DEPARTMENT OF STATISTICS

GAUHATI UNIVERSITY

Four Year Undergraduate Syllabus in Statistics under NEP

Effective from Academic Year 2023 – 24

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.

Unit1: 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.

7. Artin, M.: Algebra. Prentice Hall of India, 1994.
8. Datta, K.B.: Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., 2002.
9. Hadley, G.: Linear Algebra, Narosa Publishing House (Reprint), 2002.
10. Searle, S.R.: Matrix Algebra Useful for Statistics. John Wiley & Sons., 1982.

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

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 .

Semester 5

Course code : STA501

Course Name : Sampling Distributions and Test of Significance

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

Course Level : 300-399

Number of Contact classes : 60

Number of Non contact classes : 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.

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: 18, Weightage: 30%)

Definition and derivation of p.d.f. of $\chi^2$with n degrees of freedom (d.f.) using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2distribution.Applications of this distribution, Tests of significance and confidence intervals based on distribution. Non central chi square distribution (derivation of pdf).

Unit 3: Exact sampling distributions- t distribution:

(No. of classes: 18, Weightage: 30%)

Student's and Fishers t- distribution, Student's and Fishers t distribution, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution, Applications of this distribution. Non Central t distribution (with derivation of pdf)

Unit 4: Exact sampling distributions- F distribution:

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

Snedecor's F -distribution: Derivation of p.d.f., 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. Non Central F distribution (with derivation of pdf)

Unit 5 : Large sample tests (No. of classes: 06, Weightage: 10%)

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

SUGGESTEDREADING:

1. Goon, A.M., Gupta,M.K. and Dasgupta, B. (2003): AnOutline 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 : Kishore Kr Das, Rajan Sarma, Dept of Statistics, GU .

Semester 5

Course code : STA502

Course Name : Statistical Inference-2

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

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

Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Minimum variance unbiased estimator (MVUE). Cramer-Rao inequality and MVB estimators.

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

Unit 2 : Hypothesis Testing II (No. of classes: 24 Weightage: 40%)

Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region- harder problem and concepts (over and above what is covered in unit 3 of paper STA 201). Testing of hypothesis based on traditional and p-value approach

MP test, UMP test, unbiased test, Neyman Pearson Lemma (with proof) and it use, power curve. Likelihood ratio test, properties of likelihood ratio tests (without proof).

Unit 3: Non-parametric Tests: (No. of classes: 12, Weightage: 20%)

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, Kruskal-Wallis test – all without derivation.

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.

Course designed by : Rajan Sarma, Jagriti Das, Sahana Bhattacharjee, Dept of Statistics, GU .

Semester 5
Course code : STA503
Course Name : DESIGN OF EXPERIMENTS 2
Credits: 4 (Theory: 04 credits, Practical/Lab: 00 credit)
Course Level : 300-399
Number of Contact classes : 60
Number of Non contact classes : 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.

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, relative efficiency, analysis with missing observations (one missing observation), Split Plot Design, Strip Plot Design.

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

Factorial experiments : advantages, notations and concepts,2^2, 2^3, . . . , $2^n$and 3^2 factorial experiments, design and analysis, Total and Partial confounding for $2^n(n \leq 5)$. 3^2experiment.

Unit4: Regression Analysis: (No. of classes: 06, Weightage : 10%)

Simple regression analysis, Estimation and hypothesis testing in case of simple regression models.

SUGGESTEDREADING:

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, 8thEdn. 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.

Course designed by : Arpita Basak, Paramita Roy, Dept of Statistics, GU

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Semester 5
Course code : STA504
Course Name : Practical 5
Credits: 4 (Theory: 00 credits, Practical/Lab: 04 credit)
Course Level : 300-399
Number of Contact classes : 60
Number of Non contact classes : 00

Course Objective: This course has the objective of teaching students how to apply concept of statistical inference and field experiments in practice.

Learning Outcomes: At the end of the course, students shall be able to practically apply field experimentation techniques as well as sampling techniques.

Note: Students can use (Calculator/ Ms Excel/R Programming)

Practicals from the following :

(a) Units 2-5 of paper 501 (No. of classes: 12 Weightage: 20%)

(b) Units 2 and 3 of 502 (No. of classes: 24 Weightage: 40%)

(c) Units 2-4 of 503 (No. of classes:24 Weightage: 40%)

SUGGESTED READING:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol.
II, 8thEdn. World Press, Kolkata.
2. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
3. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

Course designed by : Dept of Statistics, GU .

Semester 6
Course code : STA601
Course Name : Applied Statistics
Credits: 4 (Theory: 04 credits, Practical/Lab: 00 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.

Unit 1: Time Series: (No. of classes: 12 , Weightage: 20%)

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, method of semi-averages and method of least squares (linear, quadratic and modified exponential), Measurement of seasonal variations by method of ratio to trend.

Unit 2: Index Numbers: (No. of classes: 12 , Weightage: 20%)

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, Index of Industrial Production.

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

Consumer price index number.

Unit 3: Statistical Quality Control: (No. of classes: 12 , Weightage: 20%)

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 and sigma chart. Control charts for attributes: p and c-charts. Product control – basic ideas of Single sampling and double sampling plans .

