Institute of Science and Technology

Master of Arts/Master of Science in Statistics

M.A./M.Sc. Statistics

Curriculum

1999

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M.A./M.Sc.Statistics

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Kathmandu, Nepal

Introduction:

To start with, the syllabi prescribed at the Master level education were similar to those prescribed in most of the Indian universities and the total courses were spread over eight papers, each consisting of 100 marks. In 1988, Tribhuvan university felt the need to improve the syllabus and increase the total number of papers from eight to nine. Accordingly, the Masters level syllabi have been upgraded by incorporating new topics.

In 1996, the structure of Bachelor level education was made to be of three years' duration. The objective of the change was to make the Bachelor level as a terminal level for most of the students and make its academic standard equivalent to the honors levels on a par with the syllabi that are in prescription in the mainstream universities of the SAARC region. The extension of one more academic year at the Bachelor's level called for inclusion of greater coverage in the syllabus content. The deficiency has been removed by including many of the topics from the first year Master level course. This naturally led to the urgent need for upgrading Master level courses. Tribhuvan University instructed its subject committees to prepare a new syllabus by extending the number of papers from nine to ten papers.

The present M.A./M.Sc. statistics syllabus has been prepared accordingly. While preparing the syllabus, great care has been taken to make it relevant to the country's manpower needs. The country needs manpower that are not only quite knowledgeable about the theory aspect but also very competent to put the theory into practice. This is the guiding principle adopted in preparing present syllabus.

Objectives :

The broad objective of the syllabus is to produce high level manpower in statistics in terms of experts and specialists who are quite competent in performing statistical activities on their own. There are different areas of statistical activities. The first is to propagate and develop statistical techniques. The second is to prepare and present "statistics" as sets of data, which are indisputable, continuously connected and comparable. The third activity is to explain, analyze and establish the cause and effect relations of variables of both physical and non-physical phenomena.

Thus specific objectives are:

- To produce high level manpower in the field of Statistics who are well versed in statistical knowledge to work as teachers, academics and specialists that can undertake activities for the furtherance of statistical knowledge;
- To produce official statisticians, who are competent in making collection and presentation of authentic data so as to support the planners in making programs to fulfill the basic needs of the population;
- To produce research officers who are quite competent in formulating research designs, information analysis and inference making.

Eligibility for Admission:

Students who have passed Bachelor level education with Statistics as one of the major subjects or an equivalent degree course from Tribhuvan University from any other university recognised by Tribhuvan University are eligible for admission to the M. Sc. course in Statistics.

Admission Criteria:

An applicant seeking admission to M.Sc. Statistics must appear in an Entrance Examination of two hours' duration conducted by the Central Department of Statistics / Campus. The applicant who fails to obtain a minimum qualifying score will not be granted admission. A merit list of the qualified applicants will be prepared on the basis of their score in B. Sc. Examination and the marks obtained in the Entrance Examination. Admission of the students will be based strictly on the merit list and on the enrollment capacity of the Central Department of Statistics / Campus.

Course Structure:

The entire M. Sc. course in Statistics will be of two academic years. The whole course is divided into two parts, each of one year's duration and carrying a total of 500 marks.The first year (Part I) comprises four theory papers each of 100 marks, one theory paper of 50 marks and one practical paper of 50 marks. In the second year (Part II) three theory papers each of 100 marks and one practical paper of 50 marks are compulsory. The students will have to choose any three of the elective papers, each of 50 marks, from among the given five elective subjects.

First Year

Compulsory:

S.N	Course No	Title	Full Marks	Pass Marks
1	Stat. 511	Mathematics for Statistics	100	40
2	Stat. 512	Probability Theory	100	40
3	Stat. 513	Inference	100	40
4	Stat. 514	Mathematical Demography	100	40
5	Stat. 515	Social Research Methodology	50	20
6	Stat. 516	Practical 1st Year	50	20

Second Year

a) Compulsory:

S.N	Course No	Title	Full Marks	Pass Marks
1	Stat. 611	Stochastic Process	100	40
2	Stat. 612	Multivariate Analysis	100	40
3	Stat. 613	Sampling and Design of Experiment	100	40
4	Stat. 614	Practical 2nd Year	50	20

b) Elective:

S.N	Course No	Title	Full Marks	Pass Marks
Any three of the following optional papers				
1	Stat. 621	Econometrics	50	20
2	Stat. 622	Bio-Statistics	50	20
3	Stat. 623	Quality Control and Sampling Inspection	50	20
4	Stat. 624	Non-parametric Statistics	50	20
5	Stat. 625	Agriculture Statistics	50	20

The above-mentioned Master level curriculum intends to provide the students with a strong background knowledge of statistics in theory and practice.

Course Duration : The entire course is spread over two academic years.

Working Days: 150 days in one academic year.

Class Hours:

Theory: One theory paper of 100 marks will have 6 hours' and that of 50 marks will have 3 hours' lectures per week.

Practical: One practical paper of 50 marks will have 6 hours' practical work per week.

Attendance: Seventy percent attendance in the class is compulsory.

Examination:

There will be 4 hours' examination for a theory paper of 100 marks and 2 hours' examination for a theory paper of 50 marks. One practical paper of 50 marks will have three hours' examination.

In practical papers (computational statistics), examinations are conducted by the concerned department with the approval of the Dean's Office. The duration of practical examination for a paper of 50 marks will be 3 hours. An external examiner appointed by the Dean's office and internal examiner appointed by the concerned Campus/ Central Department will conduct the practical examination and evaluate the performance of students on the following basis:

1) Viva 20%
2) Records of practical problems 20%
3) Problems solving examination 60%

Evaluation : Central level annual examination for both the first year and second year courses is the basic criterion for the evaluation of the performance of students in theoretical papers. Minimum marks to pass a paper is 40% and the students have to pass each paper as prescribed in the course separately.

