

## **STT 16**

## **ASYMPTOTIC INFERENCE**

**UNIT I:** Consistency and asymptotic normality (CAN) of real and vector parameters. Invariance of consistency under continuous transformation.

**UNIT II:** Invariance of CAN estimators under differentiable transformations, generation of CAN estimators using central limit theorem.

**UNIT III:** Method of moments, method of maximum likelihood, Special cases such as exponential class of densities and multinomial distribution, Cramer-Huzurbazar theorem, method of scoring.

**UNIT IV:** Tests based on MLEs. Likelihood ratio tests, asymptotic distribution of log likelihood ratio, Wald Test, Score Test, locally most powerful tests, Bartlett's test for homogeneity of variances.

**UNIT V:** Applications to categorical data analysis, three dimensional contingency tables, Pearson's chi-square test and LR test. Asymptotic comparison of tests. Asymptotic Relative Efficiency (Pitman's), asymptotic normality of posterior distributions.

### **REFERENCES:**

- 1) Kale B.K. (2005) A First Course on Parametric Inference, Second Edition, Narosa.
- 2) Cramer, H.(1974) Mathematical Methods in Statistics, Princeton Univ. Press.
- 3) Rao, C. R.(1995) Linear Statistical Inference and its Applications, Wiley Eastern Ltd.
- 4) Silvey, S. D.(1975) Statistical Inference, Chapman- Hall.
- 5) Wilks, S.S.(1962) Mathematical Statistics, John Wiley.
- 6) Ferguson, T.S. (1996) A Course in Large Sample Theory, Chapman and Hall.

## **STT 17(A) STATISTICAL METHODS IN FINANCE**

**UNIT I:** Introduction and behavior of Returns, Origins of Random Walk Hypothesis, Efficient Market Hypothesis(EMH). Discrete and Continuous compounding.

**UNIT II:** Trading Off Expected Return and Risk, One Risky Asset and Two Risky Assets. Combining Two Risky Assets with a Risk-Free Asset. Risk-Efficient Portfolios with N Risky Assets.

**UNIT III:** Introduction to Capital Asset Pricing Model(CAPM). Capital Market Line(CML). Betas and the Security Market Line, Security Characteristic Line. Estimation of Beta and Testing CAPM.

**UNIT IV:** Introduction of Option Pricing, Call Options. The law of One Price. Time value of Money and Present Value, Pricing Calls. Martingales. Introduction of Fixed Income Securities. Zero-Coupon Bonds, Yield to Maturity, Term Structure.

**UNIT V:** Introduction of Resampling, Resampling and efficient Portfolios. Need for Risk Management, Value-At-Risk(VaR) with one asset, VaR for a Portfolio Assets.

### **REFERENCES:**

- 1) David Ruppert,(2004) Statistics and Finance –An Introduction, Springer Texts in Statistics.
- 2) R. A. Johnson e D. W. Wichern,(2007) Applied Multivariate Statistical Analysis, 6th edition, Prentice Hall, New Jersey.
- 3) S. J. Sheather(2009) A Modern Approach to Regression with R, Springer Texts in Statistics.

## **STT 17(B)**

## **DEMOGRAPHY**

**UNIT I:** Definition and Scope: Basic demographic concept and components of population dynamics. Coverage and content errors in demographic data, use of balancing equations to check completeness of registration data. Adjustment of age data. Use of Whipple, Myer and UN indices. Population composition, dependency ratio.

**UNIT II :** Measure of Fertility : Stochastic models for reproduction, distribution of time to first birth, inter live birth intervals and of number of births (for both homogeneous and non-homogeneous groups of women), estimation of parameters, estimation of parity progression ratios from open birth interval data

**UNIT III:** Measure of Mortality: Various measures of mortality, infant mortality rate, cause specific death rate and standardised death rates. Construction of a bridge life table. Distribution of life table functions and their estimation.

**UNIT IV:** Migration : Indirect measures of net-internal migration. National growth rate method. Stochastic models for migration and for Social and occupational mobility based on Markov chains. Estimation of Measures of Mobility.

**UNIT V:** Measurement of Population Change : Linear, Geometric, exponential, Gompertz, Logistic Population growth models. Methods of population projection, use of Leslie matrix. Stable and Quasi Stable populations, intrinsic growth rate. Models for population growth and their fitting to population data. Stochastic models for population growth.

### **REFERENCES:**

- 1) Pollard A. H., Pollard G.N. and Yusuf F. Demographic Techniques.
- 2) Pollard J.H. Mathematical models for the growth of Human Populations
- 3) Benjamin,B.(1969) Demographic Analysis, George, Allen & Unwin.
- 4) CoxP.R.(1970) Demography, Cambridge University Press.
- 5) Keyfitz N. (1977) Applied Mathematical Demography, Springer Verlag.
- 6) Spiegelman M. (1969) Introduction to Demographic Analysis, Harvard Uni. Press.
- 7) Bartholomew D.J. (1982) Stochastic Models for Social Processes, John Wiley.

## STT 18

## ACTUARIAL STATISTICS

**UNIT I:** Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality. Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.

