

Department of Statistics
Faculty of Science
University of Chittagong

Syllabus for M. Phil./ Ph.D. Programme in Statistics

Session: 2013-2014,2014-2015 and 2015-2016

As per ordinance of the University of Chittagong the requirements for the degree of M.Phil/Ph.D are (a) course work of 200 marks, (b) two seminar presentation (Decision of the Academic committee of the department of Statistics) (c) submission of a thesis on an approved topic and (d) an oral examination

Courses offered in First year M. Phil./Ph.D. Programme in Statistics

Stat-601	:	Advanced Theory of Statistics
Stat-602	:	Statistical Inference
Stat-603	:	Design of Experiments.
Stat-604	:	Applied Econometrics.
Stat-605	:	Demography.
Stat-606	:	Biostatistics
Stat-607	:	Advanced Sampling Techniques
Stat -608	:	Design of Experiments
Stat -609	:	Regression Diagnostics

A student is required to take in the first year Paper Stat - 601 or Paper Stat - 602, and any one course from the remaining courses subject to the recommendation of the supervisor(s) and approval of the Academic Committee of the Department. Total marks for each course is 100. He/she will also have to take a Viva-Voce examination of 100 marks at the end of the first year. Pass marks in each of the course and in Viva-voce is 50% of the total marks allotted to each course. **Course work for the Ph.D. fellow will be done by tutorial system.** Failure will lead to discontinuation of the M. Phil/Ph.D. programme by the candidate concerned.

If a student passes in all the courses and the Viva-voce examination by the end of the first year of his/her study, he/she will be required to write a thesis for the M. Phil/Ph.D., degree on a topic approved by the appropriate bodies. The thesis shall be submitted in quadruplicate in typed - form to the Controller of Examinations on or before the date prescribed by the appropriate authority. Each thesis for the M.Phil/ Ph.D degree shall be examined by a Board of Examiners consisting of the supervisor and two external members appointed by the Academic Council. Studies concerned. The Examiners must be unanimous in their recommendation for awarding the degree.

The M.Phil/Ph.D Degree in Statistics shall be awarded in accordance with the Ordinance of the University of Chittagong.

Stat-601 : Advanced Theory of Statistics & Research Methodology

Full Marks: 100 Time : 4 Hours

The space of elementary events, the class of sub-sets (events), Probability of a set function, Borel field and extension of probability measures, Notation of random variable and distribution function.

Kolmogorov consistency theorem, Convergence of a sequence of random variables, Convergence of a sequence of distribution function.

Family of probability measures, Stieltjes and Lebesgue integrals, Some important theorems in measure theory and integration.

Stochastic process: Generating function, convolution, Recurrent events, Markov process, Poisson process, Birth Death and Immigration processes, Markov renewal theory, Application of the theory of inference, Estimation, Test of hypothesis and decision theory.

Different multivariate techniques: Hotelling's T^2 and its applications including profile analysis, Discriminant analysis, applications and tests associated with discriminant functions, chance of misclassification when Anderson's statistic is used, discrimination in the case of qualitative data, discrimination in the case of several groups; Canonical variables and canonical correlation, canonical analysis, use of canonical analysis in contingency tables.

Factor analysis and its applications: Cluster analysis, Principal Components, Properties and their uses, Tests of Certain hypothesis about principal components.

Stat-602: Statistical Inference

Full Marks: 100 Time : 4 Hours

Estimation : Criteria of a good estimator, Sufficiency and completeness, Sufficiency and invariance, The Bayesian definition of sufficiency, Different method of point estimation and interval estimation, Criteria of estimation in large samples, Asymptotic efficiency of estimation.

Bayes and Minimax estimation : The structure of Bayes estimators for quadratic and convex loss functions, Theorem of Girshick and Savage, De Groot and Rao relating to the above loss functions, Definition of minimax estimation, Important theorems on minimax estimation (Theorem of Hodge and Lehmann, Blyth, Girshick and Savage)

Admissibility of estimation : Basic theorems of admissibility and complete class, Admissibility under quadratic loss, Concept of equivalent estimation.

