

**P.G. 3<sup>rd</sup> SEMESTER SYLLABUS**  
**DEPARTMENT OF STATISTICS**  
**COTTON UNIVERSITY**

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**PAPER: STA901C**

**LINEAR MODEL AND REGRESSION ANALYSIS**  
**(Credits: 3+0+1=4)**

**Unit I: (Lectures: 10)**

**Linear Model:** Gauss-Markov setup, Error and estimation space, Normal equations and least square estimator, solution of the Normal equations using g-Inverse, variance and covariance of least square estimates, estimation of error variance, least square estimates with restriction on parameters.

Tests of hypotheses for one and more than one linear parametric functions.

**Unit II: (Lectures: 12)**

Multiple regression model: Estimation of model parameters, Hypothesis Testing in multiple linear regression, Regression with and without intercept terms, standardized regression coefficients and interpretations, use of  $R^2$  & adjusted  $R^2$ .

Residual Analysis: Definition, residual plots, normal probability plots, methods of scaling residuals-standardized and studentized residuals, Lack of fit test in regression model.

**Unit III: (Lectures: 12)**

Variable selection and model building: Model building problem, Model misspecification criteria for evaluating sub set regressions.

Computational techniques for variable selection (without derivation), Stepwise regression, Mallows  $C_p$  statistic, AIC & BIC - purpose & use.

**Unit IV: (Lectures: 14)**

Regression on Dummy Variables: Dummy as explanatory variable, Chow test vs Dummy Variable approach.

Generalized linear models: Linear Probability Model, Logistic regression model for dichotomous data with single and multiple explanatory variables, ML estimation, large sample tests about parameters, Goodness-of-Fit tests (Concept of deviance), analysis of deviance, Lack-of-Fit tests in Logistic regression.

**SUGGESTED READING:**

1. Dobson, A.J. and Barnett, A.G. (2008): Introduction to Generalized Linear Models, Third Edition, Chapman and Hall/CRC. London.
2. Goon, A.M. and Gupta, M.K. and Dasgupta, B.(1991): An Outline of Statistical Theory, World Press Private Limited.
1. Greene W.H (2000): Econometric Analysis, 4<sup>th</sup> Edition, Prentice Hall.
2. Gujarati, D., Porter D.C and Gunasekar S. (2016): Basic Econometrics, 13<sup>th</sup> Edition, McGraw Hill Companies.
3. Johnston, J. (1985): Econometric Methods, 3<sup>rd</sup> Edition, McGraw Hill International.
4. Kmenta J (1986): Elements of Econometrics, 2<sup>nd</sup> Edition, Macmillan, New York.
5. Koutsoyiannis, A. (2004): Theory of Econometrics, 2<sup>nd</sup> Edition, Palgrave Macmillan Limited.
6. McCulloch, C.E. and Searle, S.R. (2001): Generalized, Linear and Mixed Models, John Wiley & Sons, Inc. New York

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7. Myers, R.H., Montgomery, D.C and Vining, G.G. (2002): Generalized Linear Models with Applications in Engineering and the Sciences, John Wiley & Sons.
8. Madnani G.M.K (2008): Introduction to Econometrics, Principles and Applications, Oxford & IBH Publishing Co. Pvt Ltd, Delhi □□
9. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4<sup>th</sup> Edition, Wiley & Sons.
10. Rao, C.R. (1991): Linear Statistical Inference and Its Applications, Wiley Eastern Limited.
  
11. Theil H (1971): Principles of Econometrics, John Wiley & Sons Inc, New York

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**PAPER: STA902C**

**STATISTICAL INFERENCE - II**  
**(Credits: 3+0+1=4)**

**Unit I: (Lectures: 14)**

Tests Based on Runs: Idea, Different lemmas, Expectation and Variance of Runs, Tests based on the length of longest run.

Tests of goodness of fit: The Chi-Square test, The Empirical distribution function, related theorems and corollaries; The Kolmogorov-Smirnov (KS) one sample test, related theorems and applications.

One sample and paired sample techniques: The Ordinary Sign test and The Wilcoxon Signed-rank test.

The General two sample problem: The Wald-Wolfowitz Run test, The K.S two sample test, Man-Whitney U test.

**Unit II: (Lectures: 10)**

Elements of Decision Theory: Introduction, Basic Concepts, Bayes and Minimax Decision rules. Different types of loss function, Estimation of Parameters: Bayes estimate and Minimax estimate with examples, Point estimation, Interval estimation and Testing of Hypothesis as Decision Problems.

