**Tribhuvan University**
**Institute of Science & Technology**
**Statistics**

Level: B.Sc.
Year: IV
Course Title: Sampling Theory and Design of Experiments (Core Course)
Course Code: STA 401 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

**Course objectives:**
To (a) familiarize students with various random sampling techniques and methods of estimation of population parameters. (b) familiarize students with various experimental designs and analysis of experimental data.

**Group A**

**Unit 1: Introduction to Sample Surveys [20]**

1.1 Concepts of population and sample, need for a sample, advantages of sample survey over census
1.2 Basic steps in sampling
1.3 Questionnaire design
1.4 Determinations of sample size
1.5 Sampling and non-sampling errors

**Unit 2: Sampling Methods [45]**

2.1 Techniques of drawing random sample and estimation of population mean population total and variance of the estimators under the sampling plan
2.2 Simple random sampling with and without replacement
2.3 Stratified random sampling
2.4 Cluster sampling (concepts and applications)
2.5 Systematic sampling
2.6 Probability proportional to size (PPS) sampling (with replacement)

**Unit 3: Ratio and regression methods [10]**

3.1 Ratio and regression methods of estimation under simple and stratified random sampling

**Group B**

**Unit 1: Introduction to ANOVA** **[10]**

1.1 Introduction, concept of liner models in ANOVA, statement of Cochran theorem
1.2 Analysis of one-way, two-way classification (1 and m observation per cell) in fixed effect model.

**Unit 2: Fundamental Experimental Designs** **[40]**

2.1 Needs for experiments in scientific inquiries
2.2 Basic terminologies of experimental designs
2.3 Basic principles of experimental designs
2.4 Completely Randomized Design (CRD): Statistical analysis of CRD, Expectation of sum of squares, ANOVA table, Advantages and disadvantages
2.5 Randomized Block Design (RBD): Statistical analysis of RBD for one observation per experimental unit, Expectation of sum of squares, ANOVA table, Efficiency of RBD relative to CRD, Estimations of missing value (one observation only), Advantages and disadvantages
2.6 Latin Square Design (LSD): Statistical analysis of m x m LSD for one observation per experimental unit, Expectation of sum of squares, ANOVA table, Estimation of missing value in LSD (one observation only), Efficiency of LSD relative to RBD, Advantage and disadvantages
2.7 Greco-LSD and its analysis
2.8 Analysis of covariance for one way layout with one concomitant variable for CRD

**Unit 3: Factorial Designs** **[25]**

3.1 Concepts of factorial experiments: Basic terminologies and principles, $2^2$, $2^3$, $3^2$ designs, Yates method of computing factorial effect totals
3.2 Confounding in $2^3$ factorial design

**Note: Separate answer sheet is required for group A and group B in examination**

**References:**


1. Montgomery, D.C,*(2012). Design and Analysis of Experiments*, John Wiley and Sons.
2. Mukhopadhyay,P. *Theory and Methods of Survey Sampling*, Prentice-Hall, Latest Edition.
3. Kapoor, V.K. and Gupta, S., *Applied Statistics*,S. Chand, Latest Edition.
4. Kempthrone,O., *Design and Analysis of Experiments*, John Wiley and Sons , Latest Edition.
5. Cochran W. G., *Sampling Techniques*, John Wiley and Sons, Latest Edition.

**Tribhuvan University**
**Institute of Science & Technology**

Level: B.Sc.
Year: IV
Course Title: Four Year B.Sc. (Core Course I Practical)
Course Code: STA 402 Full Marks: 50
Nature of the Course: Practical Pass Marks: 20
Total Number of Periods: 180

**Course objectives:**

**Pre-requisites:** Sound knowledge in the topics of Sampling Theory and Design of Experiments

**Objectives:**

- To apply knowledge of sampling theory in sample survey data
- To be able to understand, develop and analyze experimental designs

| S. No. | Title of practical problems | No. of problems |
|---|---|---|
| 1 | Simple random sampling (with sample size estimation) | 3 |
| 2 | Stratified random sampling (with different allocation schemes) | 3 |
| 3 | Systematic sampling | 2 |
| 4 | PPS sampling | 2 |
| 5 | Ratio and regression method of estimation | 2 |
| 6 | Analysis of variance (one way and two way) | 2 |
| 7 | Completely randomized design (CRD) | 2 |
| 8 | Randomized block design | 2 |
| 9 | Latin square design | 1 |
| 10 | Analysis of covariance | 1 |
| 11 | Factorial designs ($2^2$, $2^3$, $3^2$ designs) | 3 |
| 12 | Confounding in factorial designs | 2 |
| | **Total number of experiments** | **25** |

**Tribhuvan University**
**Institute of Science & Technology**

Level: B.Sc.
Year: IV
Course Title: Statistical Modeling (Core Course II)
Course Code: STA 403 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

**Course objectives:**

To impart knowledge on statistical modeling through regression methods incorporating simple and multiple regression models, curvilinear models and models with categorical independent variables.

