HANDBOOK FOR GRADUATE STUDENTS IN STATISTICS

Master of Science and Doctor of Philosophy Programs
Department of Statistics
The Fox School of Business and Management
Temple University

Effective 9/1/09

http://www.sbm.temple.edu/dept/statistics/

I. **INTRODUCTION**

This *Handbook* is a revised and updated version of the M.S. and Ph.D. programs in Statistics at Temple University. The academic requirements and policies stated in this version are effective from fall 2009. Its purpose is to keep students informed of the academic requirements of the Statistics programs consistent with the rules and procedures of the Graduate School as described in the Temple University Graduate Policies and Procedures. All graduate programs are regulated by the policies of the Graduate School of the University. In any instance of apparent conflict, the Graduate Schools policies will take precedence over those contained herein. Students are advised to consult the Director of Graduate Programs in Statistics for any aspects of the programs described or not addressed here.

The Graduate Affairs Committee (GAC) of the Department may grant or recommend exceptions to the rules and regulations established by the Department. But any exceptions will be granted only in unusual circumstances for compelling reasons.

2. PURPOSE AND PHILOSOPHY OF THE GRADUATE PROGRAMS

The general purpose of the graduate programs leading to the M.S. and Ph.D. degrees in Statistics is to educate broadly-based statisticians in the theory and methods of statistics towards a successful solution of immediate and specific problems which arise in virtually every area of societal and scientific endeavors. Seldom will a satisfactory solution to a complex practical problem be achieved by a straightforward application of existing methods or techniques. Consequently, the successful practice of statistics will require substantial competence in the theory of statistics, a sound knowledge of statistical methodology, and statistical computing.

The matriculating students are expected to pursue a rigorous program of graduate study, appropriately balanced between theory and methods. They are expected to gain actual experience in the application of statistics through research assistantships, statistical consulting, applications-oriented courses, and/or outside employment. The programs will require students to have a certain degree of competence in mathematics and statistical computing.

The objectives, goals, and general philosophy stated here will obviously apply differently in manner and extent to the M.S. and Ph.D. programs. In both programs, the Department will maintain the highest standards of academic and professional excellence. The Ph.D. program prepares students for pursuing original research and scholarship in academia, industry and government.

3. MATHEMATICAL PREREQUISITES

The programs require competence in mathematical tools necessary for fully grasping statistical theory and methods. Applicants admitted with a deficient background advanced calculus must remove it prior to starting the first year of study.

4. MASTER OF SCIENCE PROGRAM

4.1 Purpose and Objectives of the Program

The primary purpose of the M.S. program in the Department of Statistics is to educate s broadly-based statisticians for jobs in business, government, or academic settings. It strives to develop in students a firm grounding in the fundamentals of statistical theory and applications.

4.2. Requirements

The Master of Science degree requires completion of ten graduate-level courses. Of them, six core courses are required of all. They are numbered: 8001, 8002, 8003, 8004, 8101 and 8102. The remaining 4 courses are electives. There is no thesis or foreign language or core exam requirements. Students may transfer up to six semester hours of prior graduate course work in statistics. In all cases, at least 24 semester hours of graduate-level courses must be taken at Temple University. All the elective courses need not be from the Department list of Statistics courses. With the GAC approval, one or two courses may be taken from areas, for example, information science, mathematics, economics, biology, finances etc, to serve students needs and/or interests.

The terminal MS degree requires only completion of 30 credits hours, that is, of 10 courses. The MS Core exams required in past, are no longer a requirement effective immediately. To remain in good academic standing, students must not have more than two grades below B- or more than one F, and must maintain cumulative GPA of at least 3.0.

All students are advised to attend departmental seminars and the meetings of the local chapter of the American Statistical Association.

Note: Students admitted into the Ph.D. Program who have completed courses numbered 8001 and 8002 by the end of the first year, will take a Preliminary exam based on topics covered in those two courses. The aim of Preliminary exam is to advise these students if they have gained sufficient understanding of the basic theory of statistics to warrant their continuing in the Ph.D. program after the MS degree.

