

D.M. Sijem

OK  
C. Kelly

~~SYLLABUS~~ SYLLABUS OF 6 SEMESTER DEGREE COURSE IN  
**STATISTICS**  
(ELECTIVE AND HONOURS)

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Note:

1. Students with Mathematics as compulsory subject at plus two level will be eligible for admission to Statistics Honours Course.
2. Minimum eligibility marks (as prescribed by NEHU in other subjects) of Mathematics at plus two level must be considered for admission to Statistics Honours Course.
3. Statistics Honours students must opt for Mathematics as one of the pass subjects.

### Course structure for Statistics (Hons) and Elective

Semester	Paper No.	Name of the Paper	Marks
1	STEH – 1(TH)	Descriptive Statistics, Numerical Analysis & Probability (Theory)	75
1	STEH – 1(PR)	Descriptive Statistics, Bivariate Data and Numerical Analysis (Practical)	25
2	STEH- 2(TH)	Probability Distribution & Statistical Inference (Theory)	75
2	STEH- 2(PR)	Probability Distribution & Statistical Inference(Practical)	25
3	STEH – 3(TH)	Categorical Data, Survey Sampling & Design of Experiments (Theory)	75
3	STEH – 3(PR)	Categorical Data, Survey Sampling & Design of Experiments (Practical)	25
4	STEH – 4(TH)	Applied Statistics (Theory)	75
4	STEH – 4(PR)	Applied Statistics (Practical)	25
5	STH – 51(TH)	Mathematical Methods and Distribution Theory (Theory)	75
5	STH – 51(PR)	Mathematical Methods and Distribution Theory (Practical)	25
5	STH – 52(TH)	Linear Models, Regression and Operations Research, Design of Experiments (Theory)	75
5	STH – 52 (PR)	Regression and Operations Research, Design of Experiments (Practical)	25
6	STH – 61(TH)	Statistical Inference (Theory)	75
6	STH – 61(PR)	Statistical Inference (Practical)	25
6	STH - 62(TH)	Survey Sampling and Nonparametric Inference (Theory)	75
6	STH – 62 (PR)	Survey Sampling and Nonparametric Inference (Practical)	25
Total			800

STEH - Elective & Honours

STH - Honours

**Note:**

1. All theory examinations will be of 75 marks and 3 hours duration and all practical examinations will be of 25 marks and 3 hours duration.
2. For theory papers 2 questions to be set from each Unit and 1 question to be attempted from each Unit.
3. For practical papers 2 questions to be set from each Unit and 1 question to be attempted from each Unit.

3 questions  
Practical Record  
Viva-voce

4. All Practicals in 5<sup>th</sup> and 6<sup>th</sup> semester will be done using Excel Worksheet (Without using Data Analysis Tool Pack)

1<sup>ST</sup> SEMESTER (ELECTIVE AND HONOURS)

STEh - 1 (TH)

Descriptive Statistics, Numerical Analysis and Probability.(Theory)

Marks: 75  
Lectures: 75

Unit-I: Types of data: concept of a statistical population and a sample from a population, Classification (Cross and hierarchical) and Tabulation of data. Frequency and non-frequency data; discrete and continuous data; qualitative and quantitative data; primary data; secondary data.

Presentation of Data: diagrammatical and graphical representation of ungrouped and grouped data; frequency distribution, cumulative frequency distributions and their graphical representation, histogram, frequency polygon and ogives.

Descriptive measures of data: univariate data - concepts and properties of central tendency, (Mean- AM, GM, HM Median, Mode) or location(Quantiles), dispersion and relative dispersion, skewness and kurtosis and their measures including those based on quantiles and moments, Sheppard's correction for moments for grouped data (without derivation). **Lectures : 15**

Unit-II: Bivariate and Trivariate Data: Scatter diagram, product moment correlation coefficient and its properties. Regression, principle of least squares, fitting of linear regression and related results, fitting of curvilinear Regression, Multiple regression involving two independent variables - Multiple and partial correlation coefficients (fitting of second degree polynomial). Intraclass correlation coefficient. **Lectures : 15**

Unit-III: Finite difference: definition, operators  $\Delta$  &  $E$ , their properties, difference table, methods of interpolation, Newton's Forward & Backward and Lagrange's methods of interpolation. Newton's Divided differences.

*BS*  
Numerical integration, the general quadrature formula Trapezoidal rule, Simpson's one-third and three-eighth formula. **Lectures : 15**

Unit IV: Definition of probability: classical, axiomatic and relative frequency approaches. Random experiments - trial, sample points and sample spaces, definition of events, operation on events, mutually exclusive independent and exhaustive events. Discrete sample space and its properties. Conditional probability and independence of events, addition and multiplication theorems with proof, Bayes' theorem and its applications. **Lectures : 15**

Unit V: Random variables: definition of discrete and continuous random variable and their properties, probability mass function. probability density function; Distribution function and its properties. Mathematical expectation of a random variable and its properties; moments, measures of location, dispersion, skewness and kurtosis. generating functions – mgf, cgf, pgf and uses. Joint, marginal, conditional pmf and pdf. Conditional expectation and variance. Independence of Random Variables. Lectures : 15