A student who passes two years of study is graded on the basis of two years' average marks as follows:

75 percent and above Distinction
60 percent and above Frist Division
50 percent and above Second Division
40 percent and above Third Division

Mathematics for Statistics
First Year

Course Title:- Mathematics for Statistics — Full Marks:-100
Course No:- Stat 511 — Pass Marks:-40
Nature of the course:-Theory — Year:- 1st Year

Course Objective:- This course enables the students to acquire sufficient knowledge of mathematics needed for further study of the advanced theory in statistics. Students also develop their competence in applying mathematical techniques to solving practical problems in statistics.

Course Contents:

Group A

Functions, Sequence, Limits inferior and Superior; Jacobian transformation; Riemann & Riemann Stieltjes integral. Approximate integration. Multiple integral, Integration in R^n space with special reference to R^2 & R^3 space, Improper integral. Convergence of Beta & Gamma integrals, Point-wise & uniform convergence, Interchange of Limits, Convergence of infinite series, Power series, Fourier series & their applications, Compact set, Heine-Borel theorem, Metric space, Complete separable metric space, Cantor's theory of real numbers. **60 hrs**

Group B

Extrapolation, Interpolation, Problem of interpolation, Finite differences, Newton's forward & backward interpolation formula, Lagrange's interpolation formula, Use of operations Δ & E. Difference and differential equations up to n^{th} degree with problems related up to 3^{rd} degree. **30 hrs**

Group C

Basic concept of vector space. Orthogonal projection.; Linear equations and related theorems, Linear independence and Euclidean inner product, Distance and normalization vector, Gram-Schmith theorem, Matrix operations, Inverse of partition matrices, Elementary matrices, Rank of matrix, Theorems on rank of a matrix, Diagonal Reduction of a matrix, Trace of a matrix, Special products of matrices, Inverse and generalized inverse, Classification and transformation of quadratic forms, Canonical reduction of a matrix, Decomposition (Spectral etc) of matrices, Projection operations, Eigen values and Eigen vectors and their properties. **60 hrs**

References:

1. Bartlett, R.G. and Sherbet, D.R.. (1994). *Introduction to Real Analysis, 2nd edition*, John Wiley and Sons ,Pvt. Ltd., New York
2. Rao, C.R. (1985), *Linear Statistical Inference and Its Application*., 2nd edition, Wiley Eastern Limited, New York
3. Biswas, S. (1993), *A textbook of Matrix Algebra*, Khanna Publishers. India

Probability Theory

Course Title:- Probability Theory — Full Marks:-100
Course No:- Stat 512 — Pass Marks:-40
Nature of the course:-Theory — Year:- 1st Year

Course Objective:- After completion of this course the students are expected to have an understanding of recent developments and new theories in this area.

Course Contents:

Group A

Limit of sequence of sets, Ring, Field of sets, Monotone classes. Minimal class, Borel field, Set function, Additive set function, Inverse function ,Measure, Measure space, Measurable set, Measurable function. **15 hrs**

Group B

Axiomatic approach to Probability, Probability function and its properties, Probability space, Probability distribution of a general random variable, Conditional probability, Independence of sequence of events, Borel Centelli lemma, Urn Model, Occupancy problems, Polya's urn model, Distribution function, Expectation, conditional expectation and their properties; Negative Exponential distribution, Waiting time distribution, Power series, Properties of negative exponential distribution, Truncation of continuous Distribution. (Normal) **60 hrs**

Group C

Random vectors, Function of Random vectors and their distributions. Order statistics and their distributions, Asymptotic distribution of k^{th} order statistic. Convergence in sequence of random variables, convergence theorems in probability (Convergence almost sure, convergence in distribution, convergence in quadratic mean). **37 hrs**

Group D

Holder's inequality, Jenson's inequality, Markov's inequality and Minkowski's inequality; Characteristic function of a random variable. Inversion formula and Uniqueness theorem, Khinchine's inequality, Weak law of large numbers, Kolmogorov's inequality. Strong Law of large numbers, Kolmogorov's theorem, Central limit theorem;Lindeberg-Levy and Liapounov's form. **38 hrs**

References:

1. Feller, W. (1968), *An Introduction to Probability theory and its application, Vol. I* ,John Wiley, New York
2. Meyer, Paul. (1972), *Introductory Probability and Statistical Applications*, Esley, U.K
3. Parzen, E. (1972), *Modern probability Theory and its Applications*, John Wiley Publication, New York
4. Bhat, B. R. (1985) , *Modern Probability Theory, 2nd Edition* ,Wiley Eastern Limited, India
5. Biswas, S. (1991), *Topics in Statistical Methodology*, Wiley Eastern Limited, India

6. Rohatgi, V.K. (1985) , *An Introduction to Probability theory and Mathematical Statistics*, Wiley Eastern Limited, India
7. Sheldom, Ross (1984), *A First course in Probability, 2nd edition*, Macmillan Publishing company, U.K.
8. Fisz, M. (1963) , *Probability and Mathematical Statistics* , John Wiley, New York
9. Gedenko, B (1976), *The Theory of Probability*, Mir Publication, Moscow.
10. Hoel, Porti and Stone (1971), *Introduction to Probability Theory*, Mifflin Company. New York
11. Johnson, N.C. and Kotz, S. (1970), *Distribution in Statistics Vol. I and Vol. II* ,John Wiley and Sons, New York.

Inference

Course Title:- Inference
Course No:- Stat 513
Nature of the course:-Theory

Full Marks:-100
Pass Marks:-40
Year:- 1st Year

Course Objective:- The objective of this course is to impart to the students the know-how about the statistical decision-making process. After completing this course, the students will have sufficiently enhanced their knowledge and skill in decision making ability.

