

**Course Contents  
of  
Post-graduate degree Programme  
Ph.D. (Statistics)**



**Division of Statistics & Computer Science,  
Faculty of Basic Sciences,  
*Sher-e-Kashmir University of Agricultural Sciences & Technology - Jammu.*  
Main Campus, Chatha, Jammu (J&K)- 180009.**

**STAT 601    ADVANCED STATISTICAL METHODS            2+0    Sem-II**

**Theory**

UNIT I

Ridge regression: Basic form, Use as a selection procedure. Robust regression: Least absolute deviations regression, M-estimators, Least median of squares regression. Nonparametric regression.

UNIT II

Introduction to the theory and applications of generalized linear models, fixed effects, random effects and mixed effects models, estimation of variance components from unbalanced data. Unified theory of least -squares, MINQUE, MIVQUE, REML.

UNIT III

Generalized estimating equations – logistic regression, over-dispersion, Poisson regression, log-linear models, conditional likelihoods, generalized mixed models, and regression diagnostics. Theory of statistical methods for analyzing categorical data by means of linear models; multifactor and multi-response situations; interpretation of interactions. Fitting of a generalized linear model, mixed model and variance components estimation.

UNIT IV

Fitting of Logistic regression, Poisson regression, ridge regression, robust regression, non-parametric regression.

**Suggested Readings**

- Draper NR & Smith H. 1998. *Applied Regression Analysis*. 3rd Ed. John Wiley.  
Rao CR. 1965. *Linear Statistical Inference and its Applications*. 2nd Ed. John Wiley.  
Searle SR, Casella G & McCulloch CE. 1992. *Variance Components*. John Wiley.  
Searle SR. 1971. *Linear Models*. John Wiley.

**STAT 602    ADVANCED STATISTICAL INFERENCE            3+0            Sem-II**

**Theory**

UNIT I

Robust estimation and robust tests, Robustness, M-estimates. L-estimates, asymptotic techniques, Bayesian inference. Detection and handling of outliers in statistical data.

UNIT II

Loglinear models, saturated models, hierarchical models, Analysis of multi- dimensional contingency tables. Non-parametric maximum likelihood estimation.

UNIT III

Density Estimation: Density Estimation in the Exploration and Presentation of Data. Survey of existing methods. The Kernel method for Univariate Data. Consistency of general Kernel estimators, MSE and IMSE. Asymptotic normality of Kernel estimates of density. Estimation of distribution by method of kernels.

UNIT IV

Consistency and asymptotic normality (CAN) of real and vector parameters. Invariance of consistency under continuous transformation. Invariance of CAN estimators under differentiable transformations, generation of CAN estimators using central limit theorem. Exponential class of densities and multinomial distribution, Cramer-Huzurbazar theorem.

UNIT V

Efficiency: asymptotic relative efficiency and Pitman's theorem. Concepts and examples of Bahadur efficiency and Hodges-Lehmanns efficiency with examples. The concepts of Rao's second order efficiency and Hodges-Lehmann's Deficiency with examples. Rank tests, permutation tests, asymptotic theory of rank tests under null and alternative (contiguous) hypotheses.

UNIT VI

Concept of loss, risk and decision functions, admissible and optimal decision functions, a-priori and posteriori distributions, conjugate families. Bayes and Minimax decision rules and some basic results on them. Estimation and testing viewed as cases of decision problems. Bayes and Minimax decision functions with applications to estimation with quadratic loss function. Concept of Bayesian sequential analysis. Bayes sequential decision rule. The SPRT as a Bayes procedure. Minimax sequential procedure.

#### UNIT VII

U-Statistics: definitions of estimable parametric function, kernel, symmetric kernel and U-statistics. Variance and covariance of U-statistics, the Infinitesimal Jackknife, the Delta and the Influence function methods. Resampling Plans : Estimation of standard and biased deviation of point estimator by the Jackknife, the Bootstrap.

