BOSTON UNIVERSITY

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The Biostatistics Graduate Program at Boston University (MA/PhD)

Program Handbook 2017-2018

Boston University Graduate School of Arts & Sciences

Boston University School of Public Health

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Mission Statements

The mission of the Graduate School of Arts & Sciences (GRS) is the advancement of knowledge through research and scholarship, and the preparation of future researchers, scholars, college and university teachers, and other professionals.

The mission of the Boston University School of Public Health is to improve the health of local, national and international populations, particularly the disadvantaged, underserved and vulnerable, through excellence and innovation in education, research and service.

The mission of the Department of Biostatistics:

- To teach students the proper conduct of research studies through rigorous study design and appropriate descriptive and analytic methods that enable valid, interpretable conclusions to be drawn
- To collaborate in research projects to ensure that studies are properly designed, appropriately analyzed, and suitably interpreted
- To develop and evaluate new methods of biostatistical analysis and strategies for study design

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Section 1 Introduction to the Biostatistics Graduate Program

OVERVIEW

Today biostatisticians play a critical role in studies of risk factors for disease, in assessing safety and efficacy of new therapies in clinical trials, and in the evaluation of patient outcomes. The results of these studies have public health and policy implications. From discussions with investigators about fine-tuning research questions to developing appropriate study designs, planning and implementing proper statistical analyses, and writing up the results, biostatisticians are involved in all aspects of research investigations. The goals of the faculty of the Department of Biostatistics are to participate actively in innovative research, to advance medical and statistical science, and to teach and work closely with students so that they may acquire the knowledge to pursue productive careers in medical and public health research and academia at the highest levels.

Students may pursue graduate study in biostatistics through the Biostatistics Graduate Program, jointly administered by the Department of Biostatistics of the School of Public Health and the Department of Mathematics and Statistics of the Graduate School of Arts and Sciences. The program offers students the opportunity to not only gain expertise in mathematical statistics, but also to specialize in the epidemiologic, medical, and bioscientific applications of statistics. Students are required to take courses in both the Department of Mathematics and Statistics and the Department of Biostatistics. The program offers a Master of Arts (MA) in Biostatistics and a Doctor of Philosophy (PhD) in Biostatistics. Students pursue the PhD degree on a full-time basis and can choose to pursue the MA degree on either a full- or part-time basis, although they must complete their programs within a specified period of time as required by the Graduate School of Arts & Sciences.

Students who complete these programs will gain knowledge of probability, statistical inference and hypothesis testing, the design and conduct of experimental and epidemiological studies, statistical computation, and data analysis. Research interests of the Biostatistics department faculty include multivariate modeling, survival analysis, medical statistics, clinical trials methodology, statistical genetics, robust statistics, methods for the analysis of correlated data (longitudinal, spatial) data, estimation theory, and the design of experiments. Further information can be obtained from the directors of the program.

Section 2

Admission Requirements

APPLICATION FOR ADMISSION

The application deadline for the Biostatistics Program for Fall admission is **December 1** of the prior year for all MA and PhD applicants. We do not offer spring admission. All applications for admission are to be completed online through the Graduate School of Arts and Sciences (GRS). Please review all of the application instructions carefully, including the Frequently Asked Questions.

Department-specific admissions questions should be directed to biostat@bu.edu. Questions about the general admissions process should be directed to the Graduate School, grs@bu.edu.

APPLICATION REQUIREMENTS

- GRS online application
- Official transcripts in English from all colleges and universities attended
- One page personal statement
- Three letters of recommendation
- Official report of GRE scores from within the past 5 years (use school code 3087 to send your scores)
- Official report of TOEFL or IELTS scores for applicants whose native language is not English (see International Students below)
- Previous Coursework Document

PROGRAM PRE-REQUISITES

- At least the equivalent of a Bachelor's degree; no specific undergraduate major is required
- One year of calculus including multivariate calculus
- One formal course in linear algebra (with a minimum of four credits)

Applicants who have not met the pre-requisites will not be considered for admission.

INTERNATIONAL STUDENTS

Students from abroad must submit official English translations of all academic records. **We do not accept transcripts or evaluations from WES.** Official transcripts must be in English and sent directly from the college/university attended. Students must also submit results of the Test of English as a Foreign Language (TOEFL), with minimum score requirements of 550 for the paper-based test. GRS policy requires that applicants meet the minimum requirements *of each section* on the internet-based test:

Reading—21
Listening—18
Speaking—23
Writing—22

As an alternative to the TOEFL, the International English Language Testing System (IELTS) is also accepted as proof of English proficiency. The band score of 7.0 or higher is required for admission to the Graduate School of Arts & Sciences.