Course Contents:

Group A

Sampling Distribution; Non Central t, F and x^2distributions. Likelihood functions - Exponential family with k-parameters **15 hrs.**

Group B

Estimation: Point Estimation- Minimum Variance unbiased estimators; Cramer-Rao Inequality. Rao -Blackwell Theorem. Completeness, Lehmann-Scheffe Theorem. Methods of Estimation-Method of moments, Method of Maximum likelihood, Properties of maximum likelihood estimators. Ridge Regression, Robust Estimation. Interval Estimation- problems, Shortest-length confidence intervals, Uniformly most accurate confidence interval, Uniformly most accurate unbiased confidence interval, Baye's confidence intervals **38 hrs.**

Group C

Hypothesis Testing: Formulation of null and alternative hypotheses: Simple and composite hypothesis, Power and size of a test, Most power full (MP) and Uniformly most powerful (UMP) tests, Neyman-Pearson Fundamental Lemma, UMP tests in families with monotone likelihood ratio, Concept of unbiasedness in hypothesis testing, Unbiased tests. Relation between interval estimation and hypothesis- testing. Likelihood Ratio Test (LRT)- Its principle and properties, Derivation of LRT for testing means and variances in exponential families, Fisher-Behren's problem, Welsh approach, Scheffe's approach. Sequential Test- Need for sequential tests, Sequential Probability Ratio Test (SPRT). Derivation of SPRT for testing parameters of Normal, Binomial, Exponential and Poisson distributions, Fundamental Identity of Wald' Operating characteristics (OC) and Average Sample Number (ASN) functions. **67 hrs**

Group D

Bayesian Inference: Subjective probability- Prior and Posterior distributions, Baye's estimation in Normal and Binomial distribution. Baye's confidence interval, Baye's testing of hypothesis. **30 hrs.**

References:

1. Rohatgi, V.K (1978), *An Introduction to Probability*, John Wiley Publication, New York
2. Leh,Mann (1968), *Testing of Hypothesis*, John Wiley Publication , New York

Mathematical Demography

Course Title:- Mathematical Demography — Full Marks:-100
Course No:- Stat 514 — Pass Marks:-40
Nature of the course:-Theory — Year:- 1st Year

Course Objective:-The course is intended for the students to consolidate the theory and practical of Demography in analysing human characteristics as well as to make them realise the importance of Demography in the practical field.

Course Contents:

Group A

Population Changes, Theories and Factors, Nature of Demographic studies. Population dynamics and World; Some population theories: Malthus and Cantor's approaches; Dooms and Booms approaches. Some Simple population growth models- Exponential, Logistic. Demographic transition theory. Factors affecting population dynamics- Social factors, Demographic factors and their relationships. Population movement and Migration - Introduction, Technical study of migration. Estimation of migration from direct and indirect data, Determinants of migration process. Estimation of migration from Census and Surveys. Measurement of population redistribution. **30 hrs**

Group B

Demographic Models and Indirect techniques, Types of population; Stationary, Stable, Quasi stable, and Malthusian populations, Mathematical analysis of these populations and their inter-relation ships, Indirect techniques in demography- Its needs and evolution. Application of Indirect technique in estimating demographic variables: Fertility- Coale and Trussel's models, Gompertz's curve. Brass's Comparative fertility model, Estimation of fertility based on information about children ever born, Nature of information on children ever born- Typical errors in data on children ever born. El- Badry correction. Brass's P/F method. Trussel's methods. Increment of cohort parity method. Reverse-Survival methods. Nuptuality- Coale and McNeil model; Mean age at first marriage- its estimation by using Hajnal method, Cohort method, Stable population model, Vande-Wallys method.; Mean age at first child birth.

Mortality-: Estimation of child mortality from information on children ever born and children surviving (Brass's method only). Derivation of a smooth life table from a set of survivorship probabilities. Indirect techniques in estimating life expectancies and Infant moralities, Model life tables- Coale- Demeny for under developed countries. UN's model life table. Logit system. Age distribution- Smoothing and Adjusting of he age distributions by using indirect techniques. Estimation of fertility and mortality by using stable age distribution. **110 hrs.**

Group C

Family Planning, Stochastic models & Population dynamics, Measuring impacts of family planning- Data needs, techniques used and state of affairs in

Nepal. Stochastic models in study of demographic studies. Population dynamics of Nepal and Review of International migration in Nepal **10 hrs.**

Refernces :

1. Singh. M.L ; Sayami, S. B, (1997): *An Introduction to Mathematical Demography*, J.M. Singh and B.D Manandhar, Kathamndu.
2. Singh, M.L.(1995), *Some Measures of Demographic Variables*, Kathmandu
3. O.P, Vig, (1976) , *India's population - A Study through Extension of stable Population Techniques*, Sterling Publishers Pvt. Ltd, India
4. Keyfitz, Nathan (1977). *An Introduction to Mathematics of Population*, Wiley Publishing Company, U.S. A
5. Coale, A. J Coale. (1972), *The Growth and Structure of Human Population*, Princeton University Press. USA.
6. Biswas, Suddhendu, (1988). *Stochastic Process in Demography and Application*, Wiley Eastern Limited, India.

Social Research Methodology

Course Title:- Social Research Methodology — Full Marks:-50
Course No:- Stat 515 — Pass Marks:-20
Nature of the course:-Theory — Year:- 1st Year

Course Objective:- The objective of this course is to provide to the students the knowledge about the detailed steps of research methodology. After completion of this course, the students will be able to carry out social research work independently.