#### **Suggested Readings**

- Ferguson TS. 1967. *Mathematical Statistics, A Decision Theoretic Approach*. Academic Press.  
Gibbons JD & Chakraborty S. 1992. *Non-parametric Statistical Inference*. Marcel Dekker.  
Gray HL & Schucany WR. 1972. *The Generalized Jackknife Statistics*. Marcel Dekker.  
Kale BK. 1999. *A First Course on Parametric Inference*. Narosa Publ.  
Prakasa Rao BLS. 1983. *Nonparametric Functional Estimation*. Academic Press.  
Rao CR. 1965. *Linear Statistical Inference and its Applications*. 2nd Ed. John Wiley.  
Silverman BW. 1986. *Density Estimation for Statistics and Data Analysis*. Chapman & Hall.  
Silvey SD. 1975. *Statistical Inference*. Chapman & Hall.  
Tapia RA & Thompson JR. 1978. *Nonparametric Probability Density Estimation*. Johns Hopkins Univ. Press.  
Tiku ML, Tan WY & Balakrishna N. 1986. *Robust Inference*. Marcel Dekker.  
Wald A. 2004. *Sequential Analysis*. Dover Publ. Wasserman L. 2006. *All of Nonparametric Statistics*. Springer.

### **STAT 603    ADVANCED SAMPLING TECHNIQUES**

**2+0**

**Sem-II**

#### **Theory**

##### UNIT I

Controlled selection. Two way stratification, collapsed strata. Systematic sampling in two dimensions. Use of combinatorics in controlled selection. Integration of surveys - Lahiri and Keyfitz's procedures.

##### UNIT II

Variance estimation in complex surveys. Taylor's series linearisation, balanced repeated replication, Jackknife and bootstrap methods.

##### UNIT III

Unified theory of sampling from finite populations. UMV - Non-existence theorem and existence theorem under restricted conditions. Concept of sufficiency and likelihood in survey sampling. Admissibility and hyper-admissibility.

##### UNIT IV

Inference under super population models - concept of designs and model unbiasedness, prediction approach. Regression analysis and categorical data analysis with data from complex surveys. Small area estimation.

##### UNIT V

Stochastic parameter models, Bayes' linear predictor, Bayesian models with multi-stage sampling. Measurement error and small area estimation, Time series approach in survey sampling. Dynamic Bayesian prediction, Kalman filter, Empirical and Hierarchical Bayes predictors.

#### **Suggested Readings**

- Berger JO. 1993. *Statistical Decision Theory and Bayesian Analysis*. Springer.  
Bolfarine H & Zacks S. 1992. *Prediction Theory for Finite Population Sampling*. Springer.  
Cassel CM, Sarndal CE & Wretman JH. 1977. *Foundations of Inference in Survey Sampling*. John Wiley.  
Des Raj & Chandhok P. 1998. *Sample Survey Theory*. Narosa Publ. House.

- Ghosh M & Meeden G. 1997. *Bayesian Method for Finite Population Sampling. Monograph on Statistics and Applied Probability*. Chapman & Hall.
- Mukhopadhyay P. 1998. *Theory and Methods of Survey Sampling*. Prentice Hall of India.
- Rao JNK. 2003. *Small Area Estimation*. John Wiley.
- Sarndal CE, Swensson B & Wretman JH. 1992. *Model Assisted Survey Sampling*. Springer.

**STAT 604      ADVANCED DESIGN OF EXPERIMENTS                      2+0                      Sem-I**

**Theory**

UNIT I

General properties and analysis of block designs. Balancing criteria.  $M$  associate PBIB designs, and their association schemes including lattice designs - properties and construction, Designs for test treatment – control(s) comparisons; Nested block designs.

UNIT II

General properties and analysis of two-way heterogeneity designs, Youden type designs, generalized Youden designs, Pseudo Youden designs. Structurally Incomplete block designs, Designs for two sets of treatments.