5. DOCTOR OF PHILOSOPHY PROGRAM

5.1. Purpose and Objectives of the Program

The primary purpose of the Ph.D. program is to prepare professional for research contributions to statistics and applications in related areas. The distinguishing characteristic of the Ph.D. program is its research dissertation. Students entering the post-master's part of the Ph.D. program enter a rigorous preparation in the theory, methods, and applications of statistics. The program aims to develop in students: 1) a thorough knowledge of research methodology and its application; 2) the foundations necessary to understand new statistical theory tools as they develop; 3) the capability for undertaking an original research investigation which will make a substantial contribution to the state-of-the-art and science of statistics; 4) the ability to communicate statistical knowledge effectively; 5) the ability to understand the relationships and interactions

of statistics as a discipline with other fields.

5.2. General Requirements

Students enrolled in the Ph.D. program in Statistics must complete a minimum of 48 semester hours of graduate course work beyond the bachelor degree or 18 semester hours beyond the MS degree from Temple, pass the Ph.D. qualifying exam in statistical theory, a proposal exam for dissertation research, accomplish the propose research to write a dissertation, and defend it. Additionally, the student must satisfy certain residency set forth by the Graduate School.

The GAC will annually review the progress of students who have passed the Ph.D. qualifying exam to ensure that no unjustified delays occur in completion of the degree requirements.

5.3. Course Requirements

Required course work is not rigidly packaged to satisfy the minimum requirement of 48 semester hours (16 courses), not including dissertation credits, beyond the baccalaureate degree. Toward the 48 credit hours, Stat. 9001- 9002 and at least two more 9000-level courses are required. Also, elective courses from disciplines other than Statistics may count towards the required course work if approved by the GAC. The courses numbered 9000 or above offered outside the Department of Statistics may not be recognized as advanced courses. This determination will be made by the GAC.

The students should recognize that completion of the 48 semester hours of course work may not necessarily be adequate preparation to achieve the high degree of proficiency demanded by the exams and the dissertation research. They should expect to undertake intensive individual study and advanced topic seminars (9180 and 9190) as offered.

Generally for 9000-level courses, 8000-level courses are prerequisites. Students with an M.S. degree from another university may have taken equivalent to our 8000-level prerequisites as part of their previous program. With the GAC approval, courses from other institutions may be transferred within the limits (upto 24 credit hours) set forth by the Graduate School's policy.

5.4. Examinations

5.4.1. The Placement Exam

Students admitted into the Ph.D. program with an MS degree from other institutions may be asked to take a placement exam for advising them in the selection of theory courses.

5.4.2. The Ph.D. Qualifying Examination

After completing the advanced theory sequence numbered 900 and 9002, students will take Qualifying exam on topics covered in those courses. It will be a closed-book exam given each year early in the spring semester. The dates and times will be announced at least three weeks in advance. The exam will be graded independently as Pass or Fail. If a student failed the exam on the first try, he or she will get one more

attempt next year to pass the exam. One who failed the Qualifying exam twice will be dismissed from the program.

Note: The statistical methods exam is no longer required.

5.4.3. Ph.D. Proposal Examination

Having successfully completing the Qualifying Exam, students must direct their efforts to the specialty area in which they hope to pursue their dissertation research. This effort should begin under the advisement of the Doctoral Advisory Committee chaired by the student's dissertation adviser. The advisor and the Advisory Committee may identify a number of published research papers and/or books for the student to read in the specialty area, with the aim of identifying a research problem for the dissertation.

The proposal exam requires a formal written proposal. It will consist of a general introduction to the specialty area, outlines of the proposed research for the dissertation, and detailed review of the relevant literature. The review should focus on the link of the proposed research with the relevant literature.

The Proposal Exam culminates in a formal presentation by the student to the Advisory Committee, in the presence of an independent representative of the GAC, and all interested faculty and students. The Advisory Committee will evaluate if the proposed research will be an original piece of research for dissertation, student's command of the literature and his/her ability to complete the proposed research.

- ◊ Student will submit a draft of the proposal to the Advisory Committee. It will have two weeks to approve or disapprove the draft or suggest modifications.