**Text Books :**

- |   |   |  |
|---|---|--|
| Hogg R.V. and Tanis E.A. (2003)               | : | Probability and Statistical Inference, Pearson Education, New Delhi                        |
| Saxena, H.C.(1998)                            | : | Calculus of Finite Difference, S.Chand & Co.   |
| Goon A.M., Gupta, M.K. and Dasgupta, B(1999)  | : | Fundamental of Statistics, Vol-I, World Press Kolkata.                                     |
| Goon A.M., Gupta, M.K. and Dasgupta, B (2003) | : | Basic Statistics, World Press, Kolkata   |
| Mood, A.M. Graybill, F.A. Boes, D.C. (1974)   | : | Introduction to the Theory of Statistics Tata-Mc-Graw Hill.                                |
| Ross, S. M (2003)                             | : | A first Course in Probability, 6 <sup>th</sup> Edn. Pearson and Education, New Delhi       |
| Hogg, R. V., Craig, A. T. (2002)              | : | Introduction to Mathematical Statistics, 5 <sup>th</sup> Edn. Pearson Education, New Delhi |

**References:**

- |   |   |  |
|---|---|--|
| Bhatt, B.R. Srivenkataramana, T and Rao Madhava K.S. (1997) | : | Statistics : A Beginner's Text Vol-II New Age International (P) Ltd. |
| Croxton, F.E. Cowden D.J. and Kelin, S. (1973)              | : | Applied General Statistics, Prentice Hall of India                   |
| Gupta S. C. and Kapoor V. K (2000)                          | : | Fundamental of Mathematical Statistics. S.Chand & Co., New Delhi.    |
| Medhi, J. (1992)  | : | Statistical Methods, New Age Publication.                            |
| Sastry, S.S. (1999)   | : | Introductory Methods of Numerical Analysis, Prentice Hall, India.    |

- Scarborough, J. B.,(1955) : Numerical Mathematical Analysis Oxford and IBH Publishing
- Bhattacharyya, G. K., Johnson, R.A. (1977) : Statistical Concepts and Methods, Wiley Series, New York
- Hogg, R.V. and Tanis, E.A. (2003) : Probability and Statistical Inference, Pearson Education, New Delhi

### 1<sup>ST</sup> SEMESTER (ELECTIVE AND HONOURS)

#### STEh - 1 (PR)

#### Descriptive Statistics and Numerical Analysis.(Practical)

- Unit-I:
1. Drawing of line, bar, multiple bar, divided bar and pie diagrams.
  2. Drawing of histogram, frequency polygon, frequency curve, ogives.
  3. Computation of measures of central tendency.
  4. Computation of measures of dispersion.
  5. Computation of moments (upto order 4)
  6. Application of Sheppard's correction to moments.
  7. Computation of coefficients of skewness and kurtosis.
- Unit-II:
8. Calculation of correlation and regression coefficients (ungrouped and grouped data)
  9. Fitting of straight line, parabola by least square method.
  10. Spearman's rank correlation.
  11. Fitting of curvilinear\_linear regression by linearizing transformation.
  13. Computation of multiple and partial correlation coefficients.
  14. Computation of multiple regression.
  15. Fitting of second degree polynomial.
- Unit-III:
16. Interpolation by Newton's Forward and Backward interpolation formulae.
  17. Interpolation by Lagrange's formulae.
  18. Interpolation by Divide difference formulae.
  19. Numerical Integration using Trapezoidal, Simpson's 1/3 rd and 3/8<sup>th</sup> formulae.

References:

- Hogg, R.V. and Tanis, E.A. (2003) : Probability and Statistical Inference, Pearson Education, New Delhi.
- Bhattacharyya, G. K. and Johnson, R.A. (1977) : Statistical Concepts and Methods, Wiley Series, New York
- Bhatt, B.R. Srivenkataramana, T and Rao Madhava K.S. (1997) : Statistics : A Beginner's Text Vol-II New Age International (P) Ltd.
- Goon A.M., Gupta, M.K. and Dasgupta, B(1999) : Fundamental of Statistics, Vol-I, World Press Kolkata.
- Goon A.M., Gupta, M.K. and Dasgupta, B (2003) : Basic Statistics, World Press, Kolkata
- Gupta, S.C and. Kapoor, V.K (2000) : Fundamentals of Mathematical Statistics, S. Chand and Co.
- Scarborough, J. B, (1955) : Numerical Mathematical Analysis Oxford and IBH Publishing

2<sup>nd</sup> SEMESTER (ELECTIVE AND HONOURS)

STEh - 2 (TH)

Probability Distributions and Statistical Inference (Theory)

Marks : 75  
Lectures : 75

- Unit-I: Discrete Distributions: Definition and derivation of properties including MGF, PGF and CGF of – Bernoulli, Binomial, Poisson, geometric and Trinomial Distributions. Derivation of mean, Variance and other properties. Related Problems. **Lectures : 15**
- Unit-II: Continuous distributions – Definition and properties of uniform, exponential and Normal distributions, Bivariate normal distribution-mean, Variance, median mode, MGF, and CGF. Related problems. Idea of Box Plot, QQ Plot and PP plot. **Lectures : 15**
- Unit-III: Sampling distribution theory – Random sample from a probability distribution, Statistic and its sampling distribution. Distribution of functions of Random Variables.  
Distribution of sums of independent random variables, Distribution of Sample mean from Normal population.  $\chi^2$  (chi-square), t and F – definition and properties only. Law of large numbers – Tschebyshev's inequality and its applications. Statement and application of Weak law of large numbers (WLLN) and central limit theorem (CLT). **Lectures : 15**
- Unit-IV: Estimation—Point Estimation – Likelihood function, method of maximum likelihood and method of moments. Properties of estimators- unbiasedness and consistency. Mean square error (MSE). Minimum variance unbiased Estimation (MVUE). Interval Estimation- confidence intervals for means and Differences of means and proportions and difference of proportions from sampling from normal populations. **Lectures : 15**
- Unit-V: Hypothesis testing for small samples: null and alternative hypothesis, types of error, p-values. Testing of mean and variance of univariate normal distribution, testing for the significance of correlation and regression coefficients, paired t-test. Hypothesis testing for large samples: Tests for single mean, single proportion, difference of two means and two proportions, chi-square test for goodness of fit. **Lectures : 15**

