Department of Statistics
Jahangirnagar University

Syllabus for MS in Statistics

Session: 2015-2016, 2016-2017, 2017-2018 and 2018-2019

The Master of Science (M.S.) program in Statistics fosters at specializing and training in statistical methodology in its theoretical, practical/applied, and in scientific research aspects of modern age, particularly with computer intensiveness.

This program shall extend over one academic year (July to June). Students enrolled under this program comprise of two groups namely Non-Thesis Group and Thesis Group. The courses offered by the department are of compulsory and optional nature. The total unit of courses is 7, totaling 700 marks, 4 units of which being compulsory courses and remaining 3 units being optional courses. Students from each group have the option to choose any 3 of the available optional courses offered by the department. Out of 7 units 1½ units of practical courses has to be taken by the general group students and 1 unit of practical courses has to be taken by the thesis group students.

The examinations to evaluate students' performance shall be held at the end of the academic year. The class attendance carries 10% of the total marks in all courses (theoretical and practical). The course-end examinations carry 70% marks both in theoretical and practical courses, while 20% of the total marks are allocated for tutorial examinations that spread through the whole academic year. The general group students shall have to submit a report carrying 50 marks, out of which 20 for oral presentation and 30 for report evaluation; and the thesis group students shall have to submit a dissertation carrying 100 marks, out of which 40 for oral presentation and 60 for thesis evaluation. At the end of all course examinations students shall

The group-wise structure for the M.S. program is given below:

General Group

Courses	Units	Credit Hours	Total Marks
Theoretical	4½	18	450
Practical	1½	6	150
Report	½	2	50
Viva Voice	½	2	50
Total	**7**	**28**	**700**

Thesis Group

Courses	Units	Credit Hours	Total Marks
Theoretical	4½	18	450
Practical	1	4	100
Thesis	1	4	100
Viva Voice	½	2	50
Total	**7**	**28**	**700**

The course distribution portraying courses code, title and their marks is given below:

Compulsory Courses

Course No	Course Title	Marks	Credit Hours
STAT. 501	Advanced Multivariate Analysis	100	4
STAT. 502	Advanced Classical and Bayesian Inference	100	4
STAT. 503	Sample Survey	50	2
STAT. 504	Applied Stochastic Process and Stochastic Simulation	50	2

Optional Courses

Course No	Course Title	Marks	Credit Hours
STAT. 505	Advanced Design of Experiment	50	2
STAT. 506	Advanced Time Series Analysis	50	2
STAT. 507	Econometric Analysis	50	2
STAT. 508	Generalized Linear Models	50	2
STAT. 509	Epidemiology and Survival Analysis	50	2
STAT. 510	Big Data	50	2
STAT. 511	Meta Analysis	50	2
STAT. 512	Population Studies	50	2
STAT. 513	Environmental Statistics	50	2
STAT. 514	Computer Intensive Statistics	50	2

Practical Courses

Course No	Course Title	Marks	Credit Hours
	General Group		
STAT-LAB.515	Statistical Data Analysis-I	50	2
STAT-LAB.516	Statistical Data Analysis-II	50	2
STAT-LAB.517	Statistical Data Analysis-III	50	2
	Thesis Group		
STAT-LAB.518	Statistical Data Analysis-IV	50	2
STAT-LAB.519	Statistical Data Analysis-V	50	2

Stat-501: Advanced Multivariate Analysis

1 Unit/4 Credit (at Least 50 Class Hours)

Theory of Distance and its Application to Classification Problems: Objectives of Multivariate Analysis, Concept of Distance in Multivariate Analysis, Different Measures of Distance, Some Properties of Distance Function, Multivariate Normal Distribution, Assessing Assumptions of Multivarite Normality By Box-Cox Transformation, Detecting and Cleaning Outliers, Transformation of Multivariate Normal Observations to Near Multivariate Normal, Inference about Mean Vector, Hotteling T^2, Confidence Region, Conferring Methods of Multiple Comparison.

Analyzing Association among Variables: Measuring and Interpreting Association Especially Between two Variables, Graphical Investigation of Many Associations, Correction of Correlation for Effects of Extraneous Variables, Measuring Association between Two Sets of Variables, Testing Hypotheses about Sets of Associations, Test that all Population Correlations are Zero (Mutual Independence of all Variables), Test that all Population Canonical Correlations are Zero, Test that some Population Canonical Correlations are Zero.

Two and Three-Way Contingency Tables: Log-Linear Models, Interpretation of Log-Linear Parameters, Choice of Model, Detection of Model Deviations, Log-Linear Hypotheses, Estimation, Testing Hypotheses.

Multi-Dimensional Contingency Tables: Log-Linear Models, Classification and Interpretation of Log-Linear Models, Choice of Model, Diagnostics, Model Search Strategies.

Analysis of Covariance Structure: Covariance Structure, Hypotheses about Covariance Structure, Model of Covariance Structure Analysis, Scope of Covariance Structural Analysis, Illustration of Likelihood Ratio Test, Illustration of Likelihood Ratio Test Procedures, Tests of Covariance Structure Based on Union-Intersection Principle, Illustration of Structural Analysis Based on Union-Intersection Principle, Sphericity Test, Advantages of Covariance Structure Analysis, Assumptions of Covariance Structure in Statistical Analysis, Estimation of Variance Components, Confirmatory Factor Aspect of Multivariate Analysis, Power of Statistical Tests when Covariance Structure is Known, Tests for Broad Class of Covariance Structures, Bayesian Inference in Multivariate Regression, Multivariate Analysis of Covariance, Checking and Violation of Assumptions, Two-Way Multivariate Analysis of Variance (Manova), Profile Analysis, Repeated Measures with Growth Curves.