**UNIT II:** Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

**UNIT III:** Life insurance: Insurance payable at the moment's of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance. Life annuities: Continuous life annuities, discrete life annuities, life annuities with monthly payments.

**UNIT IV:** Net premiums: Continuous and discrete premiums, true monthly payment premiums. Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses. Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi continuous basis, reserves based on true monthly premiums.

**UNIT V:** Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws. Distribution of aggregate claims, compound Poisson distribution and its applications.

### REFERENCES:

1) N. L. Bowers, H. U. Gerber, J. C. Hickman, D. A. Jones and C. J. Nesbitt, (1986) Actuarial Mathematics', Society of Actuaries, Itasca, Illinois, U. S. A. Second Edition (1997)

Section I – Chapters: 1, 2, 3, 8, 9, and 11

Section II – Chapters: 4, 5, 6, 7, 13, and 14

2) Deshmukh S.R. (2009) An Introduction to Actuarial Statistics Using R , Universities Press.

### ADDITIONAL REFERENCES:

1) Spurgeon E. T. (1972) Life Contingencies, Cambridge University Press.

2) Neill, A. (1977) Life Contingencies, Heinemann.

## **STT 19**

## **SURVIVAL ANALYSIS**

**UNIT I:** Basic concepts of Time, Order and Random Censoring. Life distributions - Exponential Gamma, Weibull, Lognormal, Pareto, Linear Failure rate.

**UNIT II:** Parametric inference Point estimation, Confidence Intervals, Scores, tests based on LR, MLE Life tables, Failure rate, mean residual life and their elementary properties. Ageing classes - IFR, IFRA, NBU, NBUE, HNBUE and their duals, Bathtub Failure rate.

**UNIT III:** Estimation of survival function - Actuarial Estimator, Kaplan - Meier Estimator, Estimation under the assumption of IFR/DFR.

**UNIT IV:** Tests of exponentiality against non-parametric classes - Total time on test, Deshpande test. Two sample problem - Gehan Test, Log rank test. Mantel - Haenszel Test, Tarone -Ware tests.

**UNIT V:** Semi-parametric regression for failure rate - Cox's proportional hazards model with one and several covariates.

### **REFERENCES:**

- 1) Cox, D.R. and Oakes, D. (1984) Analysis of Survival Data, Chapman and Hall, New York.
- 2) Gross A.J. and Clark, V. A. (1975) Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and Sons.
- 3) Elandt - Johnson, R.E. Johnson N.L. (1980) Survival models and Data Analysis, John Wiley.
- 4) Miller, R.G. (1981) Survival Analysis, Wiley.
- 5) Zacks, S. Reliability.

## **STT 20(A)**

## **DATA MINING TECHNIQUES**

**UNIT I:** Review of classification methods from multivariate analysis, classification and decision trees.

**UNIT II:** Clustering methods from both statistical and data mining viewpoints, vector quantization.

**UNIT III:** Unsupervised learning from univariate and multivariate data, Dimension reduction and feature selection.

**UNIT IV:** Supervised learning from moderate to high dimensional input spaces, artificial neural networks and extensions of regression models, regression trees.

**UNIT V:** Introduction to databases, including simple relational databases, data warehouses and introduction to online analytical data processing. Association rules and prediction, data attributes, applications to electronic commerce.

### **REFERENCES:**

- 1) Berson, A. and Smith, S.J. (1997) Data Warehousing, Data Mining, and OLAP, McGraw-Hill.
- 2) Breiman, L., Friedman, J.H., Olshen, R.A. and Stone, C.J. (1984) Classification and Regression Trees, Wadsworth and Brooks/Cole.
- 3) Han, J. and Kamber, M. (2000) Data Mining; Concepts and Techniques, Morgan Kaufmann.
- 4) Mitchell, T.M. (1997) Machine Learning, McGraw-Hill.
- 5) Ripley, B.D. (1996) Pattern Recognition and Neural Networks, Cambridge University Press.

## **STT 20(B)**

## **DIRECTIONAL DATA ANALYSIS**

**UNIT I:** Graphical representation of data, Frequency distribution, Measures of location, circular variance and concentration, Correction for mean grouping, Measures of skewness and kurtosis.

**UNIT II:** Circular models, distribution theory, independence, convolution, moments, distributions of an arc, mixtures, lattice distributions, wrapped normal, Cauchy, Poisson distributions, Von Mises, Fisher distribution characteristics functions, Polar distributions, isotropic random walk on the circle.

**UNIT III:** Point estimation, Cramer Rao type bound, sufficiency, Methods of estimation.

**UNIT IV:** Testing hypothesis from parametric models. Neyman-Pearson and likelihood ratio principles.

**UNIT V:** Non-parametric methods: Tests for randomness, goodness of fit, Rayleigh's test. Durand and Greenwood's test, Range test, Kuper's test Watson's test, Uniform score tests, Runs test, Rank sum test, Test for dispersion.

### **REFERENCES:**

- 1) Mardia K.V. (1972): Statistics of Directional data, Academic Press.
- 2) Batschelet E. (1981): Circular Statistics in Biology, Academic Press.
- 3) Watson G. S. (1983): Statistics on Spheres, Wiley.