UNIT III

Balanced factorial experiments - characterization and analysis (symmetrical and asymmetrical factorials). Factorial experiments with extra treatment(s). Orthogonal arrays, Mixed orthogonal arrays, balanced arrays, Fractional replication, Regular and irregular fractions.

UNIT IV

Response surface designs - Symmetrical and asymmetrical factorials, Response optimization and slope estimation, Blocking. Canonical analysis and ridge analysis. Experiments with mixtures: design and analysis. Experiments with qualitative cum quantitative factors.

UNIT V

Optimality criteria and optimality of designs, robustness of designs against loss of data, outliers, etc. Diagnostics in design of experiments.

**Suggested Readings**

- Chakraborti MC. 1962. *Mathematics of Design and Analysis of Experiments*. Asia Publ. House.
- Dean AM & Voss D. 1999. *Design and Analysis of Experiments*. Springer.
- Dey A & Mukerjee R. 1999. *Fractional Factorial Plans*. John Wiley.
- Dey A 1986. *Theory of Block Designs*. Wiley Eastern.
- Hall M Jr. 1986. *Combinatorial Theory*. John Wiley.
- Hedayat AS, Sloane NJA & Stufken J. 1999. *Orthogonal Arrays: Theory and Applications*. Springer.
- John JA & Quenouille MH. 1977. *Experiments: Design and Analysis*. Charles & Griffin.
- Khuri AI & Cornell JA. 1996. *Response Surface Designs and Analysis*. 2<sup>nd</sup> Ed. Marcel Dekker.
- Montgomery DC. 2005. *Design and Analysis of Experiments*. John Wiley.
- Ogawa J. 1974. *Statistical Theory of the Analysis of Experimental Designs*. Marcel Dekker.
- Parsad R, Gupta VK, Batra PK, Satpati SK & Biswas P. 2007. *Monograph on  $\alpha$ -designs*. IASRI, New Delhi.
- Raghavarao D. 1971. *Construction and Combinatorial Problems in Design of Experiments*. John Wiley.
- Shah KR & Sinha BK. 1989. *Theory of Optimal Designs. Lecture notes in Statistics*. Vol. 54. Springer.
- Street AP & Street DJ. 1987. *Combinatorics of Experimental Designs*. Oxford Science Publ.

**STAT 605      RECENT ADVANCES IN THE FIELD OF SPECIALIZATION      1+0      Sem-I / II**

**Theory**

Recent advances in the field of specialization - sample surveys / design of experiments / statistical genetics / statistical modeling / econometrics / statistical inference, etc. will be covered by various speakers from the University / Institute as well as from outside the University / Institute in the form of seminar talks.

**STAT 606    ADVANCED STATISTICAL GENETICS****2+0****Sem-I****Theory**UNIT I

Hardy-Weinberg law with multiple allelic systems, auto-tetraploids and self-sterility alleles. Complex cases of selection with two or more loci.

UNIT II

Different approaches to study inbreeding process, methods of path coefficient, probability and generation matrix. Fisher's approach to inbreeding. Stochastic process of gene frequency change, transition matrix approach using finite Markov chains, diffusion approximation, Steady decay and distribution of gene frequency, Probability of fixation of a gene,.

UNIT III

Prediction and estimation of genetic merit. Best linear unbiased prediction, Use of mixed model methodology in analysis of animal and plant breeding experiments. Newer reproductive technology and its effect in genetic evaluation of individual merit. Estimation of genetic parameters – problems relating to computational aspects of genetic variance components, parameter estimation in variance component models for binary response data.

UNIT IV

Identification of genes with large effects, Use of molecular markers (RFLP, PCR-AFLP, RAPD and SSR), Gene mapping and Quantitative trait loci. Molecular manipulation for genetic variability.

UNIT V

Survival analysis and concept of censored observation in animal breeding. Phylogeny and analysis of molecular variance.

