Tribhuvan University
Institute of Science & Technology

Statistics

Level: B.Sc.
Year: II
Course Title: Probability and Inference-I
Course Code: STA 201 Full Marks:100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

Course objectives: To impart theoretical and applied knowledge in probability distributions and statistical inference

---

Group A

1 Probability Distributions

1.1 Discrete Distributions: [15]

- Negative binomial distribution (NBD): PMF, MGF, CF, moments, properties and uses, distribution fitting, geometric distribution as a special case of NBD
- Hypergeometric distribution: PMF, moments, properties and uses, distribution fitting
- Negative hypergeometric distribution: PMF and moments (mean and variance only), uses
- Problems and illustrative examples

1.2 Continuous Distributions: [20]

- Cauchy distribution: PDF, CDF, MGF and moments (if exists), CF, uses
- Laplace distribution (Double Exponential): PDF, CDF, MGF, CF, moments, uses
- Beta distribution: PDF, CDF, MGF, moments, properties and uses
- Gamma distribution: PDF, CDF, MGF, CF, moments, properties and uses
- Negative Exponential distribution: PDF, CDF, MGF, CF, moments, properties and uses, distribution fitting
- Problems and illustrative examples

1.3 Bivariate Distributions [10]

- Notion of bivariate random variable
- Bivariate distributions (discrete and continuous variables): Joint, marginal and conditional distributions, independence of random variables
- Transformations of random variables: Jacobian of transformations, distributions of sum, product and ratio of random variables
- Problems and illustrative examples

1.4 Sampling Distributions [30]

- Definition of a random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of the sample mean, proportion and sample variance (with consideration of SRS with/ without replacement) standard errors of sample mean and proportion, independence of sample mean and sample variance
- Estimation of sample sizes for the test of mean, proportion and variance.
- Exact sampling distributions: Canonical definitions of central χ^2, t and F random variables, derivations of the probability distributions of central χ^2, t and F
- Characteristics and properties of central χ^2, t and F distributions, their moments, inter-relations between the distributions
- Applications of χ^2, t and F distribution in statistics
- Problems and illustrative examples

Group B

2. Theory of Estimation [33]

- Concept of convergence
- Point estimation: Estimation of parameters
- Properties of a "Good" estimator: unbiasedness, consistency, efficiency and sufficiency and completeness
- Likelihood function and its properties
- Methods of estimation: Maximum likelihood estimation of parameters of binomial, Poisson and normal distribution
- Properties of maximum likelihood estimate
- Method of moments, method of minimum chi-square, method of minimum variance and method of least squares
- Cramer-Rao Inequality, Rao-Blackwell theorem, Lehmann Scheff theorem
- Interval estimation: Confidence interval and confidence coefficient, method for obtaining confidence limits, confidence interval of mean, proportion, variance and difference between means, uniformly shortest confidence interval, large sample confidence intervals
- Problems and illustrative examples

3. Theory of Hypothesis Testing [17]

- Statistical hypothesis, simple and composite hypotheses, test of statistical hypothesis: null and alternative hypotheses, type I and type II errors, level of significance, critical region, power of the test, one tailed and two tailed tests
- Neyman-Pearson's fundamental lemma, simple null vs. simple alternative hypothesis, most powerful (MP) test and construction of critical region, mean and variance of transformed distribution.
- Problems and illustrative examples

4. **Non-parametric Tests [25]**

- Differences between parametric and nonparametric tests; Nonparametric tests: their advantages and disadvantages over parametric tests
- One-sample test: Binomial test**,** median test, sign test, Kolmogorov–Smirnov test and Anderson-Darling test, Run test, Mann Whitney U test, Kruskal Wallis test
- Paired-sample test: Wilcoxon signed rank test
- Two-sample test: Median test and Kolmogorov-Smirnov test
- *K*-sample test: chi-square test, median test, Cochran's Q test and Friedman two way analysis of variance test
- Problems and illustrative examples

References:

1. Gupta S. C. and Kapoor V. K. (2007). *Fundamentals of Mathematical Statistics,* Sultan Chand and Sons
2. Shrestha H. B. (2006). *Statistics and Probability: Concepts and Techniques*, Second Edition, EKTA Books
3. Rohatgi V. K. and Ehsanes Saleh, A. K. MD (2005). *An Introduction to Probability and Statistics*, John Wiley & Sons
4. Mayer, P. L. (1970). *Introductory Probability and Statistical Applications*, second edition Oxford and IBH Publishing Co. Pvt Ltd, New Delhi.
5. Shrestha, H.B., *Statistical Inference*, Ekta Books, Latest Edition
6. Rohatgi, V. K. (1984). *Statistical Inference*, Wiley, New York
7. Hogg R.V and Criag, A.T. *Introduction to mathematical statistics,* 3rd edition, Academic Press, USA
8. *Sukubhattu*, N. P. (2063 BS). *Probability Theory and Statistical Methods,* 2nd edition, Asmita Publications, Kathmandu
9. Gibbons, J.D. and Chakrabarthi, S (1992). *Non-parametric Statistical Inference* (Third Edition)

Tribhuvan University
Institute of Science & Technology
Statistics

Level: B.Sc. | Full Marks: 50
Year: II | Pass Marks: 20
Course Title: Probability and Inference-I | Total Number of Periods:180
Course Code: STA 202 | Nature of the Course: Practical