**Unit III: (Lectures: 14)**

Subjective and Frequentist Probability, Advantages, Bayes theorem, Subjective prior distribution of a parameter, Computation of posterior distribution, Natural Conjugate family of priors for a model, Hyper parameters of a prior form conjugate family, Conjugate families for (i) exponential family models, (ii) models admitting sufficient statistics of fixed dimension, Non informative, improper and invariant priors, Jeffrey's invariant prior, Bayesian point estimation-as a prediction problem from posterior distribution, Bayes estimators for (i) absolute error loss, (ii) squared error loss, and (iii) 0-1 loss.

Bayesian interval estimation: Credible intervals, High posterior density regions; Bayesian testing of Hypothesis: Specification of the appropriate form of the prior distribution for a Bayesian testing of hypothesis problem; Bayesian Computation: Analytic approach, E-M algorithm, MCMC, Gibbs sampling.

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**Unit IV: (Lectures: 10)**

Sequential Analysis: Wald's Sequential Probability Ratio Test (SPRT), Properties of SPRT, Efficiency of SPRT, The Fundamental Identity of Sequential Analysis, OC Function, ASN.

**SUGGESTED READING:**

1. Aitchison, J. and Dunsmore, I.R. (1975) : Statistical Prediction Analysis, Cambridge University Press.
2. Bansal, A.K (2007) : Bayesian Parametric Inference, Alpha Science International Limited.
3. Box, G.E.P. and Tiao, G.C. (1973): Bayesian Inference in Statistical Analysis, Addison & Wesley.
4. DeGroot, M.H. (1970): Optimal Statistical Decisions, McGraw Hill
5. Gibbons J.D (1985): Non Parametric Statistical Inference 2nd Ed. Marcel Dekker Inc.
6. Goon, A. M., Gupta, M. K., and Dasgupta (1987): An Outline of Statistical Theory. Vol.- II, World Press.
7. Kale B. K. (1999): A First Course on Parametric Inference
8. Lee, P. M. (1997): Bayesian Statistics: An Introduction, Arnold Press
9. Leonard, T. and Hsu, J.S.J. (1999): Bayesian Methods, Cambridge University Press
10. Mukhopadhyay P (1996): Mathematical Statistics New central Book Agency (Kolkata)
11. Rao, C. R. (1973): Linear Statistical Inference and Its Application, 2/e Wiley Eastern
12. Robert, C.P. (2001): The Bayesian Choice: A Decision Theoretic Motivation, Second Edition, Springer Verlag, New York.
13. Rohatgi V. (2015): An Introduction to Probability and Statistics, 3<sup>rd</sup> Edition, Wiley Eastern Limited. New Delhi, (Student Edition)
14. Seigel sidney : Non Parametric Statistics for Behavioural Science Mc. Graw Hill.

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**PAPER: STA903C**

**TIME SERIES ANALYSIS**  
**(Credits: 3+0+1=4)**

**Unit 1: (Lectures: 8)**

Introduction to Time Series, Decomposition of Time Series, Measurement of Trend, Variate Difference method, Elimination of Seasonal and Cyclical components of Time Series, Periodogram and Correlogram analysis.

**Unit II: (Lectures: 14)**

Discrete parametric stochastic processes, Introduction to Stationary processes, Auto-covariance, Auto-correlation and Auto-regressive process, Properties of Auto-covariance function, Concept of Weak Stationarity, Autoregressive (AR), Moving Average (MA), Linear processes.

**Unit III: (Lectures: 14)**

ARMA and AR integrated MA (ARIMA) models, Box-Jenkins methodologies, ARIMA (p, d, q), Spectral Analysis: Spectral densities of AR and MA.  
Exponential and Moving Average Smoothing, Holt winters smoothing, Forecasting based on smoothing.

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**Unit IV: (Lectures: 12)**

ARCH, GARCH, Spatio Temporal Analysis, Cointegration, Logitudinal and Panel Data Analysis.

**SUGGESTED READING:**

1. Anderson, T.W. (1971): Statistical Analysis of Time Series, Wiley, NY
2. Box, G.E.P and Jenkins, G.M.(1976): Time series Analysis-Forecasting and Control, Holden-day, San Francisco.
3. Brokckwell, P.J. and Davis, R.A.(1996): Introduction to Time Series and Forecasting, Springer, New York.
4. Enders, W.,(2008): Applied Econometric Time Series, 2<sup>nd</sup> Edition, Wiley
5. Medhi, J. (2009): Stochastic Processes, 3rd Ed., New Age International Publishers, New Delhi, India.

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**(SPECIAL PAPER)**

**PAPER: STA904S**

**DEMOGRAPHY**  
**(Credits: 4+1+0=5)**

**Unit I: (Lectures: 12)**

Theory of stable population: one sex model, concept of stationary, stable and Quasi stable model.

