# DEPARTMENT OF STATISTICS

# GAUHATI UNIVERSITY

**Four Year Undergraduate Syllabus in Statistics under NEP**

**Effective from Academic Year 2023 – 24**

## Summary Structure

| Semester | Course Code | Course Name | Credit |
|---|---|---|---|
| I | STA101<br>STA-010104 | Descriptive Statistics& Probability-1 | 4 (Theory 3 +Practical 1) |
| 2 | STA201 | Correlation & Regression, Probability Distributions, Statistical Inference-I & Finite Difference | 4 (Theory 3 +Practical 1) |
| 3 | STA301 | Survey Sampling& Design of Experiments-1 | 4 (Theory 3 +Practical 1) |
| 4 | STA401 | Probability-2 and Probability Distributions-2 | 4 (Theory 4 +Practical 0) |
| 4 | STA402 | Mathematical Methods | 4 (Theory 4 +Practical 0) |
| 4 | STA403 | Linear Algebra and System of Equations | 4 (Theory 4 +Practical 0) |
| 4 | STA404 | Practical 4 | 4 (Theory 00 +Practical 4) |
| 5 | STA501 | Sampling Distributions and Test of Significance | 4 (Theory 4 +Practical 0) |
| 5 | STA502 | Statistical Inference-2 | 4 (Theory 4 +Practical 0) |
| 5 | STA503 | DESIGN OF EXPERIMENTS 2 | 4 (Theory 4 +Practical 0) |
| 5 | STA504 | Practical 5 | 4 (Theory 0 +Practical 4) |
| 6 | STA601 | Applied Statistics | 4 (Theory 4 +Practical 0) |
| 6 | STA602 | Bivariate/Multivariate Analysis, Stochastic Process & Computer Programming | 4 (Theory 4 +Practical 0) |
| 6 | STA603 | Operations Research | 4 (Theory 4 +Practical 0) |
| 6 | STA604 | Practical 6 | 4 (Theory 0 +Practical 4) |

**Semester 1**

**Course code : STA101**

**Course Name : Descriptive Statistics & Probability**

Credits: 4 (Theory: 03 credits, Practical/Lab: 01 credit)

Course Level : 100-199

Number of Contact classes : 60

Number of Non contact classes : 0

Prerequisites : NIL

**Course Objectives:** The objective is to give students foundational ideas about the various statistical methods, measures of central tendency and basics of probability. The students are introduced to the methods of collecting data, their representational formats and basic statistical tools.

**Learning Outcomes:** At the end of the course, students will be able to analyse a data set, represent the data in tabular and diagrammatic form, prepare the frequency distribution, find the summary measures viz. the measures of central tendency, measure of dispersion, measures of skewness and kurtosis of a univariate data.

**Unit** I: Statistical Methods: (No. of classes: 09, Weightage: 15%)

Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, boxplot. Collection and Scrutiny of Data: Primary data-designing a questionnaire and a schedule; Secondary data- their Major sources including some government publications.

**Unit** 2: Measures of Central Tendency, Dispersion and location:
(No. of classes: 12, Weightage: 20%)

Mathematical measures of central tendency. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, skewness and kurtosis, Deciles, percentiles, quartiles.

**Unit 3** : Probability: (No. of classes: 15 , Weightage : 25%)

Introduction, random experiments, sample space, 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.

**Unit 4**: Random variables and Expectations: (No. of classes: 9, Weightage: 15%)

Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties. Expectation of univariate random variables.

**Unit 5 : Practical 1** (No. of classes: 15 Weightage: 25%)
**Note** : Students can use calculators / Ms Excel / R programming as convenient.

1. Graphical representation of data.
2. Problems based on measures of central tendency & dispersion.
3. Problems based on measures of location.
4. Problems based on combined mean, variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.

SUGGESTED READING:

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

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

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.

4. Medhi, J., Statistical Methods: An Introductory text (New Age International (P) Ltd. 2000).

Course designed by : Amit Choudhury, Kishore Kr. Das and Rajan Sarma, Dept of Statistics GU .