**Suggested Readings**

- Crow JF & Kimura M. 1970. *An Introduction of Population Genetics Theory*. Harper & Row.  
Ewens WJ. 1979. *Mathematical Population Genetics*. Springer.  
Falconer DS. 1985. *Introduction to Quantitative Genetics*. ELBL.  
Fisher RA. 1949. *The Theory of Inbreeding*. Oliver & Boyd.  
Fisher RA. 1958. *The Genetical Theory of Natural Selection*. Dover Publ.  
Haldane JBS. 1932. *The Causes of Evolution*. Harper & Bros.  
Kempthorne O. 1957. *An Introduction to Genetic Statistics*. The Iowa State Univ. Press.  
Lerner IM. 1950. *Population Genetics and Animal Improvement*. Cambridge Univ. Press.  
Lerner IM. 1958. *The Genetic Theory of Selection*. John Wiley.  
Li CC. 1982. *Population Genetics*. The University of Chicago Press.  
Mather K & Jinks JL. 1982. *Biometrical Genetics*. Chapman & Hall.  
Mather K. 1951. *The Measurement of Linkage in Heredity*. Methuen.  
Nagilaki T. 1992. *Introduction to Theoretical Population Genetics*. Springer.  
Narain P. 1990. *Statistical Genetics*. Wiley Eastern.

**STAT 607    STATISTICAL MODELING****1+1****Sem-I****Theory**UNIT I

Empirical and mechanistic models. Nonlinear growth models like monomolecular, logistic, Gompertz, Richards. Applications in agriculture.

UNIT II

Nonlinear estimation: Least squares for nonlinear models, Methods for estimation of parameters like Linearization, Steepest, and Levenberg- Marquardt's Reparameterization.

UNIT III

Two-species systems. Lotka-Volterra, Leslie-Gower and Holling-Tanner non-linear prey-predator models. Volterra's principle and its applications. Gause competition model.

UNIT IV

Compartmental modelling - First and second order input-output systems, Dynamics of a multivariable system.

### Practical

Fitting of mechanistic non-linear models; Application of Schaefer and Fox non-linear models; Fitting of compartmental models.

### Suggested Readings

- Draper NR & Smith H. 1998. *Applied Regression Analysis*. 3rd Ed. John Wiley.  
Efromovich S. 1999. *Nonparametric Curve Estimation*. Springer.  
Fan J & Yao Q. 2003. *Nonlinear Time Series-Nonparametric and Parametric Methods*. Springer.  
France J & Thornley JHM. 1984. *Mathematical Models in Agriculture*. Butterworths.  
Harvey AC. 1996. *Forecasting, Structural Time Series Models and the Kalman Filter*. Cambridge Univ. Press.  
Ratkowsky DA. 1983. *Nonlinear Regression Modelling: A Unified Practical Approach*. Marcel Dekker.  
Ratkowsky DA. 1990. *Handbook of Nonlinear Regression Models*. Marcel Dekker.  
Seber GAF & Wild CJ. 1989. *Non-linear Regression*. John Wiley.  
Silverman BW. 1986. *Density Estimation for Statistics and Data Analysis*. Chapman & Hall.

**STAT 608      ADVANCED TIME SERIES ANALYSIS      2+0      Sem-II**  
**(Pre-requisite STAT 510)**

### Theory

#### UNIT I

Multivariate time series: modelling the mean, stationary VAR models: properties, estimation, analysis and forecasting, VAR models with elements of nonlinearity, Non-stationary multivariate time series.

#### UNIT II

Volatility: Modelling the variance, The class of ARCH models: properties, estimation, analysis and forecasting, stochastic volatility, realized volatility, Extensions: IGARCH, ARCH-t, ARCD, Multivariate GARCH, Time-varying risk and ARCH-in-mean.

#### UNIT III

Structural time-series modelling: State space models, Kalman filter. Local level model, Local linear trend model, Seasonal models, Cyclical models. Nonlinear time-series models: Parametric and nonparametric approaches. Autoregressive conditional heteroscedastic model and its extensions. Threshold and Functional coefficient autoregressive models.