Independent Component Analysis (Ica): Basic Concept on Ica: Definition, Identifiability of the Ica Model, Ambiguities of Ica, Preprocessing for Ica: Centering, Whitening, Principles of Ica Estimation: Maximization of Non-Gaussianity Using Kurtosis and Negentropy, Minimization of Mutual Information, Maximum Likelihood Estimation.

Basic Concept of Multilevel Modeling
Conceptual Framework of Multilevel Modeling, Hierarchically Structured Data, Analytical Problems with Multilevel Data, Advantages and Limitations of Multilevel Modeling. Computer Software for Multilevel Modeling.

Linear Multilevel Models
Concept of Fixed, Mixed and Random Effect Multilevel Mode, Steps for Constructing Multilevel Models, Assumptions, Formulations and Estimation of Two-Level and Three-Level Models, Fixed and Random Coefficients, Cross Level Interactions, Measurement Centering, Hypothesis Testing, Model Comparison, Level 1 and Level 2 Variances.

Application of Two-Level Linear Multilevel Models
Empty Model, Predicting Between-Group Variation, Predicting Within-Group Variation, Testing Level-1 Random, Across-Level Interactions.

Texts

1. Anderson, T. W. (1984): *An Introduction to Multivariate Statistical Analysis*, 2nd Edition, John Wiley, New York.
2. Agresti, A. (2002): Categorical Data Analysis, 2nd Edition, John Wiley, New York.
3. Jichuan Wang, Haiyi Xie and James H. Fisher, (2012): *Multilevel Models Applications Using Sas*, Higher Education Press and Walter De Gruyter Gmbh and Co. Kg, Berlin/Boston.
4. W. Holmes Finch, Jocelyn E. Bolin and Ken Kelley (2014): *Multilevel Modeling Using R*, Crc Press.
5. Hyvarinen, A. Karunen, J. and Oja, E. (2001): *Independent Component Analysis*, New York: Wiley.

References

1. Jonhnson, R. A. and Wichern, D. W. (2002): *Applied Multivariate Statistical Analysis*, 7th Edition, John Wiley, New York.

2. Mardia, K. V., Kent, J. T., and Bibby, J. M. (1979): *Multivariate Analysis*, 3rd Edition, Academic Press, London.

Stat-502: Advanced Classical and Bayesian Inference

1 Unit/4 Credit (at Least 50 Class Hours)

Theory of Estimation

Point Estimation: James Stein Estimator, Shrinkage Estimators, Em Algorithm, Principles of Data Reduction, Empirical Bayes (Eb) Method, Bayes Conventional and Empirical Bayes Techniques, Approximation of Bayes and Eb Method of Estimation for Prior Distribution, Application of Eb Methods, Minimaxity and Admissibility in Exponential Families and their Properties, Bayesian Estimation in Linear Model, Predictive Inference with Reference to Bayesian Analysis.

Robust Statistics: Fundamental Concept and Example, Different Type of Robust Statistics, One-Dimensional Estimation and Test Statistics, Influence Functions, Classes of M-Estimators, L-Estimators, R-Estimators, Multidimensional Estimators, Application of Robust Estimators.

Method of Evaluating Estimators: U-and V Statistics and their Properties, Best Unbiased Estimators and their Properties.

Confidence Sets: Confidence Belt, Shortest Set of Confidence Intervals, Theory of Confidence Set, Confidence Sets in Presence of Nuisance Parameters, Uma and Umau Confidence Sets, Randomized Confidence Sets, Invariant Confidence Sets.

Bootstrap Confidence Sets: Construction of Bootstrap Confidence Intervals, Asymptotic and Accuracy, High-Order Accurate Bootstrap Confidence Sets.

Simultaneous Confidence Intervals: Bonferronis Method, Scheffe's Method in Linar Models, Tukey's Method in One-Way Anova Models, Confidence Bands for Cumulative Distribution Functions.

Theory of Hypothesis Testing

Generalized Neyman Pearson Lemma, Locally Best Test, Tests Under Restricted Alternatives, Similar Region And Neyman Structure, Most Powerful Similar Region (Mpsr) Test, Uniformly Most Powerful Similar Region (Umpsr) Test, Asymptotic Efficiency of Test, Sequential Probability Ratio Test (Sprt) for three Hypotheses, Sobel and Wald Test, Lagrange Multiplier (Lm) Test, Test in Presence of Nuisance Parameters, Union-Intersection and Intersection-Union Test, Armitage Method for Composite Hypotheses, Sequential *T*, χ^2 and T^2 Test.

Empirical Bayes Testing of Multiple Hypothesis, Lindley's Procedure for Test of Significance, Lindley's Paradox, *P*-Value and Bayesian Significance Probability, Bayes Test in Linear Model.

Use of Aic, Bic and Oic in Selecting Models and Testing of Hypotheses.

Texts

1. George, C. and Berger, R. L. (2003): *Statistical Inference*, 2nd Edition, Thompson-Duxbury, Usa.
2. Lehman, E. L. (1997): *Testing Statistical Hypothesis*, 2nd Edition, Springer-Verlag, New York.

References

1. Lehman, E. and Cassela, G. (1998): *Theory of Point Estimation*, Springer Verlag, New York.
2. Hogg, R. H., Mckean, J. W. And Craig, A. T. (2007): *Introduction to Mathematical Statistics*, 6th Edition, Pearson Education (Singapore) Pte Ltd.
3. Rohatgi, U. K. and Saleh, A. K. Md. E. (2005): *An Introduction to the Probability and Statistics*, 2nd Editions, John Wiley and Sons Inc., New York.
4. Bansal, A. K. (2007): *Bayesian Parametric Inference*, Norosa Publishing House, India.
5. O' Hagan, A and Forster, J. (2004): *Advanced Theory of Statistics, Bayesian Inferences*, Vol. 2b, Arnold.
6. Carlin, B. P. and Louis, T. A. (2002): *Bayes and Empirical Bayes Method for Data Analysis*, 2nd Edition, Crc Press.
7. Kalbfleisch, J. G. (1985): *Probability and Statistical Inference*, Vol. 1 and Vol. Ii. 2nd Edition, Springer-Verlag, New York.
8. Shao, J. (1999): *Mathematical Statistics*, Springer-Verlag, New York
9. Mukhopadhyaya, P. (1996): *Mathematical Statistics*, New Central Book Agency (P) Ltd, India.