**Unit II: (Lectures: 14)**

Migration: Basic concept and estimation – direct and indirect methods. Models for migration.

Population projection- component and matrix method.

Evaluation and adjustment of age data: concept and type of age errors, digit preference- Whipple index, Myer's index, blended method, method of smoothing.

**Unit III: (Lectures: 12)**

Methods of estimating basic demographic measures from incomplete data.

Nuptiality: different measures, nuptiality tables, computation of nuptiality from census data.

**Unit IV: (Lectures: 12)**

Estimation of fertility rates by indirect methods, stochastic models for reproduction distribution of time to first birth, inter live birth intervals and number of births, estimation of parameters. Shep's model.

**Unit V: (Lectures: 14)**

Multistate Demography. Multistate life tables. Multiple decrement life tables. Model life table: United Nations Model life table, Coley-Demeny Model life table, Model life table for developing countries. Life table from the perspective of Markov chain distribution.

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**SUGGESTED READING:**

1. Bhende A.A , Kanitkar T. (2010): Principles of Population Studies, Himalaya Publishing House.
2. Biswas S, Sriwastav G.L. (2011): Stochastic Processes in Demography and Application, New Central Book Agency (P) Ltd.
3. Chiang C.L. (1968): Introduction to Stochastic Process in Biostatistics, John Wiley.
4. Cox P.R. (1970): Demography, Cambridge University Press
5. Keyfitz N. (1977): Applied Mathematical Statistics, Spring Verlag.
6. Namboodiri and Suchindran (1986): Life Table and its applications, Academic Press.
7. Ramkumar R. (2006): Technical Demography, New Age International (P) Limited, Publisher.
8. Shryock H.S, Seiga , J.S and Associates (1997): Method and Materials Of Demography, Academic Press Inc., London.
9. Spiegelman M. (1969): Introduction to Demographic Analysis, Harvard University Press.

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**PAPER: STA905S**

**OPERATIONS RESEARCH**

(Credits: 4+1+0=5)

**Unit I; (Lectures: 16)**

**Queuing Theory:**

General concept: Basic Characteristics of a Queue, Notations, Transient and Steady state, Little's formula (without proof).

Steady state distribution and waiting time distribution of M/M/1 and M/M/c models;

Steady state distribution of M/M/1/k, M/M/c/c and M/M/c//m ( $m > c$ ).

(Models are to be discussed with numerical examples)

**Unit II: (Lectures: 16)**

**Inventory Management:**

Inventory control – definition, Variables in Inventory problems, Characteristics of Inventory system, Classification of Inventory models, Deterministic Inventory models – Concept of Economic Ordering Quantity (EOQ), Static demand models, EOQ model without shortage – The Economic Lot Size with uniform demand, The Economic Lot Size with different rates of demand in different cycles, The Economic Lot Size with finite rate of replenishment; EOQ model without shortage – The EOQ with constant rate of demand and constant scheduling time, The EOQ with constant rate of demand and variable scheduling time, The Production Lot Size model with shortages.

**Unit III: (Lectures: 18)**

**Resource Analysis and Time Estimate in Network Scheduling:**

Different time estimates related to any project under CPM and PERT, Probability distribution associated with PERT, Probability of achieving completion date of project, Resource allocation – Resource Smoothing and Resource Leveling.

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**Unit IV: (Lectures: 14)**

**Game Theory:**

Introduction to Game theory: Two person Zero sum game; The Minimax-Maximin Principle; saddle points; Game without saddle point; Pure and Mixed strategies; Solution procedure of 2x2 game; Graphical solution procedure; Equivalence of Rectangular game and linear programming.

**SUGGESTED READING:**

1. Goel, B., Mittal, S.K. (23001): Operations Research Pragati Prakshan.
2. Hadley, G: (2002) : Linear Programming, Narosa Publications.
3. Hillier, F. S. and Lieberman, G.J. (2001): Introduction to Operation Research, 7<sup>th</sup> Edition, Irwin.
4. Kanti Swarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13<sup>th</sup> Edition, Sultan Chand and Sons.
5. Sharma, S. D. (2002): Introduction to Operation Research, thirteenth Edition, Kedar Nath and Ram Nath & Co.
6. Taha, H. A. (2006): Operation Research: An Introduction, Eighth Edition, Prentice Hall.
7. Winston, W.L. and Goldberg, J.B. (2004): Operations Research: Applications and Algorithms, Thomson Brooks/Cole.