Course Contents:

Group A

Introduction to Social Research Methodology: Nature of social researches and some examples; Planning of Social researches. Problems formulation and hypothesis settings. Objectives and Goal setting. Designs of research - Meaning, purpose and principles, Inadequate designs, Design criterion, Types of researches- Experimental, Ex-posto, Field study and Survey research, Methods of data collection- Observation, Interview, Questionnaire, Schedule methods **22 hrs.**

Group B

Measurement and Scaling: Measurement, Scales, σ, T and Percentile Scores, Standardized score; Reliability and validity, Construction of questionnaire. Scaling of a questionnaire, Social scales- Borogodous scale, Scales used in measuring- Mental health, Stress and strain and their copings; Life changes experiences, Social support, Work Culture; Work-family conflict, Epidemiological depression, Social Reaction, Individualism and collectivism. Sociometry- Semitic differential and Q- methods **30 hrs.**

Group C

Sample Designs, Plans, Data Analysis and Report Presentation: Sample plans and Designs; Data analysis by using Multiple Regression and Factor Analysis, Interpretation and presentation. Projective method, Content analysis, Casual models. Cause and effects analysis. Proposal and Report writings. **23 hrs.**

References:

1. Singh,M.L (1999), *Understanding Research Methodology*, J.M.,Singh, Kathmandu.
2. Kerlinger, F.N (1983), *Foundations of Behavioral Research*, Surjeet Publication, India.
3. Mosar, C and Kalton, G (1979). *Survey Methods in Social Investigation*, Heinman Education Books Ltd., UK

Computation (Practical)

Course Title:- Computation (Practical) Full Marks:-50
Course No:- Stat 516 Pass Marks:-20
Nature of the course:- Practical Year:- 1st Year

Course Objective:- To make the students efficient in statistical computation.

Course Content:

Subject: **Numerical Analysis**

S.N.	Description
1	Newton's Forward and Backward Interpolation
2	Interpolation using Lagrangian method
3	Δ and E difference equations
4	Δ and E differential equations
5	Δ and E differential equations

Subject: **Partition Matrices**

S.N.	Description
1	Inverse of partition matrices
2	Inverse of partition matrices
3	Canonical reduction of matrices
4	Projection operations
5	Eigen values and eigen vectors computations and verification of the properties

Subject: **Probability Theory**

S.N.	Description
1	Estimating conditional and marginal probabilities
2	Estimating conditional mean and variances
3	Estimating parameters in waiting time distribution
4	Estimating parameters in power series distribution
5	Estimating parameters in truncated normal distribution
6	Estimating covariance in random vectors
7	Determining marginal and conditional densities from joint distribution
8	Application of weak law of large numbers
9	Application of Central Limit Theorem
10	Application of strong law of large number

Subject: **Statistical Inference**

S.N.	Description
1	Computing mean and variances of non central distributions
2	Numerical application of Cramer-Rao Inequality
3	Computing shortest length confidence interval
4	Computing uniformly most accurate confidence interval
5	Application of NP lemma in practical exercises
6	Determining unbiased test
7	Likelihood ratio test and its application for test of composite hypothesis

8	Determining the OC curve
9	Determining the ASN
10	Computing Baye's confidence interval and comparison with non Baye's

Subject: **Demography**

S.N.	Description
1	Fitting of population growth models such as exponential and logistics
2	Estimation of migration from census and survey
3	Fitting of Coale and Trussel model in fertility estimation
4	Fitting of Brass P/F model
5	Estimating mean age at marriage
6	Estimating mean age at first child
7	Application of Brass method in estimating child mortality
8	Application of UN model in infant mortality computation
9	Age smoothing by indirect technique
10	Measurement of impact of family planning methods.

Subject: **Social Research Methodology**

S.N.	Description
1	Framing research questionnaire and evaluating its suitability
2	Computation of σ, t and percentile scores
3	Identifying appropriate scales for mental health, stress and strain analysis
4	Measurement of epidemiological depression
5	Formulating Semitic differential and Q-method

Stochastic Process
Second Year

Course Title:- Stochastic Process — Full Marks:-100
Course No:- Stat 611 — Pass Marks:-40
Nature of the course:-Theory — Year:- 2nd year

Course Objective:- The objective of this course is to impart to the students the knowledge about the basic and advanced theory of Stochastic Process. After the completion of this course the students will be able to tackle the problem of random behaviour.

Course Contents:

Group A

Probability Distribution and Stochastic Models: Probability distribution - Generating functions, Convolutions, Compound distributions, Negative Binomial distribution, Lack of memory property of Geometric Distribution, Laplace transformations, Stochastic Models-Stages of modeling, Examples of Stochastic models, Stochastic Processes, Specification, Classification and examples of Stochastic Processes. **23 hrs.**

Group B

Random Walk and Combinatorial Methods: Random Walks- Probabilities of return, first return and no return to origin, Return to origin through negative values, Recurrent Events, Renewal equations, Ladder variables, Gambler's Ruin Problem, Ruin probability, Expected duration of a game, Expected gain/loss, Generating function for the duration of a game. Combinatorial Methods-Andrew's reflection principle and its Applications: Ballot theorem, Galton Rank order test, Kolmogorov -Smirnov Statistics. **22 hrs.**

Group C

Markov Chains/ Branching Process: Markov Chains -One step and higher order transition probabilities, Chapman Kolmogorov equations, Absolute probabilities, Two state Markov chain and its spectral representation, Two state Markov chain with rewards, Probabilities of first visit in a two state Markov chain, Combining of states, Finite Markov chain, Mean recurrence time, Mean time to absorption, Mean number of visits to a state, Classification of states, Class properties, Absorption Probabilities, First passage times, Average gain per transition, Stationary distribution of reducible Markov chain, Discounting of rewards, Countable state Markov chain, Absorbing Markov chain, Reverse Markov chain, Basic limit theorem of Markov chain, Discrete renewal equation, Regular Markov chain. Discrete Branching Processes-Generating Functions Related to branching processes, Covariance and correlation, Probabilities of Generation sizes and Probability of Extinction/ Explosion, Two-type and Multi-type BP, Distribution of Progeny. Renewal Theory-Renewal function/ density, Integral equation of renewal theory, Elementary renewal theorem, Discrete Renewal Equation, Black-well theorem, Key renewal theorem, Stationary renewal process, Modified renewal theorem, Residual and spent lifetime distributions. **45 hrs.**