Stat-503: Sample Survey

½ Unit/2 Credit (at Least 35 Class Hours)

Review and Application of Multi-Stage Sampling, General Approach to Obtain Estimators, their Variances, and Estimated Variances, Optimum Sampling and Sub-Sampling Fractions Considering Cost.

Review and Application of Multiphase Sampling Technique, Repeated Sampling of Some Populations, Longitudinal Surveys.

Some Problems of Inference under Fixed Population Set Up, Inference from Finite Population Using Prediction-Theoretic Approach, Prediction under Multiple Regression Model, Inference from Complex Samples.

Various Techniques Used in Determining Sample Size Under Different Sampling Techniques, Estimating Population Size Using Direct and Inverse Sampling, Estimating Population Density, Design Effects and Methods for their Treatment.

Adapting Sampling, Adaptive Sampling Design, Adaptive Cluster Sampling, Stratified Adaptive Cluster Sampling.

Sources and Types of Survey Errors, Types and its Effects on Accuracy of Estimators, Techniques for Adjustment of Non-Response, Spatial Sampling, Spatial Prediction or Kriging, Spatial Designs, Plot Shapes. Non-Sampling Errors, Modified Hansen-Hurwitz Estimator, Randomized Response Method for Quantitative Data, Deming's Model for Effects of Call-Backs, Politz-Simmons Technique, Randomized Response Method.

Methods Of Increasing Response Rates, Errors of Measurement, Mathematical Models, Treatment of Missing Data, Imputations, Multiple Imputation for Non-Response, Maximum Likelihood Method for Non-Response.

Selected Topics in Sample Design and Estimation Methodology, Who-Ept Survey, Integrated Multipurpose Probability Sample (Imps), Bangladesh Demographic Health Survey (Bdhs), Labour Force Survey, Bangladesh Maternal Mortality Survey (Bmms), Household Income Expenditure Survey, Poverty Monitoring Survey.

Texts

1. Thompson, S. K. (1992): *Sampling*, John Wiley, New York.
2. Raj, D. and Chandok, P. (1998): *Sample Survey Theory*, Narosa Publishing House, India.

References

1. Cochran, W. G. (1977): *Sampling Techniques*, 3rd Edition, Wiley, New York.
2. Sukhatme, P. V. and Sukhatme, B. V. (1977): *Sampling Theories of Surveys with Applications*, Isas, New Delhi.
3. Kish, L. (1995): *Survey Sampling*, Wiley, New York.
4. Chudhury, A. and Stenger, H. (1992): *Survey Sampling Theory and Methods*, Chapman and Hall, Tayor and Francis Group, Yew York.
5. Levey, P. and Lemeshow, S. (1999): *Sampling of Population: Methods and Application*, Wiley, New York.
6. Mukhapadhyay, P. (1998): *Theory and Methods of Survey Sampling*, Prentice Hall, New Delhi.

Stat-504: Applied Stochastic Process and Stochastic Simulation

½ Unit/2 Credit (at Least 35 Class Hours)

Overview: Basic Idea of Stochastic Process and Markov Chain, Time Reversible Markov Chain, Markov Chain Monte Carlo Methods, Markov Decision Processes.

Continuous Time Markov Chain: Meaning, Birth and Death Process, Kolmogorov Forward and Backward Equation of Continuous Time Markov Chain and Their Limiting Probabilities, Time Reversibility, Uniformization, Computation for Transition Probabilities, Generator Matrix to Determine Limiting Probabilities.

Markov Chain Estimation and Hypothesis Testing Related to Finite Markov Chain: Maximum Likelihood Estimates (Mle) of Transition Probabilities, Testing of Transition Probability Matrix, Stationarity of Transition Probability Matrix, Order of Markov Chain, First Order Markov Dependence. Confidence Interval of Arrival Rate, Service Rate and Server Utilization of an M/M/1 Queue Model.

Renewal Theory and its Application: Meaning of Renewal Process, Distribution and Limiting Properties of Renewal Process, Renewal Reward Process, Regenerative Process, Semi Markov Process, Renewal Process in Continuous Time, Wald's Equation, Stopping Time and Model Equation, Central Limit Theorem for Renewals, Delayed and Equilibrium Renewal Process, Two-Stage Renewal Process, Computation of Renewal Function, Application to Patterns.

Branching Process: Meaning, Computing Mean and Variance, Properties of Generating Function of Branching Process. Total Number of Progency and its Distribution, Continuous Time Branching Process, Generalization of Classical Branching Process, Age Dependent Branching Process, Inference and Estimation Problem of Branching Process.

Markov Models in Communication and Information Systems, Storage Requirements for Unpacked Messages, Buffer Behaviour for Batch Arrivals, Transmission System, Probabilistic Model for Hierachical Message Transfer.

Social and Behavioural Processes: Social Mobility, Industrial Mobility for Labour, Educational Advancement, Labour Force Planning and Management, Analyzing Homogeneous Poisson Process, Non-Homogeneous Poisson Process, Continuous Time Birth and Death Model, Renewal Process, Branching Process by Monte Carlo and Stochastic Simulation, Multilevel Queuing System, Markov Model in Biological Sciences and Business Management.