### Text Books:

- Hogg, R. V. and Craig, A. T. (2002) : Introduction to Mathematical Statistics, 5<sup>th</sup> Edn. Pearson Education, New Delhi
- Ross, S. M (2003) : A first Course in Probability, 6<sup>th</sup> Edn. Pearson Education, New Delhi
- Mood, A.M. Graybill, F.A. and Boes, D.C. (1974) : Introduction to the Theory of Statistics Tata-Mc Graw Hill.
- Hogg, R.V. and Tanis, E.A (2003) : Probability and Statistical Inference, Pearson Education, New Delhi
- Goon A.M., Gupta, M.K. and Dasgupta, B(1999) : Fundamental of Statistics, Vol-I, World Press Kolkata.

### References :

- Gupta S. C. and Kapoor V. K. (2000) : Fundamental of Mathematical Statistics. S. Chand & Co., New Delhi.
- Medhi, J. (1992) : Statistical Methods, New Age Publication.
- Sastry, S.S. (1999) : Introductory Methods of Numerical Analysis, Prentice Hall, India.
- Das, Kishore K. and Bhattacharjee, D (2008) : A Treatise on Statistical Inference and Distribution. Asian Book House, New Delhi.

2<sup>nd</sup> SEMESTER (ELECTIVE AND HONOURS)

STEH – 2 (PR)

Probability Distributions and Statistical Inference.(Practical)

- Unit-I: 1. Fitting of standard univariate discrete and continuous distribution:  
Binomial, Poisson, Normal and exponential.
2. Drawing the Box Plot, PP Plot and QQ Plot
- Unit-II: 2. Estimation of parameters using method of moments and maximum likelihood  
(binomial, poisson, normal uniform, exponential).
- Unit-III: 3. Test for single mean, single proportion
4. Test for difference of two means, two proportions.
4. Test for the significance of correlation and regression coefficients.
5. Paired t-test.
6. Chi-square test of goodness of fit.

Reference:

- Goon A.M., Gupta, M.K. and Dasgupta, B(1999) : Fundamental of Statistics, Vol-I, World Press Kolkata.
- Mood, A.M., Graybill, F.A. and Boes, D.C. (1974) : Introduction to the Theory of Statistics Tata-Mc-Graw Hill.
- Gupta, S.C. and Kapoor, V.K. (2000): Fundamentals of Mathematical Statistics, S. Chand and Co
- Bhattacharyya, G. K. and Johnson, R.A. (1977) : Statistical Concepts and Methods, Wiley Series, New York
- Hogg R. V. and Tanis, E. A (2003) : Probability and Statistical Inference, Pearson Education, New Delhi
- Snedecor, G. W. and Cochran, W.G : Statistical Methods. Sixth Edition (1968)

3<sup>rd</sup> SEMESTER (ELECTIVE AND HONOURS)

STE H - 3 (TH)

Categorical data, Survey Sampling and Design of Experiment (Theory)

Marks : 75

Lectures : 75

- Unit-I: Analysis of Categorical Data: Consistency of Categorical data. Independence and association of attributes, various measures of association for two way and three way classified data. **Lectures : 15**
- Unit-II: Sample Survey: concept of population and sample, comparison of census and sample survey, basic principles in sampling, simple random sampling with and without replacement(SRSWR and SRSWOR), unbiased estimators of population total, mean and their variances, confidence Interval, Estimation of proportion, Methods of selection of sample by SRSWR and SRSWOR determination of sample size. Systematic sampling: variance of the estimated mean, systematic sampling vs simple random sampling. **Lectures : 15**
- Unit-III: Stratified sampling with SRSWR and SRSWOR within each stratum : estimation of population mean, population total and their variances, proportional allocation, optimum allocation, comparison of stratified sampling with unstratified sampling for SRSWR. Systematic sampling vs stratified random sampling. Estimation of proportion in stratified SRSWR and SRSWOR. **Lectures : 15**
- Unit-IV: Definition of ANOVA, analysis of variance for one-way and two-way classification with one observation under fixed effect model, fundamental principles of design. **Lectures : 15**
- Unit-V: Basic designs: CRD, RBD, LSD and their analyses, estimation of one missing observation for RBD and LSD, factorial experiments-  $2^2$ ,  $2^3$ , main effects and interactions. **Lectures : 15**

Text Books:

- Goon A.M., Gupta, M.K. and Dasgupta, B(1999) : Fundamental of Statistics, Vol-I, World Press Kolkata.
- Gupta, S. C. and Kapoor, V.K. (2000) : Fundamentals of Mathematical Statistics, S. Chand and Co.
- Murthy, M. N. (1967) : Sampling Theory and Methods Statistical Publishing Society.

- Sampath, S. (2005) : Sampling Theory and Methods, Alpha Science International
- Goon A. M., Gupta, M.K. and Dasgupta, B(1999) : Fundamental of Statistics, Vol-II, World Press Kolkata.