- ◊ Taking into account the committee's comments, students will revise the draft for distribution to the Advisory Committee, and to the GAC at least three weeks before scheduling the exam

- ◊ Attendant at the defense must be members of the Advisory Committee and representative of the GAC. The date and time of the defense must be mutually convenient to all concerned. The exam will be open to all faculty and students.

- ◊ Students must prepare a research paper from the Proposal for submission to a statistical journal before or soon after passing the Proposal exam. Prior to submitting it to a journal, it must have the advisory committee's approval and of a GAC member to ensure its contents, style of written presentation meet the journal specifications.

Having passed the Qualifying and the Proposal exams, student will have attained the status of the doctoral candidate to satisfy the Graduate School's requirement of the Ph.D. Comprehensive Examination.

5.4.4. The Dissertation Defense

Upon completion of the proposed research leading to Ph.D. dissertation, the doctoral student will present a formal oral defense to the Advisory Committee, interested faculty and students. This is in accordance with

the directives of the Graduate School. The procedures leading to the final defense are as follows:

- ◊ The doctoral candidate will submit a final draft to the Advisory Committee. The Committee will have three weeks to approve or disapprove the draft or suggest modifications.

- ◊ Taking into account the comments of the committee, students will revise the dissertation draft for distributing to the Advisory Committee, representative of the Graduate School, and to the GAC at least three weeks before scheduling the defense

- ◊ Attendant at the defense must be members of the Advisory Committee and representative of the GAC. Thus, the date and time of the defense must be mutually convenient to all concerned. The defense will be open to all University faculty and students.

- ◊ Having submitted a research paper from his/her research Proposal to a statistical journal, the student must have received a positive feedback from the editorial office on the submission by the time of defending the Ph.D. dissertation.

5.4.4. Advising and Faculty

In the course of your studies you may have multiple advisors, which includes dissertation advisor, faculty mentors, dissertation committee members and the Program Director. Formal authority in the doctoral program resides with the Program Director. In addition, should a student decide to change dissertation advisor, it should be discussed first with the Program Director prior to making changes. The Program Director will ensure protection of academic rights of every one involved in the change.

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6. TENTATIVE ACADEMIC YEAR 2009-10 SCHEDULE

Fall	5002	8001	8003	8101	8102	8104	8108	8117	9107	9180
Spring	5002	8002	8004	8105	8106	8113	8114	8122	9001	9003

Statistics Courses

Old numbers appear in parenthesis.

5002 (0403). Introduction to Biostatistics (3 s.h.). Topics cover statistical methods and concepts with special emphasis on applications in health and biological sciences.

5001 (0500). Quantitative Methods for Business (3 s.h.). This course is designed to introduce you to contemporary elementary applied statistics and to provide you with an appreciation for the uses of statistics in business, economics, everyday life, as well as hands-on capabilities needed in your later coursework and professional employment.

8001 (0501). Probability and Statistics Theory I. (3 s.h.), Prerequisite: calculus. Topics include basic probability theory and combinatorial problems, generating functions, random variables, probability distributions, law of large numbers, and limit theorems.

8002 (0502). Probability and Statistics Theory II (3 s.h.), Prerequisite: Stat. 8001 (0501). A comprehensive development of the theory of statistics, including standard distributions, sampling distributions, general theory of estimation, testing of hypotheses, statistical decision theory, order statistics, linear statistical estimation.

8003 (0503). Statistical Methods I. (3 s.h.), Prerequisite: previous coursework in statistical methodology or permission of instructor. Introduction to applied statistics. Topics include data management, probability distributions, parameter estimation, hypothesis testing, sampling methodologies, graphical display, analysis of variance, and simple and multiple regression. Use of R, S-Plus and SAS statistical software.

8004 (0504).. Statistical Methods II. (3 s.h.). Prerequisite: Stat 8003 or permission of instructor. Design of experiments, analysis of discrete data, introduction to nonparametric methods, logistic regression, ARIMA time series analysis, bootstrapping, jackknife, robustness, and selected topics in multivariate analysis. Use of R, S-Plus and SAS statistical software.