Test of hypothesis : Statement of the problem. Generalised Neyman-Pearson Lemma, Locally most powerful test, Testing a composite hypothesis, Fisher-Behren's problem, Multiple hypothesis testing, Monotone procedure of testing, Empirical Bayes testing of multiple hypothesis, The Wald sequential probability ratio test, Bayesian optimality of the Wald sequential probability ratio test.

Non-parametric Test : Rank order statistics, Linear rank statistics and the general two-sample problem, Tests of the equality of K independent samples, Measures of association for bivariate samples and parametric estimation method, Hodges-Lehmann estimators.

Decision theory: Statement of the problem, Formulation of the problem of inference in the light of decision theory, its relationship with two person zero-sum game, Problem of point estimation as a decision function, Randomised and non-randomised decision rules, Bayes and minimax decision rules, Complete class of decision rule, Admissibility of Bayes rules, Separating hyperplane theorem, Minimax theorem, Complete class theorem.

Stat-603 : Design of Experiments

Full Marks: 100 Time : 4 Hours

Advanced Developments in Design and Analysis of Experiments:

A. Preliminaries: Generalised inverse of matrices, definition, existence, uniqueness. Methods of finding G-inverses, classes of G-inverse, properties of such inverses. Moore-Penrose g-inverses. Their properties and applications in statistics. Kronecker product and sum of matrices and their properties. Hadamard matrix and its properties.

Linear models of full rank and not of full rank, estimability and reparametrization. Different versions of Gauss-Markov theorem, unified theory of least squares. Testable hypotheses test for general linear hypothesis, different versions of Fisher-Cochran theorem

B.(i) Constructions and analysis of advanced designs :

Fractional factorials – regular and irregular fraction factorials . Resolution III, IV & V plans. Asymmetrical factorial experiments.

(ii) Varietal trials and Bioassays.

Incomplete block designs, BIB designs, Properties, Constructions, Analysis; Intra-block and Inter-block; and combined. Lattice design, Youden square, Re-inforced incomplete block design and irregular designs. Partially balanced incomplete block designs. Optimality of designs.

Study of response surface design and weighing designs. Mixture experiments.

C. Theory of WANOVA, HANOVA & MANOVA.

WANOVA, HANOVA, MANOVA- their definitions, importance and applications. General theorem related to tests of WANOVA, Problems of ANOVA, WANOVA in heteroscedastic models. Different approaches towards HANOVA – Adjusted approach, Exact approach. ASD approach, ADF approach etc. ,Recent developments in WANOVA, HANOVA, MANOVA etc.

Introduction to groups of experiments, Problems of analysis in such experiments, Analysis of such experiments both in homoscedastic cases and heteroscedastic cases.

Stat-604: Applied Econometrics

Full Marks: 100 Time : 4 Hours

Models with Lagged variables Koyek transformation, Partial adjustment and adaptation expectation models, their estimation methods .The analysis of family budgets; Consumer survey, Limitations of budget surveys, the use of group means, the Engel curves, Quality variation, Household composition.

Consumption function: Keynes's simulations aggregation, Relative income hypothesis, Friedman's Permanent income hypothesis, Life cycle hypothesis and Endogenous income hypothesis, estimation of the linear consumption functions. Short term and long term effect. Liviatan's tests of permanent income hypothesis, the role of liquid assets . Production function: properties of classical production function, the Cobb-Douglas production function, the Economic model, the statistical model, Cross-section analysis, Estimation from factor shares, Time series studies, Technical changes.

The CES production function, Estimation of the CES function, Klein's analysis of rail road obey action, Estimation Manufacturing production function by Hild and Lin .The elasticity of substitution.

Investment function: Distribution of log function, The Jorgenson model, Estimation of the Jorgenson investment function, Stages of the process, Structure of the investment process. Test of Jorgenson's maintained hypothesis, Endogeneity and Dynamics.