**Reference :**

- Cochran, W. G. (1977) : Sampling Techniques, John Wiley and Wiley Eastern.
- Sukhatma, P. V., Sukhatme, B. V., Sukhatme, S and Asok, C (1984). : Sampling Theory of Surveys with applications, Asia Publishing House.
- Das, M. N. and Giri, N. C. (2006) : Design and Analysis of Experiments, New age international Publishers, New Delhi.
- Mukhopadhyay, P (1998) : Theory and Methods of Survey Sampling

**3<sup>rd</sup> SEMESTER (ELECTIVE AND HONOURS)**

**STEh – 3 (PR)**

**Categorical data, Survey Sampling & Design of Experiments. (Practical)**

- Unit-I:
1. Problems on categorical data for two way and three way classified data: test of independence of attributes.
  2. All possible samples under SRSWR and SRSWOR- verification of results
  3. Selection of sample and determination of sample size by SRSWR and SRSWOR
  5. Estimation of population mean and total and their standard errors and confidence intervals in SRSWR and SRSWOR.
- Unit-II:
5. Estimation of population mean and total and their variances in stratified sampling with SRSWR and SRSWOR.
  6. Proportional and optimum allocation in stratified sampling with SRSWR and SRSWOR.

7. Estimation of population mean and total and their variances in systematic sampling.
8. Variance of sample mean in terms of intraclass correlation coefficient and Efficiency of systematic sampling w.r.t. SRSWR and SRSWOR

- Unit-III:
9. Analysis of variance for one-way classification
  10. Analysis of variance for two-way classification (with one observation per cell).
  11. Analysis of CRD, RBD, LSD.
  12. Estimation of one missing values in CRD, RBD, LSD.
  13. Analysis of  $2^2$  designs,  $2^3$  design.

**Reference :**

- |  |   |  |
|--|---|--|
| Goon A.M., Gupta, M.K. and Dasgupta, B(1999) | : | Fundamental of Statistics, Vol-I, World Press Kolkata.                           |
| Gupta, S.C. and Kapoor, V.K. (2000)          | : | Fundamentals of Mathematical Statistics, S. Chand and Co                         |
| Goon A.M., Gupta, M.K. and Dasgupta, B(1999) | : | Fundamental of Statistics, Vol-II, World Press Kolkata.                          |
| Das, M. N. and Giri, N. C. (2006)            | : | Design and Analysis of Experiments, New age international Publishers, New Delhi. |
| Cochran, W. G. (1977)                        | : | Sampling Techniques, John Wiley and Wiley Eastern.                               |
| Murthy, M. N. (1967)                         | : | Sampling Theory and Methods Statistical Publishing Society.                      |
| Singh, D. and Chaudhary, F.S (1995)          | : | Theory and Analysis of Sample Survey Design,                                     |

4<sup>th</sup> SEMESTER (ELECTIVE AND HONOURS)

STEh – 4 (TH)  
Applied Statistics.(Theory)

Marks : 75  
Lectures : 75

- Unit-I: Demographic Methods: Sources of demographic data, measurement of mortality- crude death rate, age specific death rate, standardized death rate (direct & indirect), infant mortality rate, complete life table, measurement of fertility- crude birth rate, general fertility rate, total fertility rate, gross reproduction rate, net reproduction rate, basic idea of migration. Population projection by logistic curve. **Lectures : 15**
- Unit-II: Statistical process and product control, general theory of control chart, control limit, tools for SQC,  $\bar{X}$  –chart,  $\sigma$  chart, R-chart, p-chart, c-chart, advantages and limitations of SQC, acceptance sampling plan, producer's risk, consumer's risk, ASN curve, OC curve, single sampling plan, double sampling plan, cusum chart. **Lectures : 15**
- Unit-III: Index number: definition, applications of index number, problems involved in the construction of index number, simple and weighted aggregate method, Laspeyre's, Paasche's, Dorbish-Bowley, Marshall-Edgeworth, Fisher's index number, simple and weighted average of price relative method, time and factor reversal test, cost of living index number (CLIN). **Lectures : 15**
- Unit-IV: Time Series : Its component, illustrations, additive and multiplicative models, estimation of trend by moving average method, seasonal variation, estimate of seasonal variation by link relative method.
- Demand Analysis: Static laws of demand and supply, price elasticity of demand, income distribution, Pareto distribution, fitting of Pareto's law, Lorenz curve and estimation of elasticity. Gini's coefficient. **Lectures : 15**
- Unit-V: Indian Official Statistics: Present Official Statistical System of India. Methods of collection of official statistics, their reliability and limitations. Principal publications containing data on the topics such as population, agriculture, industry, trade, prices, labour and employment, transport and communications, banking and finance. Various official agencies responsible for data collection and their main functions. **Lectures : 15**

Text Books:

- Gun, A.M., Gupta, M.K. and Dasgupta, B. (2002) : Fundamentals of statistics, Vol 2, World Press Calcutta
- Gupta S.C. and Kapoor, V.K. (2000) : Fundamentals of applied statistics, S. Chand & Co.
- Cowden D.J. (1960) : Statistical Methods in Quality Control, Asia Publishing Society

References :

- Grant, E.L (1964) : Statistical Quality Control, Mc Graw Hill.
- Central Statistical Organisation, : Guide to current Indian Official Statistics  
Govt. Of India (2000) New Delhi.