Group D

Replacement Policies/ Markov Processes/ Diffusion Processes: Replacement Policies: Replacement of failure, age replacement, block replacement and used item replacement policies, Renewal reward process, Counter models, Self renewing aggregates. Discrete Markov Processes in Continuous Time-Poisson Process, Pure birth process, General birth process, Pure death process, General death process, Simple and General Birth and Death Processes, Immigration and Emigration process, Polya process, Non-homogeneous, generalized and compound Poisson process, Queuing Processes: M/M/1, M/M/s, M/M/∞, M/M1/r, M/G/1, GI/M/1. Markov Processes in Continuous Time-General Theory, Intensity matrix, Limiting distributions, Martingale and its kind, Wald equation, Markov renewal and Semi-Markov renewal process. Diffusion Processes-General Theory, Kolmogorov equations, Fokker Planck equations, Wiener Levy process, Uhlenbeck Ornstein Process, Brownian motion, Wiener process, First passage time distribution. Inference in Markov Chains-Galton - Watson process, Markov branching process, Finite Markov chain, Poisson process, Pure birth process, Birth and death process, Auto-regressive process.

60 hrs.

References :

1. Biswas, S. (1989). *Stochastic Processes in Demography and Applications*, Wiley Eastern Ltd. India
2. Chiang, C.L.(1968), *Introduction to Stochastic Processes in Bio-Statistics*, John Wiley and Sons, New York
3. Chung, K.L. (1978), *Elementary Probability Theory*, Springer International Student Edition, Narosa Publishing House, New Delhi,
4. Sinclair, E. (1975), *Introduction to Stochastic Processes*, Prentice Hall, India
5. Feller, W. (1968), *An Introduction to Probability Theory and its Applications, Vol. I*, John Wiley and Sons,New York
6. Karlin, S. and Taylor, H.M. (1975), *A first Course in Stochastic Processes*, Academic Press, New York.
7. Medhi. J. (1985). *Stochastic Processes*, Wiley Eastern Ltd., New Delhi.
8. Parzen, E. (1962), *Stochastic Processes*, Holden Day, Austria
9. Ross, S. M. (1983), *Stochastic Processes*, John Wiley and Sons, New York

Multivariate Analysis

Course Title:- Multivariate Analysis — Full Marks:-100
Course No:- Stat 612 — Pass Marks:-40
Nature of the course:-Theory — Year:- 2nd Year

Course Objective:- The objective of this course is to provide to the students sound knowledge in the advanced theories of the multivariate problems and to develop the skills and knowledge in handling practical problems in this area.

Course Contents:

Group A

General Theory: General Theory - Probability distribution of p variate random vector. Marginal and conditional distributions. Independence and transformation of variables. Mean Vector and Dispersion Matrix. Properties of the Dispersion matrix. Conditional Mean Vector and Conditional Dispersion matrix. Multivariate Data-Organization of Multivariate Data, Computation of sample Mean vector, Dispersion matrix, Correlation Matrix. Computation of Partial Correlation, Multiple Correlation and Regression Coefficients in Multiple Regression. Multivariate Normal Distribution-Density function and characteristic function when the covariance matrix is positive definite. Characteristic function when the covariance matrix is positive semi-definite. Singular Normal Distribution. Distribution of Linear Combinations. Independence. Marginal and Conditional distributions. Partial and Multiple Correlation Coefficients.Testing the assumption of Normality. **53 hrs.**

Group B

Mean Vector and Dispersion Matrix: Mean Vector and the Dispersion Matrix-Maximum Likelihood Estimates and Unbiased estimates of the mean vector and the dispersion matrix. Distribution of the M.L.E. of Mean vector and dispersion matrix. Inference about the Mean vector and Dispersion matrix when some data are missing. Wishart distribution (Derivation not required) and its properties. Correlation Coefficients-Maximum Likelihood Estimates of Simple, Partial and Multiple Correlation, their exact and asymptotic distribution. Testing of hypothesis regarding simple, partial and multiple correlation. **45 hrs.**

Group C

Hypothesis testing/ Linear models: Testing of Hypothesis regarding the Mean Vector and the Dispersion Matrix: The Generalized T^2 Statistic. Derivation of T^2 Statistic as a function of likelihood criterion. Distribution of T^2 Statistic. Invariance property of T^2 Statistic. Uses of T^2 Statistic. Confidence region for the mean vector. Simultaneous confidence interval for linear combinations of the mean vector. Mahalanobis's D^2 Statistic and its relation with T^2 Statistic. Multivariate Linear Models-MANOVA. Canonical reduction. Testing and illustration by likelihood ratio criterion. **37 hrs.**

Group D

Discrimination / Classification / Principal components: Ratio Procedure.Fisher' Linear Discriminator. Principal Component Analysis-Derivation of k^{th} Principal component and its variance. **15 hrs.**

References :

1. Anderson, T. W. (1958), *An Introduction to Multivariate Statistical Analysis*. John Wiley, N. Y.
2. Rao, C.R. (1984), *Linear Statistical Inference and its Applications*. Wiley Eastern Limited, New Delh
3. Shrivastava, M. S. and Khatri, C. G. (1979), *An Introduction to Multivariate Statistics*. North Holland, New York.
4. Johnson Richard A. and Wichern Dean W (1982). *Applied Multivariate Statistical Analysis*. Prentice - Hall International Editions, New Jersey.
5. Morrison, Donald F (1967). *Multivariate Statistical Methods*. McGraw-Hill International Editions, Singapore.