**UNIT1 Linear regression model [41]**

1.1 Dependent (response) and independent (explanatory) variables, linearity in variables and parameters, population and sample regression functions, cross-sectional and time series models

1.2 Simple linear regression models: Model specification, assumptions, ordinary least squares (OLS) and maximum likelihood (MLE) methods, derivation of parameter estimates and their interpretations, fitted regression model and its graphical representation, variance and standard error of estimates, properties of OLS estimators and Gauss-Markov theorem, prediction, interval estimation of regression parameters and mean response, hypothesis testing of regression coefficients, test of significance approach, use of *p* value

1.3 Model adequacy tests: Overall goodness of fit test by coefficient of determination ($R^2$) and analysis of variance, probability and quantile plots (P-P and Q-Q plots) for assessing normality, lack of fit and pure error, lack of fit mean square, detection and consequences of outliers, raw and standardized residuals, use of standardized residuals to assess violation of assumptions, residual plots in detecting the suitability of the fitted model, autocorrelation and Durbin-Watson test

1.4 Regression through origin: model specification, least square estimation, test of significance and confidence interval for parameter coefficient, $R^2$ in no intercept model.

Problems and examples

**UNIT 2 Multiple linear regression model [41]**

2.1 Definition, model specification, assumptions, three variable linear regression model, derivation of OLS and maximum likelihood estimates, partial regression coefficients and their interpretations, variance and standard errors of estimates, properties of OLS estimates, testing the overall significance of the regression model, testing significance of regression coefficients, use of *p* values, interval estimation of parameters and mean response, standardized regression coefficient

2.2 Model adequacy tests: Overall goodness of fit test by multiple coefficient of determination ($R^2$), difference between unadjusted and adjusted $R^{i2}$, relation between unadjusted and adjusted $R^{i2}$, analysis of variance, probability and quantile plots (P-P and Q-Q plots) for assessing normality, lack of fit and pure error, lack of fit mean square, detection and consequences of outliers, raw and standardized residuals, use of standardized residuals to assess violation of assumptions, residual plots in detecting the suitability of the fitted model, autocorrelation and Durbin-Watson test, concept of multicollinearity, its consequences in regression analysis, Variance inflation factors and its use in detection of multicollinearity.

Problems and examples

**UNIT 3 Curvilinear regression models [42]**

3.1 Functional forms of regression models and curvilinear relationships between variables, linearity in transformed model, log-linear model and measurement of elasticity, measurement of relative changes, semi-log models: Log-Lin and Lin-Log regression models and measurement of growth rate, absolute and relative changes, reciprocal model, logistic growth model, polynomial regression model (up to three variables), compound and S curve models

3.2 Cobb-Douglas production function and its application in econometric analysis, estimation of parameters in curvilinear models and model adequacy tests in linearized functions of the curvilinear models

Problems and examples

**UNIT 4 Regression on categorical variables [26]**

4.1 Nature of categorical (qualitative) or dummy variables and their impacts on regression models, examples of use of such variables in modeling

4.2 Regression with categorical independent variables: linear models with quantitative and qualitative independent variables, use of dummy variables in regression models, regression on one quantitative variable and one categorical variable with two classes, regression on one quantitative variable and one categorical variable with more than two classes, regression on one quantitative and two qualitative variables, use of dummy variables for measuring interaction effect, measuring seasonal effects using dummy variables

Problems and examples

**References:**


1. Drapper, N. R. and Smith, H. (1998). *Applied Regression Analysis*, Third edition, Wiley, New York.
2. Gujarati, D. N. (1995). *Basic Econometrics*, Third Edition, McGraw-Hill, Inc., New Delhi.
3. Maddala, G.S (2002). *Econometrics*, Third Edition, John Wiley and Sons, Singapore.
4. Montgomery, D. C., Perk, E. A. and Vining, G. G. (2003). *Introduction to Linear Regression Analysis*, Third edition, John Wiley and Sons, Inc., Singapore.