**Semester 2**

**Course code : STA201**

**Course Name : Correlation & Regression, Probability Distributions, Statistical Inference-I & Finite Difference**

Credits: 4 (Theory: 03 credits, Practical/Lab: 01 credit)

Course Level : 100-199

Number of Contact classes : 60

Number of Non contact classes : 00

Prerequisites : NIL

**Course Objectives:** The course will expose students to the need and nuances of correlation and basic probability distributions alongwith notions of Uncertainty and Randomness, Probability & Random variables and Basic Data Analysis.

**Learning Outcomes:** At the end of the course, students will be able to apply the tools of correlation and model building in data analysis alongwith learning the use of basic probability distributions.

**Unit** 1: Bivariate data analysis: (No. of classes: 09, Weightage: 15%)

Definition, scatter diagram, Karl Pearson's correlation coefficient and its properties, partial and multiple correlation (3 variables only), rank correlation, correlation ratio. Simple linear regression, principle of least squares.

**Unit** 2: Basic Probability Distributions: (No. of classes: 12, Weightage : 20%)

Standard probability distributions: Binomial, Poisson, Uniform, Normal. Fitting of these distributions.

**Unit** 3 : Testing of Hypothesis: (No. of classes: 12, Weightage : 20%)

Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region, size and power, Large sample tests, single mean, difference of two means (technique only; without derivation),

t – test for testing single mean, difference of two means, paired t test (technique only without derivation),

F – test for testing equality of variance (technique only without derivation).

Categorical Data Analysis: Categorical data: Tests of proportions (testing single proportion, difference of two proportions,) tests of association, independence of attributes and goodness-of-fit using Chi- square Test (technique only without derivation),

**Unit** 4: Finite Difference: (No. of classes: 12, Weightage : 20%)

Definition, Operators Δ & E, their properties, Difference table, missing terms, Interpolation: Definition, Newton's Forward and Backward interpolation formula, Gauss Interpolation formula. Divided Difference (DD): Definition, DD table, Newton's DD formula. Lagrange's interpolation formula. Numerical Integration: Introduction, General quadrature formula, Trapezoidal, Simpson's 1/3rd & 3/8th rules, Newton-Raphson method.

**Unit** 5 : Practical 2 (No. of classes: 15, Weightage : 25%)

Note : Students can use calculators / Ms Excel / R programming as convenient.

1. Fitting of binomial distributions for n and p=q =½.
2. Fitting of binomial distributions for given n and p.
3. Fitting of binomial distributions after computing mean and variance.
4. Fitting of Poisson distributions for given value of lambda.
5. Fitting of Poisson distributions after computing mean.
6. Problems based on area property of normal distribution.
7. To find the ordinate for a given area for normal distribution.
8. Fitting of normal distribution when parameters are given.
9. Fitting of normal distribution when parameters are not given.
10. Practicals on Unit-1
11. Practicals on Unit-3
12. Practicals on Unit-4

**SUGGESTED READING:**


1. Goon,A.M.,Gupta,M.K.andDasgupta,B.(2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.
3. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics.

Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K.(2001): Statistics-Principles and Methods, 4th Edn. John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.

Course designed by : Rajan Sarma, Dept of Statistics, GU .

**Semester 3**

**Course code : STA301**

**Course Name : Survey Sampling and Design of Experiments-1**

Credits: 4 (Theory: 03 credits, Practical/Lab: 01 credit)

Course Level : 200-299

Number of Contact classes : 60

Number of Non contact classes : 00

Prerequisites : NIL

**Course Objective :** This course is designed to provide students with knowledge about the techniques of data collection.

**Learning Outcomes:** At the end of the course, students will be able to know the basic designs of sampling schemes.

**Unit**1: Survey Sampling: (No. of classes: 09, Weightage: 15%)

Complete enumeration, controlled experiments, observational studies and sample surveys, Concept of population and sample, complete enumeration versus sampling, principal steps in a sample survey, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle ofsample survey.

**Unit** 2: Simple random sampling: (No. of classes: 06, Weightage: 10%)

Simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of : population mean, total and mean square. Determination of sample size- preliminary formulas only.

**Unit** 3: Stratified random sampling and Systematic Sampling: (No. of classes: 15, Weightage: 25%)

Technique of stratified sampling, estimates of population mean and total, variances of these estimates (with derivation), proportional and optimum allocations and their comparison with SRS (with derivation), determination of sample size (in case of proportional allocation only).

Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates (N=n x k). Comparison of systematic sampling with SRS (with derivation).

**Unit 4** : Design of Experiments : (No. of classes: 15, Weightage: 25%)

Basic principles of Design, Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD)– layout, model and statistical analysis (without derivations), (analysis with missing observations not required).

One way and two way ANOVA.

**Unit 5 :** Practical 3 (No. of classes: 15, Weightage : 25%)
Note : Students can use calculators / Ms Excel / R programming as convenient.

List of Practicals : Practicals on Unit-2, 3 & 4.

SUGGESTED READING


1. Cochran, W.G. (1984): Sampling Techniques ( 3rd Ed.), Wiley Eastern.

2. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok,C.(1984). Sampling Theories of Survey

With Application, IOWA State University Press and Indian Society of Agricultural Statistics

3. Murthy, M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society,

Calcutta.

5. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2001): Fundamentals of Statistics (Vol.2), World

Press.

6. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.

7. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.

8. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.


Course designed by : Rajan Sarma, Pallabi Medhi, Arpita Basak Dept of Statistics, GU .

**Semester 4**

**Course code : STA401**

**Course Name : Probability-2 and Probability Distributions-2**

**Credits: 4 (Theory: 04 credits, Practical/Lab: 00 credit)**

**Course Level : 200-299**

**Number of Contact classes : 60**

**Number of Non contact classes : 00**

**Course Objective:** This course has the objective of providing exposure to random variable and large scale properties of probability distributions. This is a fundamental course on probability theory, random variables and their distributions to make further progress on statistical analysis. Students in this course This course also introduces the ideas of Statistical Inference and its importance in real world applications

**Learning Outcomes**: At the end of the course, students shall be able to appreciate the large sample implications of various statistical measures and also learn about a number of statistical distributions. They will be able to determine whether or not moments exist of any given random variable and if so, to determine them. They will also be able to use tools like Probability Generating function and Moment generating functions to study distributions in addition to learning several univariate discrete and continuous distributions and their characterizations.

**Unit** 1: Functions of Random variables .(No. of classes: 12, Weightage: 20%)

Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations, conditional expectations, conditional variance.

Moments, factorial moments, Cumulants, Generating functions – mgf, pgf, cgf together wih their properties.

**Unit2**: Probability–II (No. of classes: 12 , Weightage: 20%)

Chebyshevs Lemma (with proof), Weak Law of Large Numbers (WLLN) due to Bernoulli, Khintchine and Lyapunov. Central Limit Theorem (CLT)-De-Moivre's and Levy – Lindeberg CLT (with proof) -

**Unit3**: Probability Distributions II : (No. of classes: 24, Weightage: 40%)

Geometric, Negative Binomial, Hypergeometric, Multinomial, Exponential, Weibull, Cauchy, Beta and Gamma distributions along with their properties and limiting/approximation cases, Lognormal.

Normal distribution – harder problems and theory (over and above what is covered in unit 2 of paper STA201).

**Unit 4** : Order Statistics:(No. of classes: 12, Weightage: 20% )

Introduction, distribution of the rth order statistic, smallest and largest order statistics. Joint distribution of rth and sth order statistics, distribution of sample median and sample range.

List of reference books:

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. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

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

Course designed by : Kishore Kr Das and Rajan Sarma Dept of Statistics, GU .

**Semester 4**

**Course code : STA402**

**Course Name : Mathematical Methods**

**Credits: 4 (Theory: 04 credits, Practical/Lab: 00 credit)**

**Course Level : 200-299**

**Number of Contact classes : 60**

**Number of Non contact classes : 00**

**Course Objective**: This course has the objective of providing student with the necessary mathematical basics of Calculus and Algebra in so far as they are used in the study of Statistics.

**Learning Outcomes**: At the end of the course, students shall be able to use the mathematical results of Calculus and Algebra to study different distribution.

**Unit**1: Calculus (No. of classes: 24, Weightage: 40%)

Indeterminate forms: L-Hospital's rule, Maxima and minima of functions of one and two variables, constrained optimization techniques (with Lagranges multiplier) along with some problems. Jacobian- transformation of variables. Beta and Gamma functions: properties and relationship between them.

Exact differential equations, Integrating factors, change of variables, Total differential equations, Differential equations of first order and first degree, Homogeneous and non-homogeneous linear differential equations of order n with constant coefficients, Different forms of particular integrals.