Stochastic Simulation: Analyzing Homogenous Poisson Process, Non-Homogenous Poisson Process, Markov Chain, Continuous Time Birth and Death Model, Renewal Process, Branching Process, Multilevel Queuing System by Monte Carlo Simulation.

Texts

1. Ross, S. (2010): *Probability Models*, 11th Edition, Academic Press, Usa.
2. Bhat, U. N. (1984): *Elements of Applied Stochastic Processes*, 2nd Edition, John Wiley and Sons, New York.
3. Banks, J. (2005): *Discrete Event System Simulation*, 4th Edition, Prentice-Hall, New Delhi, India.

References

1. Medhi, J. (1994): *Stochastic Processes*, 2nd Edition, New Age International (P) Ltd. Publisher, New Delhi.
2. Bhat, B. R. (2000): *Stochastic Models*, New Age International (P) Ltd. Publishers, New Delhi.
3. Minh, D. L. (2002): *Applied Probability Models*, Thomson-Duxbury, Usa.

Stat-505*:* Advanced Design of Experiment

½ Unit/2 Credit (at Least 35 Class Hours)

Linear Estimation, Linear Hypothesis, General Principles and Practical Difficulties in Controlled Experiments, Strategies in Planning Experimental Programs, Three-Level and Mixed-Level Factorial and Fractional Factorial Design, Two-Level Fractional Factorial Design

S^n Factorial Experiments and Their Analysis, Confounding, Split-Split-Plot Design, Split Block Design, Repeated Measurement Design, Balanced Incomplete Block Design (Inter and Intra-Block Analysis), Recovery of Inter Block Information in the Bibd, Missing Observation in Bibd.

Missing Plot, Galois Field and Finite Projective Geometry and its Application, Change-Over Design, Groups of Experiments, Optimality of Design. Response Surface Methods, Method of Steepest Ascent Analysis of Second-Order Response Surface Design, Palatability, Cararіates in Factorial Experiments.

Text

1. Montegomery, D. C. (2003): *Design and Analysis of Experiments*, 5th Edition, John Wiley, New York.

References

1. Das, M. N. and Giri, N. C. (1997): *Design and Analysis of Experiments*, 2nd Edition, New International (P) Ltd., India
2. Kempthorne, O. (1952): *The Design and Analysis of Experiments*, Wiley, New York.
3. Graybill, F. A. (1961): *An Introduction to Linear Statistical Models*, Vol. I, Mcgrow-Hill, New York.
4. Federer, W. T. (1955): *Experimental Design: Theory and Application*, Macmillan, New York.
5. Cochran, W. G. and Cox, D. R. (2000): *Experimental Design*, 2nd Edition, John Wiley, New Delhi.
6. John, P. W. M. (1971): *Statistical Design and Analysis of Experiments*, Wiley, New York.

Stat-506*:* Advanced Time Series Analysis

½ Unit/2 Credit (at Least 35 Class Hours)

Unit Root Analysis: Detailed Study on Unit Roots (Parametric and Nonparametric), Dickey-Fuller (Df) Test, Augmented Df Test; Df-Gls (Generalized Least Square) Test, Nonparametric Unit Root Test, Philips and Person (Pp) Tests: Specification of Null and Alternative Hypothesis in Unit Root Test, Tests with Unit Root as Null and Tests with Stationary as Null, Moving average Unit Root Tests, Kwiatowski, Phillips, Schmidt and Shin (Kpss) Test, Leybourne and Mccabe (Lm) Test, Confirmatory Analysis of Unit Root Tests, Different Panel Data Unit Root Tests and their Advantages and Disadvantages.

Comparative Study: Size Distortion and Low Power of Tests Mentioned Above.

Cointegration Analysis: Methods of Estimation of Single Equation: Engle-Granger Methods, System Methods: Triangular System, Johansen Procedure and Common Trends Representation, Identification Problem in Cointegration System, Cointegration and Granger-Causality Concept of Multicointegration and Polynomial Integration with Examples, Tests for Cointegration of Single Equation Residual Based Tests, Ecm Tests, Multiple Equation Methods: Johansen Tests.

Modeling Volatility: Economic Time Series, Arch Processes, Arch and Garch Estimates of Inflation, Garch Model of Ppi: Example, Garch Model Risk, Arch-M Model, Additional Properties of Garch Processes, Maximum Likelihood Estimation of Garch Models, Other Models of Conditional Variance, Estimating Nyse Composite Index.

Non-Linear Time-Series Models: Linear Versus Non-Linear Adjustment, Simple Extensions of Arma Model, Threshold Autoregressive Models, Extensions and Other Non-Linear Models, Testing for Non-Linearity, Estimates of Regime Switching Models, Generalized Impulse Responses and Forecasting, Unit Roots and Non-Linearity.

Texts

1. Hamitlton, J. D. (1994): *Time Series Analysis*, Princeton University Press, New Jersey.
2. Enders, W. (2004): *Applied Econometric Time Series*, 2nd Edition, John Wiley and Sons (Asia) Pte. Ltd.

References

1. Maddala, G. S. and Kim, I. M. (1998): *Unit Roots, Cointegration and Structural Change*, Cambridge University Press, Cambridge.
2. Gersch, W. and Kitagawa, G. (1996): Smoothness Priors of Time Series Analysis, Springer, New York
3. Gourierousx, C. (1997): *Arch Model and Financial Applications*, Springer, New York.

Stat-507*:* Econometric Analysis

½ Unit/2 Credit (at Least 35 Class Hours)

Simultaneous Equation System, Identification Problem, Indirect Least Squares (Ils), Two Stage Least Squares (2sls), Three Stage Least Squares (3sls), Full Information Maximum Likelihood (Fiml), Seemingly Unrelated Regression Equation (Sure), Monte-Carlo Studies, Concept of Model Selection In Econometrics, Specification Tests..

