

DEPARTMENT OF STATISTICS
GAUHATI UNIVERSITY



Four Year Undergraduate Syllabus in Statistics (Minor) under NEP
Effective from Academic Year 2023 – 24

Summary Structure for Minor in Statistics – 2023 BATCH

Semester	Course Code	Course Name	Credit	Remarks
I	STA101	Descriptive Statistics & Probability-1	4 (Theory 3 +Practical 1)	These courses are common with Major in Statistics
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	STA407	Probability-2 and Probability Distributions-2	4 (Theory 3 +Practical 1)	This paper will be taught only to students of Statistics Minor
4	STA408	Operations Research	4(Theory 3 +Practical 1)	This paper will be taught only to students of Statistics Minor
5	STA507	Statistical Inference	4 (Theory 3 +Practical 1)	This paper will be taught only to students of Statistics Minor
5	STA508	Design of Experiments 2	4 (Theory 3 +Practical 1)	This paper will be taught only to students of Statistics Minor
6	STA607	Sampling Distributions and Tests of Significance	4 (Theory 3 +Practical 1)	This paper will be taught only to students of Statistics Minor
6	STA608	Applied Statistics	4 (Theory 3 +Practical 1)	This paper will be taught only to students of Statistics Minor

Semester 4

Course code : STA407

Course Name : Probability-2 and Probability Distributions-2

Credits: 4 (Theory: 3 credits, Practical/Lab: 1 credit)

Course Level : 200-299

Number of Contact classes : 60

Number of Non contactclasses : 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.

Course outcomes:

CO1: Define the concepts of two dimensional random variables, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations, conditional expectations, conditional variance.

CO2: Classify the two dimensional random variable and explain their properties; explain the Chebyshev's Lemma, Weak Law of Large Numbers (WLLN) and apply these ideas to solve numerical problems. Moments and mgf.

CO3: Illustrate the various probability distributions such as Geometric, Negative Binomial, Hypergeometric, Multinomial, Exponential, Beta and Gamma distributions, their properties and limiting cases and utilize these ideas to solve numerical problems.

Unit 1: Functions of Random variables .(No. of classes: 21, Weightage: 35%)

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

Unit2: Probability–II (No. of classes: 9 , Weightage: 15%)

Chebyshevs Lemma (with proof), Weak Law of Large Numbers (WLLN) without proof). Central Limit Theorem (CLT)-De-Moivre's (without proof) -

Unit3: Probability Distributions II : (No. of classes: 18, Weightage: 30%)

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

Unit4: Practical (No. of classes: 15, Weightage: 25%)

Practicals from Unit 1 and Fitting of Exponential distribution from Unit 3.

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

Semester 4

Course Code: STA408

Course Name: Operations Research

Credits: 4 (Theory: 03 credits, Practical/Lab: 1 credit)

Course Level: 200-299

Number of Contact classes : 60

Number of Non-contact classes : 00

Course Objective: This course has the objective of inculcating the skills of Operations Research

Learning Outcomes: At the end of the course, students shall be able to use techniques of operations research to obtain optimization in field level problems.

Course Outcome:

CO1: Discuss optimization techniques using OR tools VIZ. LPP, Replacement problem, and Network Analysis.

CO2: Distinguish use of different methods to various kinds of LPP on the basis of type of constraints and number of variables in real life problems.

CO3: Choose an optimal replacement policy for a given item/equipment/machine.

CO4: Determine different types of floats and slacks, determination of critical path in network problem.

Unit 1: Linear Programming Problem: (No. of classes: 15, Weightage: 25%)

Linear Programming Problem, Mathematical formulation of LPP, Graphical solution of an LPP, Simplex procedure for solving LPP (without derivation) (three variables variable only).

Unit 2: Replacement problem: (No. of classes: 15, Weightage: 25%)

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

Unit 3: Network problems-CPM & PERT: (No. of classes: 15, Weightage: 25%)

Conception of network, idea of network node, activities, dummy activity, construction of network diagram. Network scheduling using C.P.M: determination of different types of floats and slacks, determination of critical path.

Unit 4: Practical from Unit 1, 2 and 3

(No. of classes: 15 , Weightage: 25%)

Suggested Reading :

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.
2. Kanti Swarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.
3. Hadley, G: (2002) : Linear Programming, Narosa Publications
4. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research Concepts and cases, 9th Edition, Tata McGraw Hill

Semester 5

Course code : STA507

Course Name : Statistical Inference

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

Course Level : 300-399

Number of Contact classes : 60

Number of Non contactclasses : 00

Course Objective: This course has the objective of exposing students to concepts of estimation and testing of hypothesis - its types, and desirable properties of an estimator and how to find a good estimate from a sample data

Learning Outcomes: At the end of the course, students shall be able to apply how to examine the properties of estimators and how to test different types of statistical hypothesis.