4<sup>th</sup> SEMESTER (ELECTIVE AND HONOURS)

STEh – 4 (PR)  
Applied Statistics.(Practical)

- Unit-I: 1. Computation of measures of mortality and fertility.  
2. Construction of complete life tables.  
3. Preparation of  $\bar{x}$  –chart,  $\sigma$ -chart, R-chart, c-chart and p-chart.  
4. Drawing of oc curve for single and double sampling plans for attributes, ASN, AOG and ATI curves.
- Unit-II: 5. Construction of index number by Laspeyre's, Paasche's and Fisher's method.  
6. Computation of cost of Living Index Number .  
7. Determination of trend by moving average method.  
8. Method of least squares.  
9. Determination of seasonal indices by link relative method.
- Unit-III: 10. Fitting of pareto curve to income data.  
11. Lorenz curve of concentration.  
12. Estimation of price elasticity of demand.

Reference:

- Gun, A.M., Gupta, M.K. and Dasgupta, B. (2002) : Fundamentals of statistics, Vol 2, World Press Calcutta
- Gupta S.C. and Kapoor, V.K. (2000) : Fundamentals of applied statistics, S. Chand & Co.
- Cowden D.J. (1960) : Statistical Methods in Quality Control, Asia Publishing Society
- Grant, E.L (1964) : Statistical Quality Control, Mc Graw Hill.

## 5<sup>th</sup> SEMESTER (HONOURS)

STEh - 51 (TH)

Mathematical Methods and Distribution Theory (Theory)

Marks : 75

Lectures : 75

Unit-I: Numerical differentiation based on Newtons forward and backward interpolation formulae. Numerical integration – Weddles Rule and Euler's formula for summation and integration. Solution of algebraic and transcendental equation by Bisection, False position, iteration method, Newton Raphson and their convergence (polynomials upto degree 4).

Function of several variables, partial derivatives, maxima and minima, constrained maxima and minima, applications of Lagrangian multipliers. Multiple integrals of Jacobian of transformation, Beta and Gamma integrals.

Lectures : 15

Unit-II: Linear Algebra: Linear System of equations. Row Echelon Form (REF) and Reduced REF. Gaussion elimination and Gauss Jordan Reduction Method. Inverse of a matrix. Vectors Spaces and Subspaces, Linear dependence and independence, Homogeneous and non Homogeneous systems, Rank of a matrix and applications. Eigen values and Eigen Vectors, Caley Hamilton Theorem, Quadratic forms and its different types.

Lectures : 15

Unit-III: Random Variables and expectations: Joint, marginal and conditional Distribution Functions and their properties. Properties of expectation of sums of Random Variables (R.V.s). Covariance and Variance of sums. Conditional expectation, computing expectations, variance and Probability by conditioning. Conditional variance. Generating Functions- Joint MGF, CGF and PGF of R.V.s , their properties and applications, characteristic function. Computing MGF by conditioning.

Lectures : 15

Unit IV: Statement, properties and applications of negative binomial, hypergeometric, Multinomial, Beta, Gamma, Cauchy, Weibull, Log-normal distributions- their properties and applications.

Lectures : 15

Unit-V: Derivation and independence of Sampling distributions of sample mean and variance in random sampling from normal population, sampling distribution of sample total for negative binomial, normal and gamma distributions, Chi-square, t, and F distributions-properties and their derivation.

Lectures : 15

### Text Books :

Saxena, H.C. (1998)

Calculus of Finite Difference, S. Chand & Co.

- Kolman, B. and Hill, D. R. (2007) : Introductory Linear algebra with applications, 7<sup>th</sup> Edn., Pearson and Education, New Delhi.
- Scarborough, J. B.(1955) : Numerical Mathematical Analysis Oxford and IBH Publishing
- Vasishtha, A. R. and, Vasishtha, A. K. : Matrices, KRISHNA SERIES
- Biswas, S : Textbook of Matrix Algebra, 4<sup>th</sup> edn.
- Ross, S. M (2003) : A first Course in Probability, 6<sup>th</sup> Edn. Pearson and Education, New Delhi
- Hogg R.V. and Tanis, E.A (2003) : Probability and Statistical Inference, Pearson Education, New Delhi
- Hogg, R. V., Craig, A. T. (2002) : Introduction to Mathematical Statistics, 5<sup>th</sup> Edn. Pearson Education, New Delhi

**References :**

- Hadley, G. (2002) : Linear Algebra, Narosa Publishing House, New Delhi
- ✓ Mood, A.M. Graybill, F.A. and Boes, D.C. (1974) : Introduction to the Theory of Statistics Tata-Mc-Graw Hill.
- ✓ Rohagi, V. K , and Saleh, A. K M. (2001) : An Introduction to Probability and Statistics, 2<sup>nd</sup> edn., John Wiley
- Goon A.M., Gupta, M.K. and Dasgupta, B(1999) : Fundamental of Statistics, Vol-I, World Press Kolkata.
- Sastry, S.S. (1999) : Introductory Methods of Numerical Analysis, Prentice Hall, India.
- Saxena, H.C. (1998) : Calculus of Finite Difference, S.Chand & Co.
- S.C Gupta, and Kapoor, V.K. (2000) : Fundamentals of Mathematical Statistics, S. Chand and Co
- Ross, S. M (2007) : Introduction to Probability Models, Elsevier, 9<sup>th</sup> Edn.
- Sastry, S.S. (1999) : Introductory Methods of Numerical Analysis, Prentice Hall, India.