Estimation, Testing and Predicting Panel Data Model with Individual and Time Effect Model. Difference if Different Method, Hecman Probid Model and Endogenous Switching Regression.

Non-Linear Models in Econometrics, Bayesian Inference in Econometrics.

Optimization in Econometrics, Functional form, Non-Linearity and Specification, Dummy Variables, Non-Linearity in Variables, Specification Analysis, Biased Estimators, Functional form, Non-Linearity and Specification, Biased and Pre-Test Estimators.

Non-Linear Regression Equation, Non-Linear Regression Models, Estimators of Non-Linear Regression Models, Hypothesis Testing and Parametric Restrictions, Box-Cox Transformation.

System of Regression Equations, Covariance Structure, Random Coefficient Model, Seemingly Unrelated Regression Model, Non-Linear System and Gmm Estimation.

Non-Spherical Disturbances, Generalized Regression and Gmm Estimation and Generalized Estimating Equation (Gee), Consequences for Lse, Gls, Mle and Gmm Estimation, Testing Hypothesis in Gmm Framework Models with Discrete Dependent Variable, Models for Panel Data for Fixed Random Effects, Autocorrelation and Dynamic Model.

Texts

1. Greene, W. H. (2000): *Econometric Analysis*, 4th Edition, Prentice-Hall, India.
2. Judge, G. G. (1988): *Introduction to the Theory and Practice of Econometrics*, 2nd Edition, John Wiley and Sons, New York.

Stat-508*:* Generalized Linear Models

½ Unit/2 Credit (at Least 35 Class Hours)

Introduction: Exponential Family of Distributions and their Properties, Components of a Generalized Linear Model, Measuring the Goodness of Fit, Residuals, an Algorithm for Fitting Generalized Linear Models, Likelihood Inference for Glms.

Regression Models for Categorical Responses and Count Data: Link Functions, form of Posterior, Approximations, Gibbs Sampling Via Adaptive Rejection for Binary and Categorical Response Data, Latent Variable Models: Threshold Formulations, Probit Models, Discrete Choice Models, Logistic Regression and Generalizations, Data Augmentation Algorithms, Count Data: Poisson and Over-Dispersed Poisson and Log-Linear Models, Prior Distributions, Applications.

Bayesian Glms: General Setting, Examples, Priors for Glms, Markov Chain Monte Carlo Posterior Simulation Methods for Glms, Bayesian Residual Analysis and Model Choice.

Generalized Linear Mixed Models: Definition, Examples, Normal Linear Case - Induced Correlation Structure, Priors, Computation, Hierarchical or Multi-Level Glms, Overdispersed Glms.

Texts

1. Mccullagh, P. and Nelder, J. A. (1989). *Generalized Linear Models*, 2nd Ed., Chapman and Hall/Crc.
2. Dobson, A. J. and Barnett, A. G. (2008). *An Introduction to Generalized Linear Models*, 3rd Ed., Chapman and Hall/Crc.

References:

1. Agresti, A. (2012). *Categorical Data Analysis*, 3rd Ed., John Wiley and Sons.
2. Cameron, A. C. and Trivedi, P. K. (2013). *Regression Analysis of Count Data*, 2nd Edition. Cambridge University Press.
3. Gill, J. (2001). *Generalized Linear Models: A Unified Approach. Series: Quantitative Applications in the Social Sciences*, Sage University Papers, Thousand Oaks.
4. Hardin, J. W., and Hilbe, J. M. (2012). *Generalized Linear Models and Extensions*, 3rd Ed. Stat Press, Texas.
5. Hastie, T. J. and Tibshirani, R. J. (1990). *Generalized Additive Models*, Chapman and Hall. Hoffmann, J. P. (2003). *Generalized Linear Models, an Applied Approach*. Pearson Allyn and Bacon.
6. Mcculloch, C. E., Searle, S. R. and Neuhaus, J. M. (2008). *Generalized, Linear, and Mixed Models*. 2nd Ed., John Wiley and Sons.
7. Myers, R. H., Montgomery, D. C. and Vining, G. G. (2001). *Generalized Linear Models: with Applications in Engineering and the Sciences*. Wiley.
8. Wood, S. ().*Generalized Additive Models: An Introduction with R*,

Stat-509*:* Epidemiology and Survival Analysis

½ Unit/2 Credit (at Least 35 Class Hours)

Part I: Epidemiology

Preliminary Concept: Cross Sectional, Cohort, Case-Control, Ecological Studies, Clinical Trials, Community Intervention and Cluster Randomized Trials, Longitudinal. Errors in Epidemiologic Research, Confounding Effect, Identifying Confounders, Confounding and Interaction, Controlling Confounding, Stratification, Standardization.

Brief Introduction about Ebola, Sti, Hiv/Aids, Diabetes, Mellitus, Tuberculosis, Diarrhea and Water Borne Diseases, Cardiovascular Disease, Cancer, Risk Factors and Prevention Strategy.

Modes of Transmission: The Sir Model: Introduction, the Basic Model Dynamics, the Basic Model in R, Vaccination in the Basic Model, the Basic Sir Model with Vaccination in R, the Critical Vaccination Coverage.

Modeling Infectious Diseases: Serological Data: Modeling for Hepatitis A, Model for Tuberculosis, Model Forhiv/Aids, a Mathematical Model for Hiv/Aids, a Statistical Model for the Initial Hiv/Aids Outbreak.

Estimating the Force of Infection: Age-Dependent Force of Infection, Modeling Issues, Parametric Approaches to Model the Prevalence and Force of Infection, Fractional Polynomial Models, B-Spline Model.