Course outcomes:

CO1: Describe the concepts of estimation, unbiasedness, sufficiency, consistency and efficiency, non-parametric tests and distribution free procedures.

CO2: Discuss factorization theorem. Testing of hypothesis problems based on the traditional approach and p-value approach.

CO3: Discuss the different methods of estimation such as method of moments, method of maximum likelihood.

CO4: Illustrate different non-parametric tests such as Test for randomness based on total number of runs, Empirical distribution function, Kolmogorov-Smirnov test for one sample, Sign tests-one sample and two samples, Wilcoxon-Mann-Whitney test.

CO5: Utilize the above learnt concepts to solve numerical problems.

Unit 1: Estimation: (No. of classes: 15, Weightage: 25%)

Concepts of point estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem.

Methods of point estimation - Method of moments, method of maximum likelihood estimation.

Interval estimation: concepts and simple problems.

Unit 2 : Hypothesis Testing (No. of classes: 15 Weightage: 25%)

Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Testing of hypothesis based on traditional and p-value approach

MP test, UMP test, unbiased test, Neyman Pearson Lemma (with proof) and its use, power curve.

Unit 3: Non-parametric Tests: (No. of classes: 15, Weightage: 25%)
Nonparametric Tests: Introduction and Concept, Concept of Distribution free procedure, Test for randomness based on total number of runs, Empirical distribution function, Kolmogrov-Smirnov test for one sample, Sign tests-one sample and two samples, Wilcoxon-Mann-Whitney test– all without derivation.

Unit 4: Practical: (No. of classes: 15, Weightage: 25%)

Practicals from methods of estimation, power curve and practicals from unit 3.

SUGGESTED READING:

1. Goon, A.M., Gupta, M.K.: Das Gupta, B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
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. Miller, I. and Miller, M. (2002): John E.Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
5. Mood, A.M, Graybill, F.A. and Boes, D.C,: Introduction to the Theory of Statistics, Mc Graw Hill.
6. Bhat, B.R, Srivenkatramana, T and Rao Madhava, K. S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7. Snedecor, G.W and Cochran, W.G. (1967) Statistical Methods. Iowa State University Press.

Semester 5

Course code : STA508

Course Name : DESIGN OF EXPERIMENTS 2

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

Course Level : 300-399

Number of Contact classes : 60

Number of Non contactclasses : 00

Course Objective: This course has the objective of providing student the knowledge of art of analysis of field experiments

Learning Outcomes: At the end of the course, students shall be able to understand the different types of commonly used field experimental techniques.

Course Outcome:

CO1: Recall fixed, random and mixed effect models, analysis of variance (one way and two way), principles of design of experiments, basic designs: CRD, RBD.

CO2: Discuss analysis of covariance, RBD with more than one observation per cell, Latin Square Design (LSD), analysis with missing observations,

CO3: Discuss factorial experiments 2^n and 3^n

CO4: Explain in factorial experiment.

Unit 1: Analysis of Variance: (No. of classes: 12, Weightage : 20 %)

1. Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models.

Unit 2: Design of Experiments (No. of classes: 24 , Weightage : 40 %)

Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, choice of size and shape of plots and blocks. Review of

Completely Randomized Design (CRD), Randomized Block Design (RBD) – one observation and more than one observations per cell, Latin Square Design (LSD) – layout, model and statistical analysis.

Unit 3: Factorial Experiments: (No. of classes: 18, Weightage : 30 %)

Factorial experiments : advantages, notations and concepts, 2^2 , 2^3 , and 3^2 factorial experiments, design and analysis,

Unit 4: Practical: (No. of classes: 15, Weightage : 25 %)

Practicals from unit 1, 2 and 3

SUGGESTED READING:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.
4. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
5. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley
6. Goon, A.M., Gupta, M.K., Das Gupta, B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.

Semester 6
Course code : STA607
Course Name : Sampling Distributions and Test of Significance
Credits: 4 (Theory: 03 credits, Practical/Lab: 01 credit)
Course Level : 300-399
Number of Contact classes : 60
Number of Non contactclasses : 00

Course Objective: This course will enable students to infer about the population characteristics, based on the corresponding sample analogues. Since the sample quantities are random, it is required to find their exact or asymptotic probability distributions.

Learning Outcomes: At the end of the course, students shall be able to understand the concepts of variability in sample measures and their distributions.

Course Outcome:

CO1: Define random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion.