## 5<sup>th</sup> SEMESTER (HONOURS)

### STH – 51 (PR)

#### Mathematical Methods and Distribution Theory (Practical)

- Unit-I: 1. 1<sup>st</sup> and 2<sup>nd</sup> derivatives based on Newton's Forward and Backward interpolation formulae.  
2. Numerical integration using Weddles Rule and Euler's formulae  
3. Solution of equations by Bisection, False position, iteration method, Newton Raphson (polynomials upto degree 4)
- Unit-II 4. Solution of equations by Gaussion elimination and Gauss Jordan Reduction Method.  
6. Inverse of a matrix (by adjoint and by Gauss Jordan Reduction Method)  
7. Eigen values and Eigen Vectors  
8. Finding power of a Matrix using Caley Hamilton Theorem
- Unit-III 9. Fitting of negative binomial, hypergeometric, Multinomial  
10. Fitting of Beta, Gamma, Log-normal distributions.

#### Reference :

- Scarborough, J. B.(1955) : Numerical Mathematical Analysis  
Oxford and IBH Publishing
- Kolman, B. and Hill, D. R. (2007): Introductory Linear algebra with  
applications, 7<sup>th</sup> Edn., Pearson and  
Education, New Delhi.
- Saxena, H.C. (1998) : Calculus of Finite Difference, S. Chand &  
Co.
- Sastry, S.S. (1999) : Introductory Methods of Numerical  
Analysis, Prentice Hall, India.
- S.C Gupta and Kapoor, V.K. : Fundamentals of Mathematical  
(2000) Statistics, S. Chand and Co.
- Snedecor, G. W. and Cochran, : Statistical Methods. Sixth Edition  
W.G. (1968)
- Bhattacharyya, G. K. and : Statistical Concepts and Methods, Wiley  
Johnson, R. A. (1977) Series, New York

5<sup>th</sup> SEMESTER (HONOURS)

STEJ – 52 (TH)

Linear Models, Regression, Design of Experiments and Operations Research.  
(Theory)

Marks : 75

Lectures : 75

- Unit-I: Linear Models: theory of linear estimation, estimability of linear parametric function and BLUE, method of least squares, Gauss-Markov theorem, Gauss – Markov linear model. **Lectures : 15**
- Unit-II: Regression analysis : estimation and tests of regression parameters in simple and multiple linear regression under usual assumptions, related interval estimation. Violation of usual assumptions concerning normality, homoscedasticity and collinearity. Diagnostics using probability plots. Co relation ratio and co relation index. **Lectures : 15**
- Unit-III: Two way classifications with m observations per cell under fixed, random and mixed effects models.  $3^2$  factorial experiments. Complete and partial confounding under  $2^3$  factorial experiment. Analysis of covariance (one way and two way) **Lectures : 15**
- Unit-IV: Linear programming: introduction, definition of general linear programming problems, formulation and examples of LPP, problems occurring in various fields, graphical method of solving an LPP, slack & surplus variables. **Lectures : 15**
- Unit-V: Representation of transportation and assignment problem as LPP, solution of transportation problems using initial basic feasible solution by North-West corner rule, Matrix minima and Vogel's methods, assignment problem using Hungarian method. **Lectures : 15**

Text Books :

- Joshi, D. D. (2003) : Linear Estimation and Design of Experiments, New Age International Publishers, New Delhi
- Biswas, S.(1998) : A Linear Model's Approach to Regression Analysis and its Applications

- Montgomery, D. C., Peak, E. A.: Introduction to Linear Regression Analysis, 3<sup>rd</sup> Edn, Wiley  
and Vining G.G.(2010)
- Gass, S. I (2003) : Linear Programming: Methods and Applications
- Hadley, G. (1962) : Linear Programming, Addison-Wesley Pub
- Das, M. N. and Giri, N. C. : Design and Analysis of Experiments, New  
(2006) age international Publishers, New Delhi.

Reference:

- ✓ Searle, S. R. (1997) : Linear Models, John Wiley
- ✓ Draper, N.R. and Smith, H. : Applied Regression Analysis, John Wiley.  
(1981)
- Kanti Sarup, Gupta, P. K. : Operations Research.  
and Monmohan (1998)
- Goel, B. S. and Mittal S. K. : Operations Research Pragati Prakashan  
(1974) Meerut. U.P.
- Chatterjee, S. and Price, P. : Regression Analysis by example, Second  
(1991) Edition, John Wiley & Sons.
- ✓ Cochran, W.G and Cox, G.M : Experimental Designs, 2nd Edition  
(1992)
- Federer, W. T. (1955) : Experimental design: theory and application

**5<sup>th</sup> SEMESTER (HONOURS)**

**STEh – 52(PR)**

**Regression, Design of Experiments and Operations Research (Practical).**

- Unit-I: 1. Estimation of regression coefficients by least square method.  
2. Testing of hypothesis concerning regression coefficients, correlation coefficients for simple and multiple regressions  
3. Confidence intervals.  
4. Problems based on residual analysis.
- Unit II: 5. ANOVA for two way classified data with m observations per cell.  
6. Factorial Experiments:  $2^3$  &  $3^2$

7. Complete and partial confounding for  $2^3$ .
8. Covariance analysis.

Unit-III: 9. Solving LPPs by graphical method.