#### UNIT IV

Non-linear programming, Kuhn-Tucker sufficient conditions, Elements of multiple objective programming, Dynamic Programming, Optimal control theory - Pontryagin's maximum principle, Time-optimal control problems.

### Suggested Readings

- Box GEP, Jenkins GM & Reinsel GC. 2008. *Time Series Analysis: Forecasting and Control*. 3rd Ed. John Wiley.  
Brockwell PJ & Davis RA. 1991. *Time Series: Theory and Methods*. 2<sup>nd</sup> Ed. Springer.  
Chatfield C. 2004. *The Analysis of Time Series: An Introduction*. 6th Ed. Chapman & Hall/CRC.  
Tong H. 1995. *Nonlinear Time Series: A Dynamical System Approach*. Oxford Univ. Press.

**STAT 609      STOCHASTIC PROCESSES      2+0      Sem-I**

### Theory

#### UNIT I

Introduction to stochastic process - classification according to state space and time domain. Finite and countable state Markov chains; time homogeneity; Chapman-Kolmogorov equations, marginal distribution and finite dimensional distributions.

#### UNIT II

Classification of Markov chain. Canonical form of transition probability matrix of a Markov chain. Fundamental matrix; probabilities of absorption from transient states into recurrent classes in a finite Markov chain, mean time for absorption. Ergodic state and Ergodic chain. Stationary distribution of a Markov chain, existence and evaluation of stationary distribution. Random walk and gamblers ruin problem.

### UNIT III

Discrete state continuous time Markov process: Kolmogorov difference –differential equations. Birth and death process, pure birth process (Yule-Furry process). Immigration-Emigration process. Linear growth process, pure death process.

### UNIT IV

Renewal process: renewal process when time is discrete and continuous. Renewal function and renewal density. Statements of Elementary renewal theorem and Key renewal theorem.

### UNIT V

Elements of queueing process; the queueing model M/M/1: steady state behaviors. Birth and death process in queueing theory- Multi channel models.

### UNIT VI

Branching process: Galton-Watson branching process. Mean and variance of size of nth generation, probability of ultimate extinction of a branching process. Fundamental theorem of branching process and applications.

### **Suggested Readings**

- Adke SR & Manjunath SM. 1984. *Finite Markov Processes*. John Wiley.
- Bailey NTJ. 1964. *Elements of Stochastic Processes with Applications to the Natural Sciences*. Wiley Eastern.
- Bartlett MS. 1955. *Introduction to Stochastic Processes*. Cambridge Univ. Press.
- Basawa IV & Prakasa Rao BLS. 1980. *Statistical Inference for Stochastic Processes*. Academic Press.
- Bharucha-Reid AT. 1960. *Elements of the Theory of Markov Processes and their Applications*. McGraw Hill.
- Bhat BR. 2000. *Stochastic Models; Analysis and Applications*. New Age.
- Cox DR & Miller HD. 1965. *The Theory of Stochastic Processes*. Methuen.
- Draper NR & Smith H. 1981. *Applied Regression Analysis*. Wiley Eastern.
- France J & Thornley JHM. 1984. *Mathematical Models in Agriculture*. Butterworths.
- Karlin S & Taylor H.M. 1975. *A First Course in Stochastic Processes*. Vol. I. Academic Press.
- Lawler GF. 1995. *Introduction to Stochastic Processes*. Chapman & Hall.
- Medhi J. 2001. *Stochastic Processes*. 2nd Ed. Wiley Eastern.
- Parzen E. 1962. *Stochastic Processes*. Holden-Day.
- Prabhu NU. 1965. *Stochastic Processes*. Macmillan.
- Prakasa Rao BLS & Bhat BR. 1996. *Stochastic Processes and Statistical Inference*. New Age.
- Ratkowsky DA. 1983. *Nonlinear Regression Modelling: a Unified Practical Approach*. Marcel Dekker.
- Ratkowsky DA. 1990. *Handbook of Nonlinear Regression Models*. Marcel Dekker.
- Seber GAF & Wild CJ. 1989. *Non-linear Regression*. John Wiley.