Part II: Survival Analysis

Preliminary Concept: The Proportional Hazards Model: Characteristics of the Semiparametric Model, Partial Likelihood for Data with and Without Ties, Building Multivariable Semiparametric Models, Hazard and Survival Function Estimation in Semiparametric Models, the Stratified Semiparametric Model, Diagnostics for the Cox Model: Residuals for the Semiparametric Proportional Hazards Model, Checking the Proportional Hazards Assumption, Looking for Outliers, Tracking Down Influential Observations.

Multivariate Survival Analysis: Parametric Proportional Hazards Models with Gamma Frailty: Introduction, Estimation for the Gamma Frailty Model, Maximizing the Marginal Likelihood: The Frequentist Approach, Extension of the Marginal Likelihood Approach to Interval-Censored Data, Posterior Densities: The Bayesian Approach, the Metropolis Algorithm in Practice for the Parametric Gamma Frailty Model, Theoretical Foundations of the Metropolis Algorithm.

Marginal Model for Multivariate Survival: The Fixed Effects Model, the Stratified Model, the Copula Model, the Conditional, Joint, and Population Survival Functions, the Clayton Copula, the Clayton Copula versus the Gamma Frailty Model. The Marginal Model, Consistency of Parameter Estimates from Marginal Model, Variance of Parameter Estimates Adjusted for Correlation Structure, Population Hazards from Conditional Models, Population versus Conditional Hazard from Frailty Models, Population versus Conditional Hazard Ratio from Frailty Models.

Texts

1. Duchateau L., and Janssen, P., (2002):*The Frailty Model*, Springer Science Plus Business Media, Llc
2. Hens, N., Shkedy Z., Aerts, M., Faes, C., Damme, P. V. and Beutels, P., (2012): *Modeling Infectious Disease Parameters Based on* Serological *and Social Contact Data*, Springer Science Plus Business Media New York.

References

1. Kenneth, J. and Rothman, S. G. (2008): *Modern Epidemiology*, 3rd Edition, Lippin Catt.
2. Lawless, J. F. (2011): *Statistical Models and Methods for Life Time Data*, 2nd Edition, Wiley Series, New York
3. Lee, E. T. (2003): *Statistical Methods for Survival Data Analysis*, 3rd Edition, Wiley Series, New York.

Stat-510*:* Big Data

½ Unit/2 Credit (at Least 35 Class Hours)

Introduction of Big Data: Dawn of the Big Data Era, Definition and Features of Big Data, Big Data Value, the Development of Big Data, Challenges of Big Data

Big Data Related Technologies: Cloud Computing, Relationship between Cloud Computing and Big, Iot, Relationship between Iot and Big Data, Data Center, Hadoop, Relationship between Hadoop and Big Data.

Data Collection, Sampling and Preprocessing: Types of Data Sources, Sampling, Types of Data Elements, Big Data Generation, Enterprise Data, Iot Data, Internet Data, Bio-Medical Data, Data Generation from other Fields, Big Data Acquisition, Data Collection, Data Transportation, Data Pre-Processing, Visual Data Exploration And Exploratory Statistical Analysis, Missing Values, Outlier Detection and Treatment, Standardizing Data, Categorization, Weights of Evidence Coding, Variable Selection, Segmentation.

Big Data Storage: Storage System for Massive Data, Distributed Storage System, Storage Mechanism for Big Data, Database Technology, Design Factors, Database Programming Model.

Big Data Architecture: Space of Big Data, Characteristics of Big Data, Data-Driven Decision Making, Deriving Value from Data, Data R&D—the Fertile Ground for Innovation, Building the Data Architecture, Putting it all Together, Architecture Futures.

Big Data Processing Algorithms: Multi-Core Versus Distributed Systems, Distributed Algorithms, Distributed Hash Tables, Bulk Synchronous Parallel (Bsp), Mapreduce Paradigm, Hdfs, Mapreduce Computing Platform, Job Tracker, Task Trackers, Yarn, Partitioners and Combiners, Input Reader and output Writers, Putting all Together, Hadoop Streaming, Distributed Cache, Multiple Outputs, Iterative Mapreduce, Machine Learning with Mapreduce.

Big Data Search and Mining: Big Data Search and Retrieval, K-Means Clustering, Social Network Clustering—Topology Discovery, Clustering Algorithm to find Network Topologies, Social Network Condensation, Text Sentiment Mining, Big Data Mining and Analysis Tools.

Big Data Applications: Application Evolution, Big Data Analysis Fields, Structured Data Analysis, Text Data Analysis, Web Data Analysis, Multimedia Data Analysis, Network Data Analysis, Mobile Traffic Analysis, Application of Big Data in Enterprises, Application of Iot Based Big Data, Application of Online Social Network-Oriented Big Data, Applications of Healthcare and Medical Big Data, Collective Intelligence, Smart Grid.

Texts

1. Min Chen, Shiwen Mao, Yin Zhang and Victor C.M. Leung, (2014), *Big Data: Related Technologies, Challenges and Future Prospects*, Springer.
2. Hrushikesha Mohanty, Prachet Bhuyan and Deepak Chenthati, (2015), *Big Data a Primer*, Springer.
3. Bart Baesens, (2014), *Analytics in a Big Data World: The Essential Guide to Data Science and its Applications*, Wiley

Reference

1. Zikopoulos, P.C., Eaton, C., Deroos, D., Deutsch, T. and Lapis, G., (2012), *Understanding Big Data*, Mcgrawhill, New York.

Stat-511*:* Meta Analysis

½ Unit/2 Credit (at Least 35 Class Hours)

Introduction: Situations in which Meta-Analysis is Applicable, Strengths of Meta-Analysis, Weaknesses of Meta-Analysis, Criticisms of Meta-Analysis.