**Tribhuvan University**
**Institute of Science & Technology**

Level: B.Sc.
Year: IV
Course Title: Statistical Modeling (Core Course II Practical)
Course Code: STA 404 — Full Marks: 50
Nature of the Course: Practical — Pass Marks: 20
Total Number of Periods: 180

**Course objectives:**

**Pre-requisites:** Sound knowledge in the topics of Statistical Modeling

**Objective:**

- To apply the theoretical knowledge of statistical modeling into practice through development of regression models based upon real data and supported by standard model adequacy tests

| S. No. | Title of the problems | No. of problems |
|---|---|---|
| 1 | Simple linear regression with model adequacy tests (using cross-sectional and time series data) | 4 |
| 2 | Simple linear regression through origin | 2 |
| 3 | Multiple linear regression with model adequacy tests (using cross-sectional and time series data) | 4 |
| 4 | Log-linear model (double log) | 2 |
| 5 | Log-Lin and Lin-Log models | 2 |
| 6 | Reciprocal model | 1 |
| 7 | Logistic growth model | 2 |
| 8 | Polynomial models (two and three degree polynomials) | 2 |
| 9 | Cobb-Douglas production function | 2 |
| 10 | Regression with categorical independent variables | |

| | | |
|---|---|---|
| | (Regression on one quantitative variable and one categorical variable with two and more than two classes and regression on one quantitative and two qualitative variables) | 4 |
| | **Total number of problems** | **25** |

**Tribhuvan University**
**Institute of Science & Technology**

Level: B.Sc.
Year: IV
Course Title: Demography and Official Statistics
(Applied Science: Leading to Core Course)
Course Code: STA 405 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

**Course objectives:**

1. To impart substantial knowledge to the students on demography, demographic measures, population models and to compute different demographic measures
2. To make students aware of official statistics, Statistical System, Survey and census, Agriculture statistics, Industrial statistics, Trade statistics, Price statistics, etc

## Group A: Demography

### Unit 1: Introduction to Demography [30]

1.1 Age-Sex Composition**:** Evaluation of age and sex data, Errors in age reporting, Whipple's index, UN's age –sex accuracy index, Population pyramid and age dependency ratio, Adjustment or smoothing of age distributing (Method of simple parabola)

1.2 Measurement of Mortality and life Tables: Crude death rate and age-specific death rate, Standardized death rates (direct and indirect methods), Comparative mortality index, Complete life table its functions and relation between its various functions, Abridged life table and construction by Reed-Merrell and Greville's methods

1.3 Measurement of Fertility: Crude birth rate, general fertility rate, age-specific birth rate, total fertility rate and child-woman ratio, standardized birth rate (directed and indirect) and UN's age-sex adjusted birth rate, Replacement index

### Unit 2 Population Growth Models: [20]

2.1 Compound interest model, Simple exponential model, Polynomial model up to third degree, Logistic models, Use these models in population projection, Population projection by component method

2.2 Time series model
2.3 Factors affecting the population growth
2.4 Booms and Dooms theory
2.5 Malthus Theory
2.6 Demographic Transition Theory
2.7 Ultimate and optimum population

**Unit 3 Population Models:** **[25]**

3.1 Survival probability model, Age structure model, Estimation of birth death rates from these models
3.2 Establishment of the relationship $c(x) = be^{-rx}l(x)$
3.3 Construction of life table from age structure model
3.4 Estimation of birth and death rates from life table
3.5 Stable population model: Lotka's fundamental stable population model
3.6 Stationary population as a special case of stable population
3.7 Estimation of Population growth by using Lolka's method, r- method, Vig's method and K- method (with derivation)

## Group B: Official Statistics

**Unit 4**

4.1 Basic introduction to official statistics **[3]**

- Importance of official statistics
- United Nations Fundamental principles of official statistics
- Concept of evidence based policy
- Opportunities and challenges of official statistics
- Open data access

4.2 Statistical System of Nepal **[3]**

- Concept of Statistical System
- Legal framework
- Role of CBS and other institutions
- Statistical plans and policies
- Relationship between Statistical System of Nepal and International Statistical System
- Major sources of statistics: Admin data, scientific statistical operations

4.3 Survey and census systems **[5]**

- Importance of statistical surveys
- Concept of survey design and sample design
- Households surveys, enterprise/establishments surveys, etc.
- Importance of census