8101 (0509). Stochastic Processes (3 s.h.). Prerequisite: Stat 8001 or permission of instructor. This graduate level course in probability models will provide both the theory and intuition required for modeling and analyzing the uncertainty that is encountered in problems in statistics, engineering and finance. This course assumes a proper preparation in probability theory but begins with a very quick review of some key concepts and properties of special distribution functions used throughout the course. We will spend much of the course examining discrete-time Markov chains and Poisson point processes. Additional topics include: random walks, martingales, renewal processes, wiener processes, Brownian motion, and diffusion processes. Examples from statistics, engineering and finance will be used throughout the course.

8102 (new course). Statistical Methods III (3 s.h.). Prerequisite: Stat 8004 or permission of instructor. Multivariate analysis, non-linear mixed effects modeling, generalized linear models, survival analysis, neural networks, Bayesian statistics, data mining. This is the third course in a three-course sequence providing an introduction to the major topics and techniques used in statistical analysis of data.

8103 (0511). Sampling Theory (3 s.h.). Prerequisite: Stat. 503 or permission of instructor. Theory and application of sampling from finite populations. Topics include random, stratified, cluster, and systematic sampling; estimation of means and variances; optimal allocation of resources; problems of non-sampling errors; and ratio and regression estimation.

8104 (0515). Mathematics for Statistics (3 s.h.). Prerequisite: undergraduate linear algebra or permission of instructor. Vector spaces and subspaces; Linear independence; Rank of a matrix; Special matrices like orthogonal, idempotent, nilpotent, Hadamard, and Givens, partitioned matrices; Determinant; Inverse and g-inverse; Solutions of linear equations; Eigenvalues and eigenvectors; Diagonalization theorems; Quadratic forms and optimization; Sets; Sigma Field, Lebesgue and Probability Measures; Limits and continuity of functions; Derivatives and partial derivatives; Mean value theorem; Taylor's expansion; Maxima and minima of functions; Infinite sequences and series with tests of convergence; Integration of several variables; Gamma and beta integrals; Sterling's formula; Fundamental inequalities; Some results on optimization and approximation of functions.

8105 (0518). Time Series Analysis I. (3 s.h.). Prerequisite: Stat. 8002 or permission of instructor.
Theory and application of univariate time series analysis. Includes both time domain and frequency domain methods. Considers stationary and nonstationary linear processes, time series model building, forecasting, unit root test, intervention models and outlier detection, spectral theory of stationary processes, spectral windows, and estimation of spectrum.

8106 (0521). Generalized Linear Models I. (3 s.h.). Prerequisite: Stat. 8002, Stat 8004 and Stat. 8104 or permission of instructor. Covers the basic theory and practice of generalized linear models (GLM), such as the logistic, Poisson and gamma regression, as well as models for multilevel or longitudinal Gaussian responses, such as the hierarchical linear model and linear mixed model. The students will need to work with R and SAS throughout the semester.

8107 (0522). Design of Experiments I. (3 s.h.). Prerequisite: Stat. 504 or permission of instructor. Principles of experimental designs, completely randomized designs, multiple comparisons, randomized block design, latin square design, missing value problems, analysis of covariance, and factorial experiments.

8108 (0533). Applied Multivariate Analysis I. (3 s.h.). Prerequisite: Stat. 504 and 515, or permission of instructor. Multivariate normal distribution; marginal and conditional distributions; estimation of population mean vector anddispersion matrix; correlation, partial correlation, and multiple correlation coefficients; Hotelling's T2; MANOVA; discriminant function; repeated measurements analysis; principal components and canonical correlation; factor analysis; and multidimensional scaling.

8109 (0551). Regression, Time Series, and Forecasting for Business Applications (3 s.h.). Prerequisite: Stat. 500 or statistics 212 or permission of instructor. Intermediate level course that covers regression analysis, time series analysis, and forecasting. The course is application oriented and standard statistical packages such as MINITAB are introduced and extensively used.

