STA-HC-4016

Statistical Inference

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

8.1 Theory

8.1.1 Unit 1: *Estimation*: (Lectures: 20)
Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems (statement only). Cramer-Rao inequality and MVB estimators.

8.1.2 Unit 2: *Methods of Estimation*: (Lectures: 19)
Method of moments, method of maximum likelihood estimation, method of minimum Chi-square.

8.1.3 Unit 3: *Principles of test of significance*: (Lectures: 18)
Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).

8.1.4 Unit 4: *Principles of test of significance*: (Lectures: 3)
Sequential Analysis: Introduction to Sequential probability ratio test (SPRT).

8.2 Practical/Lab

List of Practical
1. Unbiased estimators (including unbiased but absurd estimators)
2. Consistent estimators, efficient estimators and relative efficiency of estimators.
3. Cramer-Rao inequality and MVB estimators
4. Sufficient Estimators – Factorization Theorem, Rao-Blackwell theorem, Complete Sufficient estimators
5. Lehman-Scheffe theorem and UMVUE
6. Maximum Likelihood Estimation
7. Estimation by the method of moments, minimum Chi-square
8. Type I and Type II errors
9. Most powerful critical region (NP Lemma)
10. Uniformly most powerful critical region
11. Unbiased critical region
12. Power curves
13. Likelihood ratio tests for simple null hypothesis against simple alternative hypothesis
14. Likelihood ratio tests for simple null hypothesis against composite alternative hypothesis
15. Asymptotic properties of LR tests

SUGGESTED READINGS:

1   Goon, A.M., Gupta, M.K.: Das Gupta, B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
2. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.
3. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
5. Mood, A.M, Graybill, F.A. and Boes, D.C,: Introduction to the Theory of Statistics, McGraw Hill.
6. Bhat, B.R, Srivenkatramana, Tand Rao Madhava, K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7. Snedecor, G.W and Cochran, W.G.(1967) Statistical Methods. Iowa State University Press.

STA-HC-4026

Linear Models

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

9.1 Theory

9.1.1 Unit 1: *Gauss-Markov Set-up*: (Lectures: 12)
Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

9.1.2 Unit 2: *Regression Analysis*: (Lectures: 15)
Simple regression analysis, Estimation and hypothesis testing in case of simple regression models.

9.1.3 Unit 3: *Analysis of Variance*: (Lectures: 18)
Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models.

9.1.4 Unit 4: *Model Checking*: (Lectures: 15)
Prediction from a fitted model, Violation of assumptions of AOV and their remedies by transformation.

9.2 Practical/Lab

List of Practical
1. Estimability when X is a full rank matrix and not a full rank matrix
2. Distribution of Quadratic forms
3. Simple Linear Regression
4. Multiple Regression
5. Tests for Linear Hypothesis
6. Bias in regression estimates
7. Lack of fit
8. Orthogonal Polynomials
9. Analysis of Variance of a one way classified data
10. Analysis of Variance of a two way classified data with one observation per cell
11. Analysis of Covariance of a one way classified data
12. Analysis of Covariance of a two way classified data

SUGGESTED READINGS:

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.

SUGGESTED READINGS:

1 Goon, A.M., Gupta, M.K.: Das Gupta, B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
2. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2^{nd}Edn. (Reprint) John Wiley and Sons.
3. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
5. Mood, A.M, Graybill, F.A. and Boes, D.C,: Introduction to the Theory of Statistics, McGraw Hill.
6. Bhat, B.R, Srivenkatramana, Tand Rao Madhava, K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7. Snedecor, G.W and Cochran, W.G.(1967) Statistical Methods. Iowa State University Press.

STA-HC-4036

Statistical Quality Control

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

10.1 Theory

10.1.1 Unit 1: *Statistical Process Control*: (Lectures: 18)
Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II, historical perspective of Quality Gurus and Quality Hall of Fame. Quality system and standards: Introduction to ISO quality standards, Quality registration. Statistical Process Control - Seven tools of SPC, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3-σ Control charts, Rational Sub-grouping.

10.1.2 Unit 2: *Control Charts for Variables*: (Lectures: 18)
X-bar & R-chart, X-bar & s-chart. Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability.

10.1.3 Unit 3: *Acceptance Sampling Plan*: (Lectures: 20)
Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.

10.1.4 Unit 4: *Six-Sigma*: (Lectures: 4)
Introduction to Six-Sigma: Overview of Six Sigma.

10.2 Practical/Lab

List of Practical
1. Construction and interpretation of statistical control charts X-bar & R-chart
   - X-bar & s-chart
   - np-chart
   - p-chart
   - c-chart
   - u-chart
2. Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves
3. Calculation of process capability and comparison of 3-sigma control limits with specification limits.

SUGGESTED READING:

1. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

3. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.

4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.

5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press.

6. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.

STA – SE - 4014

Statistical Data Analysis using R

Total Lectures: 20 Credits: 4 (Theory: 02, Practical/Lab: 02)

29.1 Theory/Practical/Lab

This course will review and expand upon core topics in probability and statistics through the study and practice of data analysis and graphical interpretation using 'R'.

29.1.1 Unit 1: *Plotting Graphs*: (Lectures: 8)
Learn how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data
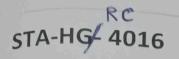
29.1.2 Unit 2: *Report Generation*: (Lectures: 6)
Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.

29.1.3 Unit 3: *Generation of Random Numbers*: (Lectures: 8)
Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.

29.1.4 Unit 4: *Statistical Analysis*: (Lectures: 8)
Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.

SUGGESTED READING:

1. Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley Publications.

2. Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York

Applied Statistics

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

26.1 Theory

26.1.1 Unit 1: *Time Series*: (Lectures: 12)
Economic Time Series: Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential).Measurement of seasonal variations by method of ratio to trend.

26.1.2 Unit 2: *Index Numbers*: (Lectures: 12)
Index numbers: Definition, Criteria for a good index number, different types of index numbers. Construction of index numbers of prices and quantities, consumer price index number. Uses and limitations of index numbers.

26.1.3 Unit 3: *Statistical Quality Control*: (Lectures: 12)
Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts

26.1.4 Unit 4: *Demography*: (Lectures: 12)
Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates. Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.

26.1.5 Unit 5: *Demand Analysis*: (Lectures: 12)
Demand Analysis: Theory of consumption and demand, demand function, elasticity of demand, determination of elasticity of demand by family budget method, Lorentz curve and Gini's coefficient, Engel's law and Engel's curve, Pareto's law of income distribution.

SUGGESTED READING:

1 Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.

2 Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.

3 Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edition (Reprint), Sultan Chand & Sons

4 Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.