## **STAT 610    ADVANCED ECONOMETRICS**

**2+0**

**Sem-II**

### **Theory**

#### UNIT I

Quantile regression, binary quantile regression, extreme values, copula, loss functions, Point and interval forecasting, unconditional and conditional forecasting, forecasting with serially correlated errors, bootstrap: asymptotic expansion, bootstrap consistency, asymptotic refinement, recent developments for dependent time series

#### UNIT II

Multivariate time series: modelling the mean, stationary VAR models: properties, estimation, analysis and forecasting, VAR models with elements of nonlinearity, Non-stationary multivariate time series: spurious regression, co-integration, common trends; Volatility:

Modelling the variance, The class of ARCH models: properties, estimation, analysis and forecasting, stochastic volatility, realized volatility.

### UNIT III

Basic Concepts of Bayesian Inference, Probability and Inference, Posterior Distributions and Inference, Prior Distributions. The Bayesian linear model and autoregressive (AR) processes; Model selection with marginal likelihoods and fractional priors, Comparison of Bayesian Methods with Classical approaches, Bayes risk and their applications, and Sample Selection Monte Carlo integration, importance sampling and Gibbs sampling, The Regression Model with General Error Covariance Matrix, Qualitative Choice Models, Bayesian information criterion (BIC), Markov Chain Monte Carlo (MCMC) Model Composition and stochastic search variable selection, BUGS [Bayesian Inference Using Gibbs Sampling] , BUCC [Bayesian Analysis, Computation and Communication].

### **Suggested Readings**

Banerjee A, Dolado J, Galbraith J & Hendry DF. 1993. *Co-integration, Error Correction, and the Econometric Analysis of Non stationary Data*. Oxford Univ. Press.

Bauwens L, Lubrano M & Richard JF. 1999. *Bayesian Inference in Dynamics of Econometric Models*. Oxford Univ. Press.

Carlin BP & Louis TA. 1996. *Bayes and Empirical Bayes Methods for Data Analysis*. Chapman & Hall.

Gilks WR, Richardson S & Spiegelhalter D. 1996. *MCMC in Practice*. Chapman & Hall.

Greenberg E. 2008. *Introduction to Bayesian Econometrics*. Cambridge Univ. Press.

Hamilton JD. 1994. *Time Series Analysis*. Princeton Univ. Press.

Judge GG, Griffith WE, Hill RC, Lee CH & Lutkepohl H. 1985. *The Theory and Practice of Econometrics*. 2nd Ed. John Wiley.

Koop G, Poirier D & Tobias J. 2007. *Bayesian Econometric Methods*. Cambridge Univ. Press.

Koop G. 2003. *Bayesian Econometrics*. John Wiley.

Lancaster A. 2004. *An Introduction to Modern Bayesian Econometrics*. Blackwell.

Pindyck RS & Rubinfeld DL.1981. *Econometric Models and Economic Forecasts*. McGraw Hill.

**STAT 611    ADVANCED STATISTICAL COMPUTING                                  2+1                                  Sem-I**  
**Theory**

#### UNIT I

Measures of association. Structural models for discrete data in two or more dimensions. Estimation in complete tables. Goodness of fit, choice of a model. Generalized Linear Model for discrete data, Poisson and Logistic regression models. Log-linear models.

#### UNIT II

Elements of inference for cross-classification tables. Models for nominal and ordinal response.

#### UNIT III

Computational problems and techniques for robust linear regression, nonlinear and generalized linear regression problem, tree-structured regression and classification, cluster analysis, smoothing and function estimation, robust multivariate analysis.

#### UNIT IV

Linear mixed effects models, generalized linear models for correlated data (including generalized estimating equations), computational issues and methods for fitting models, and dropout or other missing data.

#### UNIT V

Multivariate tests of linear hypotheses, multiple comparisons, confidence regions, prediction intervals, statistical power, transformations and diagnostics, growth curve models, dose-response models.