8111 (0554). Survey Techniques for Business Applications (3 s.h.). Prerequisite: Stat. 500 or permission of instructor. Application oriented. A course dealing with statistical and nonstatistical aspects of organizing a sample survey. Included are discussions of objectives, measurement, sample selection, pilot testing, data collection, data editing, summarization and interpretation of results in addition to describing the various sampling schemes. Students may be required to plan and execute a survey.

8112 (0555). Statistical Methods for Business Research I (3 s.h.). Prerequisite: One-year undergraduate statistics courses, old CIS 401 or equivalent. Part I of a doctoral level, one-year sequence of courses for the PhD students in Business Administration program. The course covers a variety of statistical methods useful in business research, such as: multiple regression analysis, ANOVA, linear models, analysis of covariance, logistic regression, principal component analysis, exploratory factor analysis and canonical correlation analysis. Emphases are placed on rationales, assumptions, techniques, and interpretation of results from computer packages. Relevant mathematical results will be presented, but proofs or abstract arguments shall be avoided. The lectures cover computer usages, such as R and/or SAS, and the students are expected to work with SAS (or equivalent packages) throughout the semester.

8113 (0556). Statistical Methods for Business Research II. (3 s.h.). Prerequisite: Statistics 8112 or equivalent. Part II of a doctoral level, one-year sequence of courses for the PhD students in Business Administration program. Topics covered in this course are: discriminant analysis, confirmatory factor analysis and structural equations modeling, time-series intervention analysis, survival (event history) analysis, MANOVA, multivariate profile analysis, hierarchical linear models (HLM), linear mixed models (LMM) for multilevel data.

8114 (0566). Survival Analysis I (3 s.h.). Prerequisite: Statistics 8002. Life tables; parametric and nonparametric methods for estimating hazard and survival functions; inference with Cox proportional hazard model with covariates.

8115 (0571). Nonparametric Methods (3 s.h.). Prerequisite: Stat. 502 or permission of instructor. A thorough course in nonparametric statistics. Estimation and testing of hypothesis when the function form of the population distribution function is not completely specified.

8116 (0572). Categorical Data Analysis (3 s.h.). Prerequisite: Stat. 8002 or permission of instructor. Sampling models and analyses for discrete data: Fisher's exact test; Logistic regression; ROC analysis; Log-linear models and Poisson regression; Conditional logistic regression; Cochran-Mantel-Haenszel test; Measures of agreement between observers; Quasi-independence; Multinomial logit models; Proportional odds model; Association models; generalized estimating equations (GEE); generalized linear mixed model (GLIMMIX); GSK models; Composite link functions. The students will need to work with R and SAS throughout the semester.

8117 (0575). Clinical Trials (3 s.h.). Prerequisite: Stat. 502 or 504 or permission of instructor. Introduction to the special problems associated with medical trials on humans. Topics include randomization, sample-size determination, methods for early trial termination, and tests for superiority, equivalence, and non-inferiority. Also discussed are choice of endpoints, control, side effects, use of historical data, meta-analysis and ethics of experimentation on humans.

8121 (0581). Statistical Computing (3 s.h). Prerequisites: Stat. 504 and CIS 401 or permission of instructor. Use of computers in the solution of statistical problems. Topics include: floating point architecture, random number generation, design of statistical software, computational linear algebra, numerical integration, optimization methods.

8122 (0590). Advanced SAS Programming (3 s.h.). 0598. Independent Study (1-6 s.h.). Prerequisite: approval of the department. Special study in a particular aspect of statistics under thedirect supervision of an appropriate graduate faculty member. No more than six semester hours of independent study may be counted toward degree requirements.

8123 (new course), Time Series Analysis and Forecasting (3 s.h.. Prerequisite; Any one of the following: Stat 8002, Stat 8101 and Econ 8009 or advanced undergraduate statistics and probability equivalent to Math 3031-3032. A time series analysis course with financial and business applications. It covers important univariate and multivariate time series methods including ARIMA models, intervention analysis and outlier detection, time series regression, volatility and GARCH models, vector time series and cointegration.

0599. Independent Study (1-6 s.h.). Prerequisite: approval of the department. Special study in a particular aspect of statistics under thedirect supervision of an appropriate graduate faculty member. No more than six semester hours of independent study may be counted toward degree requirements.