Simultaneous equations: Model building, a demand and supply model, The U.S. water- melon market, Complete demand system, Restriction from utility theory, Macro econometric models, Dynamic multipliers and policy analysis, and illustration, Klein model-I, Stochastic simulation, the problem of non-linearity. The final form of dynamic econometric models, Linear dependent variable(s) models.

Stat-605 : Demography

Full Marks: 100 Time : 4 Hours

Population Research Programme in Bangladesh. Population policies and population control in Bangladesh. Discussion of different methods of contraception and their use effectiveness. Births averted analysis. Measuring the impact of Family Planning Programme on Fertility.

Concept of ideal and desired family size. Measurement of ideal and desired family size. Family formation in Bangladesh. Relation between family size and socio-economic condition.

Model life tables and their application in developing countries. Increment- decrement life tables.

Population Projections (Matrix application)

Nuptiality pattern in Bangladesh: Coale's three parameter models and Trussell method of estimating the mean age at marriage.

Coales's indices (I_f , I_g and I_n) and their relative contributions to fertility differentials. Intermediate fertility variables. Bongaart's model. Decomposition of Crude Birth Rates. Infant and child mortality estimation under the conditions of declining mortality.

Fertility and Mortality estimation by indirect techniques. Application of stochastic process in Demography. Dandekers model, Sheps & Perrin model of Human reproduction.

Fertility estimation under conditions of declining mortality. Mortality estimation by intercensal survivorship ratio.

Brass growth balance model measuring the completeness of death statistics.

Application of modified Gompertz model for estimating cohort fertility. Estimation of fertility from synthetic cohorts.

Life table analysis of breast-feeding pattern/birth intervals.

Multivariate Analysis of demography real data path analysis, MCA, Multinomial logistic regression analysis.

Models for first conception & first birth: Estimation of Measures of fecundability. Time of the first birth.

Stat – 606 : Biostatistics

Full Marks: 100 Time : 4 Hours

Types of Data (Census/Survey, Experimental, Clinical): Three Main Methods of Data Collection- Prospective, Retrospective, Cross-sectional Study.

Study of Prevalence, Incidence, Relative Risk and Odds Ratio.

Censoring and Truncation: Type I Censoring, Type II Censoring, Random Censoring.

Survival Function, Hazard Function, Conditional Probability of Failure, Central Failure Rate and their Relationship, Mean Residual Life, IFR, DFR, IFRA, DFRA.

Parametric Models: Exponential, Weibull, Poisson, Uniform and Extreme Value Distribution, Gamma Distribution and Log Normal Distribution, Rayleigh, Pareto.

Non-Parametric Methods (One Sample): Life Table (Reduced Sample Method, Actuarial Method, Green-Wood Formula, Product Limit (Kaplan-Meier) Method, Hazard Function Estimator, Robust Estimators, Series System & Parallel System.

Non-Parametric Methods (Two Samples and K-Samples): Kolmogorov-Smirnov Test, Mental-Haenszel Test, Gehan Test, Log-Rank Test, Wald Test, Score Test.

Estimation: Maximum Likelihood Methods, Newton-Raphson and Method of Scoring, Delta Method, Quasi-Likelihood Method, Pseudo-Likelihood, E-M Algorithm.

Transformation: Logit, Probit, Cumulative Log-log.

Re-sampling Method: Bootstrapping, Jackknifing.

Non-Parametric Methods (Regression): Cox's Proportional Hazard Model, Partial Likelihood Estimates, Binary Logistic Regression, Polychotomous Logistic Regression.

Markov Chain Model: Bernoulli Trials with Markov Dependence, Correlated Bernoulli Trials, Stationary Markov Chain, Markov Chain Model with Serially Dependent Observations, Markov Models for Covariate Dependence of Binary Sequences, Estimation and Test of Parameters, Test of Markovity.