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**PAPER: STA906S**

**ADVANCED STATISTICAL COMPUTING AND DATA MINING**  
**(Credits: 4+1+0=5)**

**Unit I: (Lectures: 15)**

Random number generation: Review; Simulating multivariate distributions; Simulating stochastic processes. Stochastic differential equations: introduction, Numerical solutions. Monte Carlo Integration; Variance reduction methods.

**Unit II: (Lectures: 15)**

Markov Chain Monte Carlo methods: The Metropolis–Hastings Algorithm; Gibbs sampling. EM algorithm. Smoothing with kernels: density estimation, choice of kernels.

**Unit III: (Lectures: 16)**

Review of classification methods from multivariate analysis; classification and decision trees. Clustering methods from both statistical and data mining viewpoints; Vector quantization. Unsupervised learning; Supervised learning.

**Unit IV: (Lectures: 18)**

Artificial neural networks: Introduction, multilayer perceptron network, selforganizing feature map and radial basis function network. Structural risk minimization, Introduction to support vector machine. Overview of current applications.

**SUGGESTED READING :**

1. Bishop, C.M. (1995): Neural Networks for pattern Recognition, Oxford University Press.
2. Duda, R.O., Hart, P.E. and Strok, D.G. (2000): Pattern Classification, 2<sup>nd</sup> Edition, Wiley, USA.

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3. Hastie, T., Tibshirani, R., Friedman, J. (2008) :The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2<sup>nd</sup> Edn., Springer.
4. Han, J. and Kamber, M. (2000): Data Mining: Concepts and Techniques, Morgan Kaufmann.
5. Haykin, S. (1998) : Neural Networks: A Comprehensive Foundation, 2<sup>nd</sup> Edition, Prentice Hall.
6. Hand, D., Mannila, H., and Smyth, P. (2001): Principles of Data Mining, MIT Press.
7. McLachlan, G.J. and Krishnan, T. (1997): The EM Algorithms and Extensions, Wiley.
8. Nakhaeizadeh, G. and Taylor G.C., (1997): Machine Learning and Statistics, John Wiley & Sons.
9. Pooch, Udo W. and Wall, James A. (1993): Discrete Event Simulation (A practical approach), CRC Press.
10. Rubinstein, R.Y. (1981). Simulation and the Monte Carlo Method, John Wiley & Sons.
11. Robert, C.P. & Casella, G. (2004) Monte Carlo Statistical Methods, 2<sup>nd</sup> Edn., Springer.

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**(Open Elective)**

**PAPER: STA907P**

**DEMOGRAPHY AND DATA MINING**

**(Credits: 4+1+0=5)**

**OPE1**

**Demography and Data Mining**

**Credit 5(4+1+0)**

**Unit I: (Lectures: 16)**

Demographic transition theory. Idea of Census, SRS, NFHS (with special reference to India and Assam). Coverage and content errors in demography data, use of balancing equations and Chandra-Sekharan Deming Formula. Infant mortality rate, adjusted infant mortality rate. Population growth rates- arithmetic, geometric and exponential.

**Unit II: (Lectures: 16)**

Life tables and its applications. Methods of construction of abridge life table (Greville and Chiang method), Gompertz, Makeham curve. Fertility measures from cohort data.

**Unit III: (Lectures: 16)**

Introduction to Data Mining and Knowledge Discovery in Databases, Global models and local patterns in databases, Measurement and its types, distance measures, data transformation and data quality, Data visualization- single variable, between two variables, more than two variables.

**Unit IV: (Lectures: 16)**

Simulation: Introduction, Definition, Advantages, Disadvantages and Applications of Simulation, Steps in a Simulation procedure, Monte Carlo method. Generation of random numbers using congruence method, Generation of random variables using Inverse transform method and Acceptance-rejection method.

**SUGGESTED READING :**

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1. Chiang C.L. (1968): Introduction to Stochastic Process in Biostatistics, John Wiley.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Gupta S.C and Kapoor V.K (2007): Fundamentals of Applied Statistics, 11<sup>th</sup> Edition, Sultan Chand & Sons.
4. Hand D, Mannila H. and Smyth P. (2001): Principles of Data Mining, Prentice-Hall of India pvt. Ltd.
5. Maimon O and Rokach L. (2010): Data Mining and Knowledge Discovery Handbook, Second Edition, Springer.
6. Namboodiri and Suchindran (1986): Life Table and its applications, Academic Press.
7. Pai J, Han J and Kamber M. (2011): Data Mining: Concepts and Techniques, (Third edition), Elsevier.
8. Ramkumar R. (2006): Technical Demography, New Age International (P) Limited, Publisher.

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