**Unit** 2 : Infinite Series: (No. of classes: 12, Weightage: 20%)

Infinite series, positive termed series and their convergence; Comparison test, D'Alembert's ratio test, Cauchy's $n^{th}$ root test, Raabe's test (For all the tests, statement only is required, without proof. Applications only).

**Unit** 3: Numerical Analysis: (No. of classes: 24 , Weightage: 40%)

Factorial notation, Zero differences, Central differences due to Bessel. Stirling's approximation to factorial n. Solution of difference equations of first order, Numerical

methods for determination of approximate solutions of equations – Regula Falsi method, Bisection method.

**SUGGESTEDREADINGS:**


1. GorakhPrasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition-1997).
2. Gorakh Prasad: Integral Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition-2000).
3. Zafar Ahsan: Differential Equations and their Applications, Prentice-Hall of India Pvt. Ltd., New Delhi
4. Piskunov, N: Differential and Integral Calculus, Peace Publishers, Moscow.
5. Bartle, R. G. and Sherbert, D.R. Introduction to Real Analysis (John Wiley and Sons, New Delhi, 2007).
6. Simmons, G.F. Differential Equations with Applications and Historical Notes (Tata McGraw- Hill, New Delhi, 1991).



Course designed by : Amit Choudhury, Rajan Sarma, Dept of Statistics, GU .

**Semester 4**

**Course code : STA403**

**Course Name : Linear Algebra and System of Equations**

**Credits: 4 (Theory: 04 credits, Practical/Lab: 00 credit)**

**Course Level : 200-299**

**Number of Contact classes : 60**

**Number of Non contact classes : 00**

**Course Objective**: This course has the objective of providing student with the necessary mathematical basics on matrices.

**Learning Outcomes**: At the end of the course, students shall be able to explain the basics of matrices and Solve numerical problems based on basics of matrices in addition to solving systems of linear equations .

**Unit** 1: Linear Algebra (No. of classes: 30, Weightage : 50%)

Rank of a matrix, standard theorems on ranks, rank of the sum and the product of two matrices. Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms, Linear orthogonal transformation and their diagonalization.

Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem.

**Unit** 2: Determinants and System of Linear Equations:

(No. of classes: 30, Weightage : 50%)

Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, Jacobi's Theorem, product of determinants. Use of determinants in solution of linear equations, the system of linear equations, row reduction and echelon forms, the matrix equations AX=B, solution of linear equations, linear independence, Applications of linear equations, inverse of a matrix.

**SUGGESTED READINGS:**


1. Lay David C.: Linear Algebra and its Applications, Addison Wesley ,2000.
2. Schaum's Outlines: Linear Algebra, Tata McGraw-Hill Edition, 3rd Edition, 2006.

3. Krishnamurthy, V., Mainra, V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
4. Jain, P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1973
5. Biswas, S.(1997): A Textbook of Matrix Algebra, New Age International, 1997.
6. Gupta,S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.

**Semester 4**

**Course code : STA404**

**Course Name : Practical 4**

**Credits: 4 (Theory: 00 credits, Practical/Lab: 04 credits)**

**Course Level : 200-299**

**Number of Contact classes : 60**

**Number of Non contact classes : 00**

**Course Objective**: This course has will expose students to the art of applying mathematical skills in practical situations

**Learning Outcomes**: At the end of the course, students shall be able to apply mathematical techniques to practical situations.

Note: Students can use Excel/Spreadsheet/ R programming

Practicals based on the following:

(a) **Unit** 1: Practicals based on Unit 3 (Numerical Analysis) of paper STA402 (No. of classes: 30 Weightage 50%)

(b) **Unit** 2: Practicals based on Rank of a matrix, inverse of a matrix, quadratic forms, Solutions of linear equations, of paper STA 403 (No. of classes: 24 Weightage 40%)

(c) **Unit** 3: Practicals based on Unit 1 and fitting of negative binomial and exponential distribution of paper STA 401 (No. of classes: 06 Weightage :10%)

SUGGESTED READINGS:

Biswas, S. (1997): A Textbook of Matrix Algebra, NewAgeInternational,1997.

Course designed by : Dept of Statistics, GU .