Stat – 607 : Advanced Sampling Techniques

Full Marks: 100 Time : 4 Hours

Sampling: Evaluation of various sampling procedures. Sampling policy. Desiderata of Statistical survey design. Determination of sample size relevant to Sampling Schemes. The Replacement and Nonreplacement Sampling Lattice Sampling. Problems of randomization. Building Sampling Frame. Two-way frames. Multiple frames. Imperfection of Sampling Frames, Ideal Conditions for Probability Sampling, Multipurpose descriptive surveys. Cost oriented sampling schemes. Sampling through time. Statistical Techniques for Analysis of Survey Data.

Survey Methodology: Survey Method vs. Scientific Method. Survey planning and General planning. Survey Design and Structure. Pilot Survey. Multirecord Survey (MRS) and Dual Record System (DRS) and their comparison with SRS. Coverage Errors Models – M_g (the General Model), M_o (the Equal Catchability Model) M_b (the behavioral Response Model), M_t (the Patterson Model). M_t Models for Survey Design. Model for response Errors, Response Bias and Reliability in sensitive topic surveys. Assessment of the quality of survey data. Strategies for the analysis of imputed data from a sample survey. Types of problems in investigations based on surveys. The *Missing and Hard – to – Get Data*- Effect and Estimation, Significant and Interpretation of Non- sampling Errors.

Familiarity with several large-scale national surveys in Bangladesh: Methodology and Questionnaire Related to Census and National Samples Surveys (Like WFS, BFS, BDHS, BNS, BAS and so on) of Bangladesh. Development of survey design plan for any real life problem with special references to design issues, strategy and development plans.

Stat 608: Design of Experiments

Full Marks: 100

Time : 4 Hours

Incomplete Block Design: Detailed study of incomplete block designs BIBD, General considerations, Tactical configurations and doubly balanced design, finite geometries for the construction of BIBD, Methods of symmetrically repeated differences, BIBD through the methods of block section and intersection.

Partially BIBD: Association scheme and PBIBD, Two class association schemes, Group divisible designs. Triangular designs, Latin Square type design, Two associated cyclic design.

Fractional Factorial Experiment: Regular fractions and irregular fractions, Construction of designs in 2^n , 3^n and s^n factorials, analysis of variance of data in the above types experiments, Orthogonal Main effect plans of different types.

Weighing design: Definition, method of estimation, incomplete block designs as weighing design. Two pan weighing design from BIBD, Two associated PBIBD as one pan weighing design. Weighing designs from trancted BIBDs, Efficiency.

Response Surface Methodology: Designs for fitting first order model, Designs for fitting second order model. Location of the stationary points. Characterizing the response surface. Ridge system, Multiple response, Blocking the response surface design.

Stat: 609 Regression Diagnostics

Full Marks: 100

Time : 4 Hours

Introduction: Preliminaries, Departure from classical assumptions. Shortcomings and modifications of least squares residuals. The Hat matrix. Influential observations, high leverage points and outliers.

Diagnostic Quantities: Deletion of observations. Measures of influence. Cook's distance. DEEITS. DFFITS. DFBETA. MDFIT. Outlier diagnostics. Measures of high leverage points.

Tests for Normality: Basic ideas. Moments, skewness and kurtosis of OLS residuals. Tests on residual plots. Shapiro-wilk test. Anderson-Darling test. Bowman-shenton test. Rescaled moments test, Tests on other residuals.

Diagnostic Plots: Residual plots. Normal probability plots, Leverage-Residual plots. Added variable plots, partial regression leverage plots, Partial residual plots.

Robust Regression: Group deletion. Masking and swamping. The Breakdown point and Robust estimators. The Least Median of Squares (LMS) technique. The Reweighted Least Squares residuals. Detection of multiple outliers.

Further Diagnostic Quantities: Transformation diagnostics, Logistic regression diagnostics, Diagnostics in nonlinear regression, Diagnostics for generalized linear models.