Pre-requisites: Sound knowledge in the topics of Probability and Inference-I

Course objectives:

- To develop computational skills in probability and inference
- To understand and apply theoretical knowledge in practical and numerical problems and thus relate theory with practice confidently

---

Title of the practical problems:

S. No.	Title of the practical problem	No. of problems
1	Discrete probability distributions (Negative binomial, hypergeometric and negative hypergeometric)	3
2	Continuous probability distributions (Beta, gamma, negative exponential)	3
3	Joint, marginal and conditional distributions, distributions of sum, product and ratio of random variables	3
4	Sampling distributions of the sample mean and sample variance (random sampling with and without replacement) and standard error of sampling mean and variance ct sampling	2
5	Computation of sample size	1
6	Exact sampling distributions (chi-square, t and F)	2
7	Problems of methods of estimation	2
8	Problem in interval estimation	1
9	Problems in hypothesis testing	2
10	One sample test (Wilcoxon signed rank test , Kolmogorov–Smirnov test and Anderson-Darling test)	2
11	Two sample test (Median test and Kolmogorov-Smirnov test)	2
12	Several sample test Cochran's Q test and Friedman two way analysis of variance test)	2
	Total number of practical problems	**25**

Tribhuvan University
Institute of Science & Technology
(**Applied Statistics, Compulsory Paper**)

Level: B.Sc.
Year: II
Course Title: Applied Statistics
Course Code: APS 203 — Full Marks: 50
Nature of the Course: Theory — Pass Marks: 17.5
Total Number of Periods: 75

Course objectives: To impart the knowledge of descriptive as well as inferential analysis exclusively in solving numerical problems in applied set up.

---

1. **Methods of Data Summarization:** Review of basic concept of Statistics, Scales of measurement, data distribution, diagrammatical and graphical presentation of data, measures of central tendency, measures of dispersion, measures of skewness, measures of kurtosis. Numerical problems related to physical and biological sciences. **[10]**

2. **Correlation:** Karl Pearson's correlation, Spearman rank correlation, Kendal Tau correlation. Numerical problems related to physical and biological sciences. **[5]**

3. **Methods of Data Modeling:** Principles of Ordinary Least Squares (OLS), linear regression up to three variables, methods of fitting of first and second degree equations, exponential curves, partial and multiple correlations, analysis of residuals, Fisher decomposition of total sum of squares, coefficient of determination and its interpretation. Numerical problems related to physical and biological sciences. **[13]**

4. **Analysis of Categorical Data:** Class frequencies, relation between class frequencies, consistence of data, condition for consistency of data, independence and association of attributes, Yule's method and coefficient of contingency, Yule's coefficient of colligation, Pearson's coefficient of contingency and their interpretation. Numerical problems related to physical and biological sciences. **[8]**

5. **Introduction to Probability:** Basic concept of probability, fundamental rules of probability, marginal, joint and conditional probabilities (Concepts and applications only focusing on numerical problems related to physical and biological sciences) **[5]**

6. **Probability distributions:** Binomial distribution, Poisson distribution, Normal distribution (characteristics and applications without derivation focusing on numerical problems related to

physical and biological sciences) **[6]**

7. **Estimation:** Point & interval estimation, confidence interval for mean and proportion, determination of sample size, relationship of sample size with desired level of error Numerical problems related to physical and biological sciences **[3]**

8. **Hypothesis Testing :** Types of statistical hypotheses – null and alternative hypothesis, type I and type II errors, level of significance, critical value and critical region, concept of p–value and use of p-value in hypothesis testing, steps used in testing of hypothesis, one sample tests for mean of normal population (for known and unknown variance), test for proportion, test for difference between two means and two proportions, paired sample t-test, two independent sample tests for variances of normal populations, relationship between hypothesis testing and confidence interval, one way and two way ANOVA, test of significance of simple correlation and regression coefficients. Numerical problems related to physical and biological sciences **[20]**

9. **Nonparametric tests:** Needs of applying non-parametric tests, short introduction of the alternative tests of parametric tests, Chi-square test for independence of attributes and test for goodness of fit (Focusing on numerical problems related to physical and biological sciences). **[5]**

References:

1. Harry Frank & Steven C. Althoen (1995). *Statistics concepts and applications*, Cambridge University Press (Low price edition).
2. Murray R. Spiegel & Larry J. Stephens (2000). *Statistics (Schaum's outlines),* Tata McGraw-Hill Publishing Company Ltd, New Delhi, India
3. Sidney Siegel & N. John Castellan (1988). *Nonparametric Statistics for Behavioral Sciences*, McGraw-Hill Publications
4. S.C. Gupta & V.K. Kapoor (2001). *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi India
5. Shrestha, S.L. (2010). *Statistical Methods, for environment, Biological and Health Sciences*, Ekta Books, Kathmandu, Nepal
6. Sthapit Azaya, Yadav Rashinder, Khanal Shankar, Dangol Prakash(2014). *Applied Statistics*, Ashmita Publication, Kathmandu, Nepal
7. J. N. Kapoor & H.C. Saxena (2001). *Mathematical Statistics*, S.Chand & Company Ltd., New Delhi, India.