Sampling and Design of Experiment

Course Title:- Sampling and Design of Experiment — Full Marks:-100
Course No:- Stat 613 — Pass Marks:-40
Nature of the course:-Theory — Year:- 2nd Year

Course Objective:- The basic objective of this course is to acquaint the students with the theoretical and practical knowledge of experimental design and, as the survey sampling course enables the students to acquire the basic as well as advanced theories of sample surveys, to provide to the students a sufficient background in sample curves and experimental design in practice along with creating contidence in applying the theory to practical aspects.

Course Contents:

Group A

Introduction to Fixed and Super Population Approaches: An outline of Fixed population and super-population approaches, Distinctive features of finite population sampling, Probability sampling designs and estimators along with their basic statistical properties, Review of important results in srs with/without replacements, Estimation based on pps and π ps sampling, Stratified sampling with varying probabilities of selection: post stratification ,deep stratification, Unbiased ratio type estimators: Hartley-Ross, Beale- Tin's estimators, Product estimators, Difference estimators in stratified sampling, multivariate ratio estimator and combined ratio estimator **53 hrs.**

Group B:

Sampling Methods: Double Sampling: Description of techniques, Double sampling for stratification, Optimum allocation, Estimated variance in double sampling for regression, Repeated sampling of the same population. Cluster Sampling: rational, Comparisons of precision made from survey data, Variance in terms of intra-cluster correlation, cluster sampling for proportion, cluster units of unequal sizes. Multistage sampling upto 3 stage: Variance of the estimated means and its estimate in optimum sampling and sub sampling fractions, Design – effect , Design of Experiments **45 hrs.**

Group C

Nested and BIB Design: Review of linear estimation and basic design, determination of number of replications using type I and power of test, Nested design: One way and two way and comparison with crossed design, Incomplete block design, concept of connectedness, orthogonality and BIB with and without intra-block recovery **37 hrs.**

Group D

Factorial and Split Plot Designs: The 2^k Factorial design, Confounding in 2^k in two blocks and in 2^{k-}p blocks, Two level fractional Factorial designs: The one-half fraction, the one-quarter fraction and 2^k fraction, Confounding in fractional factorial design, Split and Strip Plot Designs, Analysis of Covariance for two way, Taguchi approach to parameter design, Response Surface Design **15 hrs.**

References:

1. Cochran , W.G. (1977) , *Sampling Techniques*. Wiley Eastern Publication.,India
2. Kish , L (1965), *Survey Sampling*, John Wiley and Sons, .New York
3. Sukhatme, P.V. Sukhatme B.V., Sukhatme, Ashok, C.(1984), *Sampling Theory of Surveys with Application*, :ISAS, India
4. Mukhopadhya, P.(1998), *Theory and Methods of Survey Sampling*, Prentice –Hall of India, New Delhi.
5. Murthy M.N. (1967), *Sampling Theory and Methods*. Statistical Publishing Society, India
6. Des ,Raj (1978), *Sampling Theory*, Mc Graw Hill, New York
7. Hedayat , A.S.; Sinha, B.K.(1991): *Design and Inference in Finite Population Sampling*, John Wiley and Sons, New York
8. Samdal, C.E. Swensson , B, Wretman J. (1991). *Model Assisted Survey Sampling*, Springer Verlag, New York

Computation Practical

Course Title:- Computation Practical — Full Marks:-50
Course No:- Stat 614 — Pass Marks:-20
Nature of the course:-Practical — Year:- 2nd Year

Course Objective:- The objective of this course is to enable the students to apply the theories learnt to solving the statistical problems.

Course Content:

Subject: **Stochastic process**

S.N.	Description
1	Numerical processing of different stages of Markov chain including absorbing states
2	Determining replacement stages of failure items and also determining the aging of replacement
3	Determining queue length, waiting periods and other parameters of queuing models
4	Determining the population size and other parameters of birth and death process
5	Determining parameters of auto regressive process

Subject: **Multivariate**

S.N.	Description
1	Compute correlation matrix and regression coefficients for multivariate data
2	Determine and estimate the characteristics of multivariate normal data
3	Testing hypothesis for mean vector and dispersion matrix
4	Numerical processing using MANOVA
5	Estimating confidence regions for mean vector

Subject: **Sampling**

S.N.	Description
1	Determining sampling parameters for pps and πps sampling
2	Determining the estimators based on Hartley-ross estimator
3	Determining sampling plan based on double sampling
4	Comparison of cluster sampling with other sampling methods
5	Estimate in optimum sampling and sub sampling fractions
6	Estimation based on multivariate ration estimators
7	Estimation based on difference estimators
8	Computing design effect under various sample design
9	Variance estimation in multistage sampling
10	Variance estimation in terms of intra-cluster correlation

Subject : **Design of experiment**

S.N.	Description
1	Execution of nested design
2	Lay out and analysis of BIBD
3	Confounding in factorial layout

4	Lay out and analysis of 2^k fractional design
5	Analyzing split plot design
6	Analyzing strip plot design
7	Estimating parameters using Taguchi principle
8	Estimating response surface design parameters
9	Analysis of ANACOV
10	Orthogonalizing the parameters in design

Subject: **Econometrics**

S.N.	Description
1	Determining the Akaike transformation values
2	Determining the models using dummy variables
3	Comparison between various methods of model specifications
4	Determining the parameters in serial correlation and auto correlation
5	Forecasting the values using ARMA models

Subject: **Biostatistics**

S.N.	Description
1	Fitting of survival data using non parametric approach
2	Estimating density and associations between the species
3	Computing the change of gene frequency under migration
4	Heritability estimation and its precision's
5	Metric character under natural selection of metric character to fitness