CO2: Discuss exact sampling distributions viz: chi square, t and F and its application in real life scenario.

CO3: Illustrate the concept of large sample tests, testing single proportion, difference of two proportions, single mean, difference of two means.

CO4: Compare central and non central sampling distributions. Distinguish between small and large sample tests.

Unit 1: Sampling Distributions: (No. of classes: 06, Weightage: 10%)

Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion.

Unit 2: Exact sampling distributions- Chi square distribution:

(No. of classes: 12, Weightage: 20%)

Definition, p.d.f. of χ^2 with n degrees of freedom (d.f.) (Without derivation), nature of p.d.f. curve for different degrees of freedom, mean, variance,

m.g.f., mode, additive property and limiting form of χ^2 distribution. Applications of this distribution, Tests of significance and confidence intervals based on distribution.

Unit 3: Exact sampling distributions- t distribution:

(No. of classes: 12, Weightage: 20%)

Student's and Fishers t- distribution: pdf of Student's and Fishers t distribution (Without derivation), nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution, Applications of this distribution.

Unit 4: Exact sampling distributions- F distribution:

(No. of classes: 12, Weightage: 20%)

Snedecor's F -distribution: pdf (without derivation), nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n_1, n_2)$. Relationship between t, F and χ^2 distributions, Applications of this distribution. Test of significance and confidence Intervals based on t and F distributions.

Unit 5 : Large sample tests

(No. of classes: 03, Weightage: 5%)

Large sample tests, testing single proportion, difference of two proportions, single mean, difference of two means.

Unit 6: Practical: (No. of classes: 15, Weightage: 25%)

Practicals from unit 2,3,4, 5

SUGGESTED READING:

1. Goon, A.M., Gupta, M.K. and Dasgupta, 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.

Semester 6
Course code : STA608
Course Name : Applied Statistics
Credits: 4 (Theory: 03 credits, Practical/Lab: 01 credit)
Course Level : 300-399
Number of Contact classes : 60
Number of Non contact classes : 00

Course Objective: This course has the objective of exposing students the different domains of applied statistics.

Learning Outcomes: At the end of the course, students shall be able to understand how statistics is directly applied in economic analysis, govt. and society.

Course outcomes:

CO1: Define and construct index numbers of prices and quantities (Laspeyres', Paasche's, Fisher's and Marshal-Edgeworth's).

CO2: Outline the organisations involved in official data collection in India along with major publications on such official statistics in India.

CO3: Explain the importance of statistical methods in industrial research and practice, how tolerance limits are determined, chance and assignable causes of variations in quality, prepare various control charts for process and product control.

CO4: Explain various methods of fertility, mortality and reproduction, construction of life tables.

CO5: Use various methods like method of free-hand curve, moving average method, method of semi-averages and method of least squares to measure trend and method of ratio to trend to measure seasonal variations, fit k-variable regression model.

Unit 1: Time Series: (No. of classes: 9, Weightage: 15%)

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, moving average method and method of least squares (linear only), Measurement of seasonal variations by method of ratio to trend.

Unit 2: Index Numbers: (No. of classes: 9, Weightage: 15%)

Index numbers: Definition, Uses and limitations of index numbers.

Criteria/tests for a good index number.

Different types of index numbers- price, quantity, value. Wholesale price index number.

Construction of index numbers of prices and quantities – Laspeyres' , Paasche's, Fisher's Index numbers.

Consumer price index number.

Unit 3: Statistical Quality Control: (No. of classes: 9, Weightage: 15%)

Statistical Quality Control: Importance of statistical methods in industrial research and practice. Rational subgroup., Determination of tolerance limits. Causes of variations in quality: chance and assignable.

General theory of control charts, process & product control, Control charts for variables: X-bar, R-charts. Control charts for attributes: p and c-charts.

Unit4: Demography and official Statistics: (No. of classes: 9, Weightage: 15%)

Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates. Complete life (mortality) tables.

Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.

Present Official Statistical System in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission.

Unit 5: Regression Analysis: (No. of classes: 9, Weightage: 15%)

Bivariate linear regression model- fitting, estimation of regression coefficients, Testing significance of regression coefficients (without proof). Computation of R-square.

Unit 6 : Practical from Unit 1, 2 and 3 (No. of classes: 15, Weightage: 25%)

SUGGESTED READING:

1. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.
3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edition (Reprint), Sultan Chand & Sons.
4. Montgomery, D.C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
5. Mukhopadhyay, P. (1999): Applied Statistics, Books and Allied (P) Ltd.
6. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition, World Press.
7. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
8. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
9. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag New York.