10. Problem based on Transportation problem: (a) Vogel Method and (b) North West corner rule
11. Solution of assignment problem by Hungarian Method

Reference :

- |  |   |  |
|--|---|--|
| Montgomery, D. C., Peak E. A. and Vining G.G. (2010) | : | Introduction to Linear Regression Analysis, 3 <sup>rd</sup> Edn, Wiley           |
| Gass, S. I (2003)                                    | : | Linear Programming: Methods and Applications                                     |
| Hadley, G. (1962)                                    | : | Linear Programming, Addison-Wesley Pub   |
| Das, M. N. and Giri, N. C. (2006)                    | : | Design and Analysis of Experiments, New age international Publishers, New Delhi. |
| Federer, W. T. (1955)                                | : | Experimental design: theory and application                                      |
| Draper, N.R. and Smith, H. (1981)                    | : | Applied Regression Analysis, John Wiley.   |
| Kanti Sarup, Gupta, P. K. and Monmohan (1998)        | : | Operations Research.   |
| Chatterjee, S. and Price, P. (1991)                  | : | Regression Analysis by example, Second Edition, John Wiley & Sons.               |
| Cochran, W. G. and Cox, G. M. (1992)                 | : | Experimental Designs, 2nd Edition  |
| Snedecor, G. W. and Cochran, W.G. (1968)             | : | Statistical Methods. Sixth Edition   |

6<sup>th</sup> SEMESTER (HONOURS)

STEh - 61 (TH)

Statistical Inference (Theory)

Marks : 75

Lectures : 75

- Unit-I: Point estimation: properties of estimators, mean square error(MSE) and minimum MSE estimation, unbiasedness and minimum variance unbiased estimators (MVUE), Rao-Crammer Lower Bound of variance and related results, relative efficiency of an estimator. Amount of information, consistency of estimators and sufficient conditions for consistency. Sufficient statistic and optimal estimators, idea of sufficient statistics with illustration, Rao-Blackwell theorem. **Lectures : 15**
- Unit-II: Method of Estimation: Method of maximum likelihood, method of moments, statement and properties of MLE. Method of minimum chi-square. Interval estimation - general method of constructing confidence interval, confidence interval for the parameter of binomial, Poisson and normal distributions. **Lectures : 15**
- Unit-III: Testing of Hypotheses: statistical hypotheses-simple and composite, statistical tests, critical region, errors of Type-I and Type-II, size and power of a test, definition of most Powerful (MP), uniformly most powerful (UMP) and unbiased test. **Lectures : 15**
- Unit-IV: Neymann-Pearson Lemma and its application in testing of hypotheses regarding binomial, Poisson, normal and Exponential distributions. Power functions of UMP tests with simple illustrations. Likelihood Ratio tests for parameters of binomial and Poisson. Sequential tests - Walds SPRT with illustrations. Approximate OC and ASN functions for tests regarding parameters of binomial and normal distributions. **Lectures : 15**
- Unit-V: Large Sample Tests: Use of CLT to obtain large sample tests for binomial proportion, difference of two binomial proportions, mean of a population and difference of means of two independent populations. Related confidence intervals. **Lectures : 15**

Text Book :

- Hogg, R.V and Tanis, E. A : Probability and Statistical Inference,  
(2003) Pearson Education, New Delhi
- Mood, A. M. and Graybill, F. A : Introduction to the theory of Statistics, Mc  
(1963) Graw Hill Book Co. New York.
- Goon, A. M., Gupta, M. K. and : An outline of Statistical theory, Vol. II. The

- Das Gupta, B. (2003) : World Press Private Limite.
- Hogg, R. V. and Craig, A. T : Introduction to Mathematical Statistics, Mac  
(1978) - Millan.
- Kendall, M. G. and Stuart : The advanced Theory of Statistics, Vol. II.  
Charles Griffin.

**Reference:**

- Casella, G. and Berger, R. L. : Statistical Inference, 2<sup>nd</sup> Edn., Duxbury  
(2002)
- Das, Kishore K. and : A Treatise on Statistical Inference and  
Bhattacharjee, D (2008) Distribution. Asian Book House, New Delhi.
- Rao, C. R. (1973) : Linear Statistical Inference and its  
applications. John Wiley and Sons, New York.
- Rohagi, V. K and Saleh, A.K.M : An Introduction to Probability and Statistics,  
(2001) 2<sup>nd</sup> edn., John Wiley
- Chaudhuri, Salil Kumar and : Statistical Methods, Asian Book House,  
Chakrabarty, A. (2010) New Delhi.
- Bhattacharyya, G. K. and : Statistical Concepts and Methods, Wiley  
Johnson, R.A. (1977) Series, New York

**6<sup>th</sup> SEMESTER (HONOURS)**

**STH – 61 (PR)**

**Statistical Inference (Practical)**

- Unit-I: 1. Estimation of parameter by MLE.  
2. Estimation of parameter by method of moments.  
3. Estimation of parameter by minimum chi-square.
- Unit-II: 4. Construction of confidence interval of binomial distribution.  
5. Construction of confidence interval of poison distribution.  
6. Construction of confidence interval of normal distribution.
- Unit-III: 7. SPRT for binomial distribution for finding OC and ASN function.  
8. SPRT for normal distribution for finding OC and ASN function.