Unit4: Demography and official Statistics: (No. of classes: 12, Weightage: 20%)

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. Life (mortality) tables: definition of its main functions and uses – differences between complete and abridged life table.

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. Government of India's Principal Publications containing data on the topics such as population, Industry, Economy, Development and Finance.

Unit5: Demand Analysis: (No. of classes: 12, Weightage: 20%)

Demand Analysis: Theory of consumption and demand, demand function, elasticity of de-mand, determination of elasticity of demand by family budget method, Lorentz curve and Gini's coefficient, Engel's law and Engel's curve, Pareto's law of income distribution.

SUGGESTEDREADING:

1. Mukhopadhyay,P.(1999):AppliedStatistics,NewCentralBookAgency,Calcutta.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II,9thEditionWorldPress,Kolkata.
3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edition(Reprint), Sultan Chand & Sons.
4. Montogomery,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.

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

Semester 6

Course code : STA602

Course Name : Bivariate/Multivariate Analysis, Stochastic Process and Computer Programming

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

Course Level : 300-399

Number of Contact classes : 60

Number of Non contact classes : 00

Course Objective: Students have to move from univariate to higher dimensional analysis. Moreover, this course will enable students to understand the transition from fundamental probability theory to stochastic process. It covers the structure of discrete time and continuous time stochastic process. This course will also expose students to elements of programming logic.

Learning Outcomes: On completion of the course, students will be able to understand the basics of stochastic process, Markov models, Poisson process and its applications, learn the analysis of higher dimensional random variables. They will also be able to write basic computer programs.

Unit 1: Bivariate Distributions: (No. of classes: 12, Weightage: 20%)

Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN.

Unit 2: Multivariate Normal Distributions:
(No. of classes: 12, Weightage: 20%)

Multivariate Data: Random Vector: Probability mass/ density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.

Multivariate Normal distribution and its properties. Marginal and conditional distribution, Sampling distribution for mean vector and variance- covariance matrix without derivation). Hotelling T^2–concept and applications.

Unit 3: Computer Programming in C (No. of classes: 12, Weightage: 20%)

History and importance of C. Components, basic structure programming, character set, C tokens, Keywords and Identifiers and execution of a C program. Data types: Basic data types, Enumerated data types, derived data types. Constants and variables: declaration and assignment of variables, Symbolic Constant.

Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression.
library functions. Decision making and branching - if…else, nesting of if…else, else if, . Looping in C: for, nested looping.

Unit 4: Stochastic Process (No. of classes: 24, Weightage: 40%)

Stochastic Process: Introduction, Stationary Process. Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains. Poisson Process: postulates of Poisson Process, properties of Poisson Process with applications.

SUGGESTEDREADING:

1. Anderson,T.W.(2003):AnIntroductiontoMultivariateStatisticalAnalysis,3rd Edn.,JohnWiley.
2. Muirhead,R.J.(1982):AspectsofMultivariateStatisticalTheory,JohnWiley.
3. Kshirsagar, A.M.(1972):MultivariateAnalysis,1stEdn.MarcelDekker.
4. Johnson, R.A. and Wichern, D.W.(2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall.
5. Mukhopadhyay, P.: Mathematical Statistics.
6. Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition, Tata McGraw Hill.
7. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
8. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.

Course designed by : Amit Choudhury, Kishore Kr Das, Pallabi Medhi, Dept of Statistics, GU .

Semester 6

Course code : STA603

Course Name : Operations Researach

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

Course Level : 300-399

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.

Unit 1: Linear Programming Problem: (No. of classes: 18, Weightage: 30%)

Linear Programming Problem, Mathematical formulation of LPP, Graphical solution of an LPP, Simplex procedure for solving LPP (without derivation) (three more variables variable) , slack and surplus variable

Unit 2: Transportation problem: (No. of classes: 06 , Weightage: 10%)

Transportation Problem, Initial solution by North West corner rule, Least cost method

Unit 3: Replacement problem: (No. of classes: 12 , Weightage:20%)

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

Unit 4: Network problems-CPM & PERT: (No. of classes: 18 , Weightage: 30%)

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 5 : Inventory Control: (No. of classes: 06, Weightage:10%)

Inventory Management: ABC inventory system, characteristics of inventory system. EOQ Model and its variations (with and without shortages).

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

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

Semester 6
Course code : STA604
Course Name : Practical-6
Credits: 4 (Theory: 00 credits, Practical/Lab: 04 credit)
Course Level : 300-399
Number of Contact classes : 60
Number of Non contact classes : 00

Course Objective: This practical level course has the objective of providing student hands on training on application of skills of operations research and applications of Statistics.

Learning Outcomes: At the end of the course, students shall be able to use techniques of operations research to attain optimality as well as apply applied statistical techniques to field levels problems in industry, govt and society.

Practicals on the following:

(a) all units of STA601(Applied Statistics) (No. of classes: 30 Weightage: 50%)

(b) all units of STA603(Operations Research) (No. of classes: 30 Weightage: 50%)

Reference books :

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
5. Parimal Mukhopadhyay, Applied Statistics

Course designed by : Dept of Statistics, GU .