Subject: **Quality Control and Sampling Inspection**

S.N.	Description
1	Formulating X- chart
2	Formulating CUSUM chart
3	Determining OC, ASN and AOQ
4	Determining and testing of hypothesis related to SPRT, and semi curtailed sampling inspection plan
5	Estimating hazard rate

Subject: **Non Parametric Statistics**

S.N.	Description
1	Confidence interval estimation for population quantiles
2	Chi-square test and its comparison with Kolmogorov-Smirnov test
3	Tests based on median, Fisher exact probability and Wald Wolfowitz run
4	Tests based on Kruskal- Wallis and Friedman
5	Kendall coefficient of concordance

Subject: **Agricultural Statistics**

S.N.	Description
1	Yield estimation using traditional versus random sampling technique
2	Sample design and agricultural input estimation

3 Preparing a food balance sheet
4 Questionnaire evaluation in agricultural census
5 Logical and cross analysis of agricultural data

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Econometrics

Course Title:- Econometrics — Full Marks:-50
Course No:- Stat 621 — Pass Marks:-20
Nature of the course:-Theory — Year:- 2nd Year

Course Objective:-The main objective of this course is to give empirical content to *a* priori reasoning in economics. After completing this course, the students will be able to carry out market research and to study the effect of cartain economic decision.

Course Contents:

Group A

Introduction: Introduction of the subject, Multiple Regression Model: Applications, Finite prediction error, Akaike Information criteria, and Generalized Cross Validation (GCV) and Wald Test, Specialized Wald Test, The Aitken's Model, Cobb Douglas Production Function Model, Logit Model and the Box-Cox Transformation, Concept of exact Multicollinearity, Near Multicollinearity, Identifying Multicollinearity and their solutions, Effect of Dummy variables on the intercept form, variables with two and more categories, more than one qualitative variables, Effect of dummy on slope form **26 hrs.**

Group B

Model Specification: Testing for Model Specification, Heteroscadasticity and Serial Correlation, The data generation process (DGP) and Hendry/LSE approach, Lagrangian Multiplier Test, Concepts and consequences of ignoring Heteroscadasticity, Goldfeld-Quandt test, Bredsch-Pagan Test, White's test, Heteroscadasticity Consistent Covariance Matrix (HCM) estimation, Generalized least squares, Concepts and consequences of ignoring auto correlation, Testing for first order auto correlation: The Durbin-watson test, Treatment of serial correlation-Cochran-Orcutt Iterative procedure, HILU Search Procedure **24 hrs.**

Group C

Auto correlation: Higher Order Auto correlation, Distributed Lag Model and Forecasting, AR (p) model, LM test, Estimating a model with general order auto regressive models, Unit roots Test and Engle's ARCH test, Concept, Average lag, Koyck lag, Almon lag, Consequences of ignoring Lagged dependent variables, Random walk and unit root test, LM test model with auto correlated disturbance terms and model with moving average terms, Smoothing in economic time series, exponential smoothing ARMA and ARIMA (p,q) nodels, Dickey fuller test for co-integration **25 hrs.**

References:

- Ramanathan, Ramu (1995), *Indroductory Econometrics with Application*, Dryden HBJ Publisher,.Canada
- Harvey, A.C (1985), *Econometrics Time Series*, John Wiley Publication, New York

3. Koutsyanees,(1981). *Introduction to Econom trics*, John Wiley publication, New York
4. Johnstone (1972), *Econometric Methods*, John Wiley Publication, New York

Bio-Statistics

Course Title:- Bio-Statistics
Course No:- Stat 622
Nature of the course:-Theory

Full Marks:-50
Pass Marks:-20
Year:- 2nd Year

Course Objective:- The objective of this course is to explain the behavior of the biological as well as genetic phenomenon with the help of Statistics.

Course Contents:

Group A

Stochastic Models: Stochastic Model -Simple and general epidemic model. Survival and Risk theory- Crude, Net and Partial crude probabilities and their interactions. Censuring. Blue and MVUE of longevity from censured sample from exponential populations. Parametric survival models (exponential, Weibul, Lognormal). Non parametric approach to Survival data (based on censured sample). **15 hrs.**

Group B

Quantitative measures of vegetation: Quantitative measures of vegetation-Density, Contagious distribution of plants. Estimation of density. Tests of random distribution. Index of dispersion. Distance and Quadrant method. Thomas distribution. Association between two species. Covariance between species. Communities. **15 hrs.**

Group C

Quantitative genetics: Quantitative genetics-Genetic constitution of a population, Gene and genotype frequencies. Hardy-Weignberg equilibrium. Change of gene frequency under Migration, mutation and selection; and under simplified conditions. The idealized population. Sampling, Inbreeding. Effective population size. Random drift in natural populations. Pedigreed population and closed inbreeding, Regular systems of inbreeding. Continuous variation: Metric Character. Values and Means. Genotypes and environmental variances. Genetic components of variance. Resemblance between relatives: Genetic Covariance, Environmental covariance, and Phenotypic resemblance. Heritability-estimation, its precision, Identical twins. Selection-Response to selection and its measurement. Inbreeding and cross breeding-Change in mean values, inbreeding dispersion, Heterosis, utilization of heterosis. Variance of crosses. Correlated characters: Genetic and environmental correlation. Metric character under natural selection-relation of metric character to fitness, maintenance of variation. **45 hrs.**

Reference:

1. Grip-Smith (1967). *Quantitative Ecology*, Oliver and Boyd Ltd, Great Britain
2. Biswas. Shuddhendu (1988), *Stochastic Process in Demography and Application* Wiley Eastern Limited., India
3 Biswas, Shuddhendu (1992), *Topics in statistical Methodology*, Wiley Eastern Limited. India.