9. Large sample tests & corresponding confidence interval.

Reference:

- Hogg, R. V. and Tanis, E. A. : Probability and Statistical Inference,  
(2003) Pearson Education, New Delhi
- Bhattacharyya, G. K. and : Statistical Concepts and Methods, Wiley  
Johnson, R.A. (1977) Series, New York
- Das, Kishore K. and : A Treatise on Statistical Inference and  
Bhattacharjee, D (2008) Distribution. Asian Book House, New Delhi.
- Mood, A. M., Graybill, F. A. : Introduction to the theory of Statistics, Mc  
And Boes, D. C. (1974) Graw Hill Book Co. New York.
- Hogg, R. V. and Craig, A. T. : Introduction to Mathematical Statistics, Mac  
(1978) - Millan.
- Kendall, M. G. and Stuart, A. : The advanced Theory of Statistics, Vol. 1.  
Charles Griffin.
- Chaudhuri, Salil Kumar and : Statistical Methods, Asian Book House,  
Chakrabarty, A. (2010) New Delhi.

6<sup>th</sup> SEMESTER (HONOURS)

STEh – 62 (TH)

Survey Sampling and Non parametric Inference (Theory)

Marks : 75

Lectures : 75

- Unit-I: Linear Systematic sampling- populations with linear trend, estimation of variance using interpenetrating sub-samples (IPSS). Circular Systematic sampling- estimation of the population mean and population total and their variances, estimation of variance using IPSS , Ratio, difference and Regression methods of estimation under SRSWR and SRSWOR- Bias and MSE and their large sample estimation. **Lectures : 15**
- Unit-II: Cluster sampling: single stage cluster sampling with equal size cluster using SRSWR and SRSWOR , estimation of population mean and total, variance in terms of intraclass correlation. Estimation of variance. **Lectures : 15**
- Unit-III: Two Stage Sampling : with equal size first stage units (FSUs) SRSWR at both stages, SRSWOR at both stages, SRSWR at first and SRSWOR at second stage, SRSWOR at first and SRSWR at second stage – Estimation of population mean per Second Stage Units (SSUs) and its sampling variance. Estimation of sampling variance. Estimation of population total. **Lectures : 15**
- Unit-IV: Definition of order statistics, derivation of the distribution of order statistics from Uniform distribution only, joint distribution of two order statistics, distribution of functions of order statistics- sample median, sample range and sample mid range. **Lectures : 15**
- Unit-V: Parametric versus Non-parametric, distribution free methods, areas of applications, non- parametric tests - sign test for location for univariate and bivariate populations, Wilcoxon rank test, Mann-Whitney tests, Kolmogorov-Smirnov test (one sample and two sample) and Median test. **Lectures : 15**

Text Books:

- Murthy, M. N. (1967) : Sampling Theory and Methods Statistical Publishing Society.
- Sampath, S. (2005) : Sampling Theory and Methods, Alpha Science International
- Cochran, W. G. (1977) : Sampling Techniques, John Wiley and Wiley Eastern.
- David, H. A. (1970) : Order Statistics, John Wiley.
- Gibbons, J. D. and Chakrabarty, S. (1985) : Non Parametric Methods for Quantitative Analysis, American Sciences Press.

Reference :

- Sukhatma, P. V., Sukhatme, B. V., Sukhatma, S. and Asok, C. (1984) : Sampling Theory of Surveys with applications, Asia Publishing House.
- Goon A.M., Gupta, M.K. and Dasgupta, B(1999) : Fundamental of Statistics, Vol-II, World Press Kolkata
- Raj, D, Chandhok (1999) : Sample Survey Theory, Narosa Publishing House
- Mukhopadhyay, P (1998) : Theory and Methods of Survey Sampling
- Siegal, S. (1956) : Non Parametric Statistics for the behavioral Sciences, Mc Graw – Hill.

**6<sup>th</sup> SEMESTER (HONOURS)**

**STH – 62 (PR)**

**Survey Sampling and Non parametric Inference (Practical)**

- Unit-I
1. Estimation of Population mean and totals and Standard errors by IPSS in LSS and CSS.
  2. Sampling Variance in case CSS in terms of intraclass correlation coefficient and its efficiency w.r.t. SRSWR and SRSWOR
  3. Ratio and Regression methods of Estimation using SRSWR and SRSWOR
- Unit-II:
4. Cluster sampling – with equal size cluster estimation of mean and total and their SEs in SRSWR and SRSWOR and variance in terms of intraclass correlation coefficient
  5. Two Stage Sampling- estimation of mean and total and their SEs with SRSWR and SRSWOR at both the stages and SRSWR at the first and SRSWOR at the 2<sup>nd</sup> stages and and SRSWOR at the first and SRSWR at the 2<sup>nd</sup> stages
- Unit-III: Non-parametric tests:
6. Sign test – for univariate and bivariate population (one sample and two sample).
  7. Kolmogorov –Smirnov test (one sample and two sample).
  8. Wilcoxon rank test (one sample and two sample).

9. Mann-Whitney test (one sample and two sample).
10. Median test (one sample and two sample).

Reference:

- Cochran, W. G. (1977) : Sampling Techniques, John Wiley and Wiley Eastern.
- Murthy, M. N. (1967) : Sampling Theory and Methods Statistical Publishing Society.
- Singh, D., Chaudhary (1995) : Theory and Analysis of Sample Survey Design,
- Siegal, S. (1956) : Non Parametric Statistics for the behavioral Sciences, Mc Graw – Hill.
- Gibbons, J. D. and Chakrabarthy, S. (1985) : Non Parametric Methods for Quantitative Analysis, American Sciences Press.