Methods of Survey Sampling, New Central Book Agency
9. G. Casella and Roger L Berger. Statistical Inference: Wadsworth & Books.
10. J. Medhi. Statistical Methods, Ed, New Age International (P) Ltd.
11. A M Mood, F A Graybill, D C Boes. Introduction to the Theory of Statistics, McGraw Hill
12. R V Hogg, A T Craig. Introduction to Mathematical Statistics, Collier Macmillan
13. H A Taha. Operations Research, Macmillan Publishing
14. F S Hiller , G J Libermann. Introduction to Operations Research, Mc Graw Hill

In the 5th Semester
Total Marks (Major) – 450
Total Credit (Major) -   36

SEMESTER – VI
(4 theory papers each of 75 marks, one Practical paper of 75 marks and one paper (projects) of 75 marks
Total Marks: 75X 6 = 450)

Paper M601: Statistical Inference 2   **75 Marks** (Internal 20%)
                                                  Credit - 6

Unit 1:   **15 Marks**

Interval Estimation: -   Concept of confidence interval and confidence co-efficient, confidence intervals for parameters of univariate normal & two independent normal.

Unit 2:   **30 Marks**

Testing of Hypothesis: -   Statistical Hypothesis—Simple, Composite, Statistical tests, critical region, errors of Type I and Type II , Size & Power of a test, Definition of MP, and UMP tests, Neyman Pearson Lemma and its application in testing hypothesis regarding univariate normal distribution, Power curves of UMP tests with simple illustrations; Likelihood ratio test, test for parameters of univariate and two variate normal distribution and equality of parameters of two independent univariate normal distributions.

Unit 3:   **30 Marks**

Non-Parametric Tests: - Need for non-parametric tests, non-parametric and distribution free, Contingency and Association, chi-square test, Kolmogrov-Smirnov test (one and two samples), Run test (one and two samples), Sign test for location of univariate and bivariate population, median test, Spearman rank correlation, Kendall's Tau, Wilcoxon-Mann-Whitney test, Wilcoxon signed rank test

(derivation of tests not required; their application and use to be stressed upon).

Paper M602: Design of Experiments   75 Marks (Internal 20%)
Credit - 6

Analysis of variance: -   Introduction, linear models, AOV with one way, two way classified data (one observation per cell), Applications of AOV in detail, violation of assumptions in AOV, transformation. [Only fixed effect model] study of relationship between two variables.

Analysis of Covariance:- Idea of one way and two way classified data, Application of AOCOV (without derivation and without practical).

Principles of experimentation: -Randomization, Replication and Local Control. Techniques of error control, choice of size, shape and structure of experimental units, grouping of experimental units, analysis of completely randomized design, randomized block, Latin square designs, and their affiances, Factorial experiments (2^s(s=2(1)5). Confounding in Factorial experiments, Total and Partial; balanced confounding. Confounding of main effects: Split plot arrangements. Techniques for analysis of experiments with one missing yields (RBD & LSD).

Paper M603: Applied Statistics – 2   75 Marks (Internal 20%)
Credit - 6

Official Statistics: 15 Marks

Study of population Census in India (Highlights of last two censuses); India as a whole & the state of Assam. Functions of NSSO and CSO, Functions of National Statistical Commission (NSC) Simple Registration system.

DEMOGRAPHY   30 Marks

Source of demographic data, vital rates, crude birth rates, general fertility rates, age specific fertility rates, total fertility rate, gross and net reproduction rates, crude death rate, age specific mortality rates, infant mortality rate, complete life table- concepts, different columns & their relationships; Standardised rates, idea of abridged life table without

construction, Population Projection by Logistic curve and its fitting, Basic idea of Stable and Stationary population. Introduction and Basic Ides of Biostatistics & Epideniology.

Statistical Quality Control   **30 Marks**

Theoretical basis of statistical quality control in industry. Tolerance limit. Different kinds of control charts $\bar{x}$, R charts, p and c charts, and group control charts. Acceptance sampling. Single, O.C . and A.S.N. functions. Sampling by attributes and variables. Use of Dodge-Romig and other tables.

Paper M604 : Computer Programming and Multivariate Analysis   **75 Marks**
Credit - 6   **(Internal 20%)**

Multivariate Analysis: 40 marks

Bivariate Normal Distribution and its properties; Marginal and Conditional distributions, independence; Multivariate Normal distribution, marginal and conditional distribution, independence, characteristic function, Hotelling T^2 – idea and application (without derivation); Multinomial distribution, mean, Variance, Covariance and properties.

COMPUTER PROGRAMMING   35 Marks

Basic idea of different parts of a computer, brief idea of software, hardware; high level languages.

Programming in Fortran 77: Fortran constants, Fortran variables (real and integer), type declaration statements, arithmetic operations, hierarchy of operations, real, integer and mixed mode arithmetic, use of simple built-in library functions, simple input-output statements without format statement, use of DO loops, Nested Do loops and While-Do statement. Writing small programs for determination of commonly used statistical measures and for carrying out simple statistical analysis.

Flowchart symbols and their uses, construction of Algorithms.

Paper M605   75 Marks (Internal 20%) Credit - 6

Practicals based on Design of Experiments, Testing of Hypothesis, Non Parametric, & Demography.

Paper M606: Project :   75 Marks Credit -6
(Internal 20%)

Students will be required to go for data collection on some topics. Selection of the topic , sampling plan and data collection will have to be done under guidance of teachers of the department. On the basis of this data collection exercise, each student will be required to submit a project report. Among other things, this project report should contain details of the topic, the hypotheses to be tested, the sampling plan, and details of data collection. It should also contain analysis and results of the study. While data collection may be done in a group, the analysis, conclusion and report writing would have to be done individually by each student under guidance of a teacher of the department. The external examiner will examine the report and also carry out a viva voce examination. Based on the report and the viva voce of the report, marks will be assigned as per project scheme of GU for TDC.

References for Semester 6 :
1. A M Goon , M K Gupta, B Dasgupta . Fundamental of Statistics, Vol 2, World Press
2. A M Goon , M K Gupta, B Dasgupta . Outllines of Statistics, Vol 1& 2, World Press
3. P Mukhopadhyay. Applied Statistics, New Central Book Agency.
4. P Mukhopadhyay.Theory and Methods of Survey Sampling, New Central Book Agency.
5. Rajaram. Computer Programming in Fortran.
6. J. Medhi. Statistical Methods, Ed, New Age International (P) Ltd.
7. P Mukherjee: Malthematical Statistics.

In 6th Semester Total Marks (in Major) 450
Total Credit - 36

Total Marks
(Part I + Part II + Part III)
Major – 1700 Credit - 208