4. Falconer, D.S. (1967), *Introduction to Quantitative Genetics*, Oliver and Boyd LTD. Great Britain

Quality Control and Sampling Inspection

Course Title:- Quality Control and Sampling Inspection — Full Marks:-50
Course No:- Stat 623 — Pass Marks:-20
Nature of the course:-Theory — Year:- 2nd Year

Course Objective:-The objective of this course is to make the students capable of tools and techniques to check the quality of the industrial output. After completion of this course, the students will be able to justify the variations present in the quality of the output due to the chance factor and some assignable course.

Course Contents:

Group A

Statistical Control Charts: Statistical Control Charts-, Modified Control chart, Economic design of $\bar{X}$ Charts ,Duncan's cost Model, CUSUM chart, A Comparison of CUSUM chart with Shewhart $\bar{X}$ chart, Comparison of V mask technique and Decision interval technique. **30 hrs.**

Sampling Inspection Technique: Sampling Inspection Technique- Concept of OC, ASN,AOQ, AOQL, AQL and LTPD, Single sampling Plan, Double Sampling Plan, Sequential Sampling Plan, Sequential Probability Ratio test curtailed and Semi curtailed sampling inspection plan, concept of sampling inspection by variables. Average Run Length. **37 hrs.**

Reliability: Reliability- Concept, Survival function, Hajard rate, Survival Methods, Application of Weibull and Log normal distribution. **8 hrs.**

Reference:

1. Grant, E.L. (1965), *Statistical Quality Control*, Mc Graw Hill ,.New York
2. Duncan, A.J. (1970), *Quality Control and Industrial Statistics*, Richard Darwin, INC. New York
3. Hopper, A.G. (1969), *Basic Statistical Quality Control*, Mc- Graw Hill. New York
4. Biswas, S. (1997): *Statistics of Quality Control*, New Age International Limited,India

Non-parametric Statistics

Course Title:- Non-parametric Statistics
Course No:- Stat 624
Nature of the course:-Theory

Full Marks:-50
Pass Marks:-20
Year:- 2nd Year

Course Objective:-The basic objective of this course is to acquaint the students with the statistical decision process without using the parameters of the distribution.

Course Contents:

Group A

Order Statistics: Order Statistics -Probability integral transformation, Joint distribution of nth order Statistics , Marginal distribution of order Statistics, Distribution of Median, Range, Exact moments of order Statistics, Confidence interval estimation for population quantiles, hypothesis testing for population quantiles. **19 hrs.**

One and two Sample Non parametric Tests: One Sample Non-parametric Tests- Binomial test, Exact null distribution of R (Run), Moments of R, Asymptotic null distribution of R, Tests based on the length of the longest run, Chi-square test and its asymptotic distribution, Comparison of Kolmogorov-Smirnov test with Chi-square test. Two Sample Non-parametric Test-McNemar test, Wald Wolfowitz runs test, Randomization Test, Fisher's exact probability test, Chi-square test, Median test. **38 hrs.**

Several Samples Non-parametric Tests: Several Samples Nonparametric Tests-Kruskall Wallis test, Friedman test, Cochran Q test. **9 hrs.**

Correlation and their tests of Significance: Measures of Correlation and their tests of Significance-Contingency coefficient, Kendall test for correlation, Spearman tests for correlation, Kendall coefficient of concordance **9 hrs.**

Reference:

1. Fraser, D.A.S.(1971), *Non-parametric Methods in Statistics*, John Wiley and Sons,New York
2. Gibbons, J.D. (1971), *Non-parametric Inference*, McGraw Hill, New York
3. Hogg, R.V. and Cralg, A.T. (1972), *Introduction to Mathmatical Statistics*, Amerind Publishing Co., New Delhi,
4. Kendall, M.G. (1948), *Rank Correlation Methods*, Griffin, London,
5. Leach, Chris. (1979), *Introduction to Statistics – A Non-parametric Approach for the Social Sciences*, John Wiley and Sons, New York
6. Ostle, B. (1966), *Statistics in Research*, Oxford and IBM Publishing Co., New Delhi,
7. Siegel, Sidney, (1956), *Non-parametric Statistics for the Behavioral Science*, McGraw Hill, New York

Agriculture Statistics

Course Title:- Agriculture Statistics
Course No:- Stat 625
Nature of the course:-Theory

Full Marks:-50
Pass Marks:-20
Year:- 2nd Year

Course Objective:- After completion of this course, the students will be able to assess and make decisions on the factors affecting the agricultural products.

Course Contents:

Group A

Introduction: Introduction- Objectives of Agri-statistics, Different Sources of Agriculture data in Nepal. Coverage- Area statistics, Crop statistics, Yield statistics- Traditional method, Normal yield, Eye average method, Random sampling techniques **12 hrs.**

Agriculture Inputs: Agriculture Inputs-Irrigation improved seeds, Implements, Labor, Insecticides etc. Chemical fertilizer. FAO's coverage for Agriculture Surveys- Features of Agriculture statistics. Survey population, Target population, Inferential population and Super population. **12 hrs.**

Methods of data collection: Methods of data collection. Sample frame, sample size, sample fraction , sample design, selection procedures, Estimation procedures, Area estimation, questionnaire. Agriculture Censuses in Nepal. Items included in various Agri-censuses of Nepal. Sampling techniques used. Estimation procedures used. Sources of Agriculture Data in Nepal.Statistical System in Food and Agriculture- Dichotomy in SSFA, Current statistics, Food Balance Sheet and its uses. Some relevant agriculture data of Nepal. **51 hrs.**

Reference:

1. Singh, M. L., (1997) *Agriculture Statistics*, Kathmandu.
2. FAO, (1978). *Collecting Statistics on Agriculture population*, FAO, Rome.
3. CBS, (1995). *The 1991/92 National Sample Censuses of Agriculture in Nepal*, Kathmandu.

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