Why Perform a Meta-Analysis? The Skiv Meta-Analysis, Statistical Significance, Clinical Importance of the Effect, Consistency of Effects

Effect Size and Precision: Treatment Effects and Effect Sizes, Effect Sizes Based on: Means, Binary Data (2×2 Tables) and Correlations, Converting among Effect Sizes, Factors that affect Precision.

Heterogeneity: Identifying and Quantifying Heterogeneity, Prediction Intervals, Subgroup Analyses, Meta-Regression.

Power Analysis for Meta-Analysis: When to use Power Analysis, Planning for Precision Rather than for Power, Power Analysis in Primary Studies, Power Analysis for Meta-Analysis, power Analysis for a Test of Homogeneity

Psychometric Meta-Analysis: The Attenuating Effects of Artifacts, Meta-Analysis Methods, Example of Psychometric Meta-Analysis, Comparison of Artifact Correction with Meta-Regression, Sources of Information about Artifact Values, How Heterogeneity is Assessed, Reporting in Psychometric Meta-Analysis

Cumulative Meta-Analysis: Introduction, why Perform a Cumulative Meta-Analysis?

Text

1. Michael Borenstein, Larry V. Hedges, Julian P. T. Higgins, Hannah R. Rothstein, (2009): *Introduction to Meta-Analysis*, Wiley

Reference

1. Harris M. (Martin) Cooper (2009): *Research Synthesis and Meta-Analysis: A Step-By-Step Approach (Applied Social Research Methods)*, Fourth Edition, Sage Publications, Inc.

2. Mark W. Lipsey and David Wilson (2000): *Practical Meta-Analysis (Applied Social Research Methods)*, 1st Edition, Sage Publications, Inc.

Stat-512*:* Population Studies

½ Unit/2 Credit (at Least 35 Class Hours)

Gender Based Domestic Violence (Gbdv): Reasons of Domestic Violence, Types of Physical Violence, Socio- Economic and Reproductive Health Implication of Gbdv, Important Steps in Reducing Gender Based Domestic Violence.

Social Development Indicator: Human Capital Indicator, Population Policy, Social Capital Development/Social Capital, Gender and Development, Social Protection/Social Network.

Couple Year Protection: Definition, Sterilization (Conversion Factor, Achievement Index, Prevalence Index), Tubectomy (Conversion Factor, Achievement Index, Prevalence Index), Intrauterine Device (Iud) (Conversion Factor, Achievement Index, Prevalence Index), Vasectomy (Conversion Factor, Achievement Index, Prevalence Index).

Effectiveness of Contraceptive Use: Fecundability and Fecundity, Life Table Analysis of Contraceptive Failure, Construction of Single and Multiple Decrement Life Table.

Decomposition of Change in Tfr between two Time Periods: Bongaart's Model, Target Setting by Bongaarts Model, Relationship between Target Fertility and Contraceptive Use.

Millenium Development Goal (Mdg): Rational of Mdg, Motivation Behind Mdg, Goal, Target, Indicator of Mdg, Current Situation Of Bangladesh Considering Different Indicators.

Population Aging: Elderly Situation, Aging Index, Support Ratio Index, Care Index, Elderly Situation in Bangladesh, Components (Elements) of Aging Policy in Bangladesh, Goals and Objectives of Aging Policy in Bangladesh.

Gender Preference: Family Size, Ideal Family Size, Sex Preference of Family Size, Factors Affecting Sex Preference in Bangladesh, Relationship Between Actual Fertility and Ideal Fertility, Fertility of Spacers and Limiters and their Effect, Effect of under Five Mortality or Infant Mortality on Desired Family Size.

Advocacy: Advocacy, Components of Advocacy, Importance of Advocacy.

Monitoring and Evaluation: Monitoring and Evaluation, Steps in Monitoring and Evaluation, Indicators of Monitoring and Evaluation.

Management Information System (Mis): Purpose of Information, Purpose of Management Information System.

Urbanization: Magacity, Urban Projection, Estimating Megacity Population and Implications on Basic Needs, Social, Economic and Demographic Implications.

Gompertz Model: Assumption, Estimation of Process Advantages and Disadvantages, Derivation of Model Parameters.

Population Stabilization: Population Stabilization, Tempo Effect, Quantum Effect, Implication of Population Stabilization if Replacement Fertility is not Achieved, Population Momentum, Reduction of Population Momentum, Factors to be Considered in Reduction Population Momentum.

Demographic Benefits: Achieved Replacement Fertility in Time, its Benefit in Falling Fertility, Demographic Window/Bonus: Implication of Macro Economic Growth.

Health Policy of Bangladesh: Definition, Reasons of Health Policy, Health Policy of Bangladesh, Health Infrastructure Information, Selected Health and Family Planning Indicators, National Health Policy (Nhp), Objectives of National Health Policy, Principles of National Health Policy.

Truncation Estimator of age at First Marriage: Truncation or Censoring, Estimate Mean age and Marriage of Truncated Distribution.

Disability Adjusted Life Years (Daly): Necessity of Measuring Daly, Concepts, Principle and Philosophy of Daly, Measurement of Daly, Construction of Life Table of Disability Prevalence, Problems in Daly.

Influence of age Structure on Fertility: Estimation of Fertility when it is affected by age Structure.

References

1. Chiang, C. L. (1984): *The Life Table and its Applications*, Krueger Pule, John Wiley, New York.
2. Bongaarts, J. and, Potter, R. G. (1983): *Potter Fertility, Biology and Behaviour: An Analysis of the Proximate Determinants of Fertility*, Academic Press, Sandiego, California.
3. Colin, N. (1988): *Methods and Models in Demography*, Belhaven Press, London.
4. Selected Articles from *Population Studies*, Demography, Population and Development Studies in Family Planning etc.