- Concept of census design
- Type of censuses
- Survey and Census practice in Nepal
- Costing of survey and census

**Unit 5**

5.1 Agriculture and rural development statistics **[3]**

- Concept and scope of agriculture, forestry and fishing and rural development statistics
- Major indicators- Nepal specific
- Sources and data gaps

5.2 Social, gender and population statistics **[3]**

- Concept and scope of social statistics (health, education, welfare, social security, etc)
- Concept and scope of gender statistics
- Concept and scope of population statistics
- Concept and scope of vital statistics
- Major indicators- Nepal specific
- Sources and data gaps

5.3 Industrial statistics **[3]**

- Concept and scope of industrial statistics
- Major indicators- Nepal specific
- Sources and data gaps

5.4 Trade statistics **[3]**

- Concept and scope of trade statistics
- International Trade in goods and services
- Distributive trade
- Major indicators-Nepal Specific
- Sources and data gaps

5.5 Price statistics **[6]**

- Concept and scope of price statistics
- Economic background of price statistics
- Measures of inflation
- Consumer Price Index
- Producers Price Index
- Other indices
- Major indices -Nepal specific
- Sources and data gaps

5.6 Economic statistics **[10]**

- Concept and scope of economic statistics
- Introduction to the System of National Accounts (SNA)
- Ranking National Account, Revisiting National Account
- Concept on Supply and use tables, IO tables
- Concept and scope of Balance of Payment (BOP)
- Introduction to BOP and international investment statistics
- Introduction to government finance statistics, financial statistics
- Major micro economic indicators-Nepal Specific
- Sources and data gaps

5.7 Labor statistics **[4]**

- Concept and scope of labor statistics
- Measuring employment, unemployment, underemployment, decent work etc.
- Major labor force indicators - Nepal specific
- International Conference of Labor Statisticians (ICLS) resolution
- Sources and data gaps

5.8 Environment statistics **[4]**

- Concept and scope of environment statistics
- UN Framework of development of Environment Statistics
- Major indicators-Nepal specific
- Sources and data gaps

5.9 Tourism statistics **[3]**

- Concept and scope of the tourism statistics
- Major indicators- Nepal specific
- Sources and data gaps

5.10. Other thematic statistics **[6]**

- Crime statistics, water statistics, energy statistics, construction, transport statistics, service statistics etc.
- Major indicators-Nepal specific
- Sources and data gaps

**Unit 6**

6.1 Statistical infrastructure **[6]**

- Master sample frame
- Statistical registers (Population registers, business registers etc.)
- Statistical classifications: International and national economic, social and other classifications, Reference and related classifications

- Information technology and statistical management
- Concept of Management Information System (MIS): Nepal specific MISs i.e. HMIS, EMIS etc
- Basic concept on Metadata

6.2 Questionnaire design **[4]**

- Principles on questionnaire design
- Types of questionnaires
- Practical issues

6.3 Development initiatives **[5]**

- National plans: Vision and strategic objectives of the current national plan
- Basic introduction to International development agenda i.e. PRS, Sustainable Development, MDGs, SDGs
- Goals, targets and indicators of development initiatives

6.4 Monitoring and Evaluation **[4]**

- Logical framework
- Concept of monitoring and evaluation
- Types of monitoring and evaluation
- Role of statistical system in monitoring and evaluation
- Basic statistical methods for impact evaluation
- Practical issues

**Note: Separate answer sheet is required for group A and group B in examination**

**References:**


1. Biswas, S. (1988). *Stochastic Processes in Demography and Applications*, Wiley-Eastern, India.
2. Pathak, K.B. and Ran F. (1988). *Techniques of Demographic Analysis*, Himalayan Publishing House
3. Singh, M.L. (1995). *Some Measures of Demography*, Kathmandu.
4. Singh, M.L. Sayami, S.B. (1997). *An Introduction to Mathematical Demography*, Kathamndu.
5. *Nepal ko Antarik Tathyanka Pranali*, CBS publication, Kathmandu.
6. *Slattery Martin* (1986). Official Statistics, Taristrek.
7. Giovanini, E : *Understanding Economic Statistics*, OECD Publication.
8. *Fundamental Principles of official statistics* www.unece.org/stats/archive/docs.fp.e.html
9. *Economic and development statistics* www.un.org/esa/progareas/stats.html

10. *World health statistics*. www.who.int/whosis/who stat/2008/en/index.html