### **Practical**

Analysis of qualitative data; Generalized linear for correlated data; Generalized linear models for discrete data; Robust methods of estimation and testing of non-normal data; Cluster analysis; Analysis of data having random effects using Linear mixed effects models; Analysis of data with missing observations; Applications of multiple comparison procedures; Building Simultaneous confidence intervals; Fitting of growth curve models to growth data; Fitting of dose-response curves and estimation of parameters.



## Suggested Readings

- Everitt BS & Dunn G. 1991. *Advanced Multivariate Data Analysis*. 2nd Ed. Arnold.
- Geisser S. 1993. *Predictive Inference: An Introduction*. Chapman & Hall.
- Gentle JE, Härdle W & Mori Y. 2004. *Handbook of Computational Statistics -Concepts and Methods*. Springer.
- Han J & Kamber M. 2000. *Data Mining: Concepts and Techniques*. Morgan.
- Hastie T, Tibshirani R & Friedman R. 2001. *The Elements of Statistical Learning: Data Mining, Inference and Prediction*. Springer.
- Kennedy WJ & Gentle JE. 1980. *Statistical Computing*. Marcel Dekker.
- Miller RG Jr. 1986. *Beyond ANOVA, Basics of Applied Statistics*. John Wiley.
- Rajaraman V. 1993. *Computer Oriented Numerical Methods*. Prentice-Hall.
- Ross S. 2000. *Introduction to Probability Models*. Academic Press.
- Thisted RA. 1988. *Elements of Statistical Computing*. Chapman & Hall.

## STAT 612 SIMULATION TECHNIQUES 1+1 Sem-II

### Theory

#### UNIT I

Review of simulation methods; Implementation of simulation methods – for various probability models, and resampling methods: theory and application of the jackknife and the bootstrap.

#### UNIT II

Randomization tests, analysis using computer software packages. Simulating multivariate distributions, MCMC methods and Gibbs sampler.

#### UNIT III

Correlograms, periodograms, fast Fourier transforms, power spectra, cross-spectra, coherences, ARMA and transfer-function models. Simulated data sets to be analyzed using popular computer software packages

#### UNIT IV

Stochastic simulation: Markov Chain, Monte Carlo, Gibbs' sampling, Hastings-Metropolis algorithms, critical slowing-down and remedies, auxiliary variables, simulated tempering, reversible- jump MCMC and multi-grid methods.

### Practical

Simulation from various probability models; Resampling methods, jackknife and the bootstrap; Randomization tests; Simulating multivariate distributions, MCMC methods and Gibbs sampler; Correlograms, periodograms, fast Fourier transforms, power spectra, cross-spectra, coherences; ARMA and transfer-function models, spectral-domain regression; Simulated data sets to be analyzed using popular computer software packages; Markov Chain, Monte Carlo, Gibbs' sampling; Reversible- jump MCMC and multi-grid methods.

### Suggested Readings

- Averill ML, Kelton D. 2005. *Simulation, Modeling and Analysis*. Tata McGraw Hill.
- Balakrishnan N, Melas VB & Ermakov S. (Ed.). 2000. *Advances in Stochastic Simulation Methods*. Basel-Birkhauser.
- Banks J. (Ed.). 1998. *Handbook of Simulation: Principles, Methodology, Advances, Applications and Practice*. John Wiley.
- Bratley P, Fox BL & Schrage LE. 1987. *A Guide to Simulation*. Springer.
- Gamerman D, Lopes HF & Lopes HF. 2006. *Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference*. CRC Press.
- Gardner FM & Baker JD. 1997. *Simulation Techniques Set*. John Wiley.
- Gentle JE. 2005. *Random Number Generation and Monte Carlo Methods*. Springer.
- Kleijnen J & Groenendaal WV. 1992. *Simulation: A Statistical Perspective*. John Wiley.
- Law A & Kelton D. 2000. *Simulation Modeling and Analysis*. McGraw Hill.