Stat-513*:* Environmental Statistics

½ Unit/2 Credit (at Least 35 Class Hours)

Outliers and Robustness: Outlier and Robustness, Aims and Objectives of Outlier, Importance of Outliers in Environmental Studies, Outlier-Generated Models, Multiple Outliers: Masking and Swamping, Accommodation: Outlier-Robust Methods, Multivariate Outliers, Detecting Multivariate Outliers, Tests of Discordancy, Robustness in General.

Environmental Monitoring and Sampling: Inaccessible and Sensitive Data, Encountered Data, Length-Biased or Size-Biased Sampling and Weighted Distributions, Composite Sampling, Ranked-Set Sampling.

Sampling in Wild: Quadrat Sampling, Recapture Sampling, Transect Sampling: Line Transects and Variable Circular Plots, Density Estimation Method for Line Transects, Random Sample of Transects, Systematic Selection of Transects, Detectability Functions of Transects, Adaptive Sampling.

Environmental Standards: Concept of Environmental Standards, Statistically Verifiable Ideal Standard (Svis), Guard Point Standards, Standards along Cause-Effect Chain.

Spatial Methods for Environmental Processes: Statistics for Spatial Data, Spatial Data and Spatial Models, Geostatistical Data: Spatial Data Analysis, Intrinsic Stationary, Stationary Process, Variogram, Covarigram and Correlogram, Estimation of Varigram, Comparison of Varigram and Covarogram Estimation, Exact Distribution Theory for the Variogram Estimator, Robust Estimation of the Variogram, Variogram Model Fitting.

Spatial Prediction and Kriging, Ordinary Kriging, Effect of Variogram Parameters on Kriging, Lognormal and Trans-Gausian Kriging, Cokriging, Robust Kriging, Universal Kriging, Median-Polish Kriging.

Environmental and Natural Resource Economics: Resources, Environment, and Economic Development, Measuring Growth Rates, Factors Essential to Economic Growth, Sustainable Development: Population and Sustainable Development, Agriculture and Sustainable Development, Energy and Sustainable Development, Sustainable Management for Natural Resources, Valuing the Environment: Cost-Benefit Analysis, Techniques of Valuation: Contingent Valuation, Demand-Side Methods, Supply-Side Methods.

Core Environmental and Metrological Issues: Land Use, Forestry, Soil Degradation, Water Resources, Air Pollution (Indoor and Outdoor) and its Effects on Health, Greenhouse Gases, Human Settlements, Bio Resources.

Text

1. Barnett, V. (2004). *Environmental Statistics: Methods and Applications*, John Wiley and Sons, New York.

References

1. Articles from Different Journals and Periodicals.
2. Bryan, F. J. (2000): *Statistics for Environmental Science and Management*, 1st Edition, Chapman and Hall/Crc, Press.
3. Millard, S. P. and Neerchal, N. K. (2000): Environmental Statistics Using S-Plus, Chapman and Hall/Crc Press.
4. Harris, M. J. (2002): Environmental and Natural Resource Economics: A Contemporary Approach, Houghton Mifflin Company.
5. John, T. (2003): Practical Statistics for Environmental and Biological Scientists, John Wiley and Sons, New York.
6. Robert, H. (1990): Spatial Data Analysis in the Social and Environmental Sciences, Cambridge University Press, Cambridge.

Stat-514*:* Computer Intensive Statistics

½ Unit/2 Credit (at Least 35 Class Hours)

Jackknifing: Bias Correction, Pseudo-Value, Approximate Confidence Intervals, Extension to 2-or-More-Sample Problems.

Bootstrapping: Bootstrap Strategy, Sampling Distributions, Empirical Distributions, Bootstrap Distributions, Percentile Bootstrap: Definition and use of Confidence Limits, Relation to Jackknife, Application to Hypothesis Testing, Number of Simulation Samples Required, Variants: Smoothed Bootstrap, Bias-Corrected Bootstrap, Computational Aspects, Balanced Re-Sampling.

Simulation Testing: Randomization Test, Approximate Randomization Test, Monte-Carlo Tests, Examples, Unbiasedness, Power, Number of Simulated Samples Needed.

Density Estimation: Definition, Examples, Bias, Mse and Imse, Choice of Kernel and Smoothing Parameter, Computation Via Fast Fourier Transform, Kernel Estimates for Non-Negative and Circular Data, Variable and Adaptive Kernel Estimators, Kernel Estimation in Nonparametric Regression.

References

1. Eforn, B. and Tibshirani, R. J. (1993): *An Introduction to Bootstrap*, Chapman and Hall, New York.
2. Efron, B. (1984): The Jackknife, the Bootstrap and other Re-Sampling Plans, Society for Industrial Mathematics.
3. Noreen, E. W. (1982): *Computer-Intensive Methods for Testing Hypothesis*, Wiley, New York.
4. Shao, J. and Tu, D. (2000): *Jackknife and Bootstraps*, Springer-Verlag, New York.
5. Silverman, B. W. (1986): *Density Estimation for Statistics and Data Analysis*, Chapman and Hall, London.

Stat Lab-515: Statistical Data Analysis-I **½ Unit/2 Credit (At Least 35 Class Hours)**

Problems Related to Stat-501.

Stat Lab-516: Statistical Data Analysis-Ii **½ Unit/2 Credit (At Least 35 Class Hours)**

Problems Related to Stat-502.

Stat Lab-517: Statistical Data Analysis-Iii **½ Unit/2 Credit (At Least 35 Class Hours)**

Problems Related to Stat-503 and Stat-504.

Stat Lab-518: Statistical Data Analysis-Iv **½ Unit/2 Credit (At Least 35 Class Hours)**

Problems Related to Stat-501 and Stat-502.

Stat Lab-519: Statistical Data Analysis-V **½ Unit/2 Credit (At Least 35 Class Hours)**

Problems Related to Stat-503 and Stat-504.