9001 (0601). Advanced Statistical Inference I. (3 s.h.). Prerequisite: Advanced Calculus, Stat 8001-8002 or equivalents. Background: Matrix Theory. Estimation: Sufficiency, Completeness, UMVU Estimation, Information Inequality, Invariance Principle, Bayes Estimation, Admissibility, Maximum Likelihood Estimation, Large Sample Properties of Estimators.

9002 (0602). Advanced Statistical Inference II (3 s.h.). Prerequisite: Stat. 9001. Testing of Hypotheses: Neyman-Pearson Fundamental Lemma; Uniformly Most Powerful Tests, Confidence Intervals, Likelihood Ratio Tests; Asymptotic Tests, Multiple Hypotheses Testing; EM algorithm, Bootstrap, Multiple Testing, etc. in addition to the standard statistical inference topics

9101 (0618). Time Series Analysis II. (3 s.h.). Prerequisite: Stat. 8105 or permission of instructor. Theory and application of multiple time series analysis and special topics. Covers transfer function models, time series regression with autocorrelated errors, ARCH and GARCH models, vector time series models, cointegration, state space models, long memory processes and nonlinear processes, time series aggregation and disaggregation.

9103 (new course). Statistical Learning and Data Mining. (3 s.h.). Prerequisite: statistical theory and methods (e.g., Statistics 8001, 8002, 8003, and 8004), or permission of instructor; a good knowledge of matrix algebra, of at least one of packages: S-PLUS, R, MATLAB, SAS, SPSS. This course includes topics such as multiple regression, prediction accuracy and model assessment, cross-validation, bootstrap, biased regression methods, principal components regression, partial least-squares regression, ridge regression, shrinkage estimators, multivariate reduced-rank regression, neural networks, principal components, canonical variates, projection pursuit, multidimensional scaling and distance geometry, linear discrimination and classification, support vector machines and kernel methods, decision trees for regression and classification, combining classifiers by bagging, boosting, and random forests, nonlinear dimensionality reduction, nonlinear manifold learning, and clustering algorithms. Emphasis will be on working with large data sets obtained from data mining, machine learning, and bioinformatics applications.

9106 (0621). Generalized Linear Models II. (3 s.h.). Prerequisite: Stat. 8106 or permission of instructor. Continuation of Stat 8106, covers the theory and practice of analyzing multivariate repeated/correlated non-Gaussian responses, with or without missing observations. Missing at random (MAR) models; informative missingness; EM algorithm; multiple imputations; quasi-likelihood estimation; generalized estimating equations (GEE); transition models; Gibbs sampling; Markov Chain Monte-Carlo (MCMC) technique. The students will need to work with R, SAS and WinBugs throughout the semester.

9107 (0622). Design of Experiments II. (3 s.h.). Prerequisite: Stat. 522 or permission of instructor. Covers symmetric and asymmetrical factorial experiments, fractional replication, split plot design, balanced and partially balanced incomplete block designs without and with recovery of interblock information and lattice designs.

9108 (0633). Multivariate Analysis II (3 s.h.). Prerequisite: Stat. 502 and 533 or permission of instructor. A study of specialized topics in multivariate analysis.

9114 (666). Survival Analysis II (3 s.h.). Prerequisite: Statistics 8114 or permission of instructor. Applications of advanced tools such as those martingale theory in survival analysis.

9180 (0701). Seminar in New Topics in Statistics (3 s.h.). Prerequisite: permission of instructor. Special topics in Statistics

9190 (0702). Seminar in New Topics in Statistics (3 s.h.). Prerequisite: permission of instructor. Special topics in Statistics

9994 (0799). Directed Study in Statistics (variable credit). Prerequisite: departmental permission. Preparation for preliminary examinations.

9183 (0896). Directed Study in Statistics (variable credit). Prerequisite: departmental permission.

9998 (0899). Directed Study in Statistics (variable credit). Prerequisite: departmental permission.

9999 (0999). Dissertation Research (1-12 s.h.). Prerequisite: departmental approval and elevation to candidacy.