Applicants who do not meet the minimum requirements of English proficiency are not eligible for admission. This requirement is waived *only* if the student has received, or expects to receive, an undergraduate or graduate degree from a college or university in any of the following countries prior to enrollment in the Graduate School of Arts & Sciences: The United States, Canada, The United Kingdom, Australia, New Zealand, or Ireland. Studying in the medium of English in a country other than the ones previously listed or studying as an exchange student in an English-speaking country without completing a degree program is not sufficient to waive the English proficiency requirement.

Section 3 MA Degree Requirements

OVERVIEW OF THE MA DEGREE

The Master of Arts in Biostatistics program is aimed primarily at students with the equivalent of a Bachelor's degree who wish to pursue advanced study in the theory and methods of biostatistics. The program prepares students to function as collaborators on research projects in academia, industry or government, and prepares students for doctoral programs.

MA LEARNING OUTCOMES

A candidate for a Master of Arts degree in Biostatistics is expected to demonstrate mastery of knowledge in biostatistics by

- Demonstrating mastery at a Master's level of biostatistical theory and application through high achievement in course work and on written comprehensive examinations.
- Demonstrating commitment to advancing the values of scholarship by keeping abreast of current advances within biostatistics and showing commitment to personal professional development through engagement in professional societies and publication.
- Conducting scholarly work in a professional and ethical manner guided by the principles of the profession.

MA DEGREE REQUIREMENTS

The Graduate School or Arts & Sciences requires students pursuing a Master of Arts in Biostatistics to:

- Complete the 32-credit curriculum
- Fulfill the Residency Requirement
- Fulfill the Grade Requirement
- Pass both the Theory and Applied Biostatistics Qualifying Examinations
- Complete the MA degree within 3 years of matriculation to the program

MA CURRICULUM

Students in the MA program must complete a total of 32 credits as follows:

Course #	Course Title	When Offered
1. Six Core Courses, required (24 credits):		
CAS MA575	Linear Models	Fall
CAS/MET MA581	Probability	Fall
CAS/MET MA582	Mathematical Statistics	Spring
SPH EP770	Concepts and Methods in Epidemiology	Fall/Spring
SPH BS805	Intermediate Statistical Computing & Applied Regression	Fall/Spring/ Summer
SPH BS852	Statistical Methods in Epidemiology	Fall/Spring
2. Elective Courses (8 credits):		
CAS MA576	Generalized Linear Models	Spring
CAS MA583	Introduction to Stochastic Processes	Spring
CAS MA585	Time Series Modeling and Forecasting	Spring
CAS MA588	Nonparametric Statistics	Spring
CAS MA589	Computational Statistics	Fall
GRS MA685	Advanced Topics in Applied Statistical Analysis	Fall
GRS MA751#	Statistical Machine Learning	Spring
GRS MA781*	Estimation Theory	Fall
GRS MA782*	Hypothesis Testing	Spring
GRS MA861*	Seminar: Applied Mathematics	
GRS MA881*	Seminar: Statistics	
GRS MA882	Seminar: Statistics (Limit 4 credits)	Fall/Spring
CAS CS542#	Machine Learning	Fall, Spring, Summer
SPH BS715	Practical Skills for Biostatistics Collaboration (1 cr)	Spring
SPH BS722	Design and Conduct of Clinical Trials	Fall/Spring
SPH BS728	Public Health Surveillance, a Methods Based Approach (2 cr)	Fall
SPH BS775	Applications of Statistical Methods in Clinical Research	Alt Springs (even years)
SPH BS810	Meta-analysis for Public Health and Medical Research	Fall
SPH BS820	Logistic Regression/Survival Analysis	Spring
SPH BS821	Categorical Data Analysis	Fall
SPH BS825	Advanced Infectious Disease Epidemiology (2 credits)	Fall
SPH BS831	Genomics Data Mining and Statistics (2 credits)	Spring
SPH BS845	Applied Statistical Modeling & Programming in R	Fall

SPH BS849	Bayesian Modeling for Biomedical Research & Public Health (2 credits)	Spring
SPH BS851	Applied Statistics in Clinical Trials I	Fall/Spring
SPH BS853	Generalized Linear Models with Applications	Spring
SPH BS854	Bayesian Methods in Clinical Trials	Alt Falls (odd years)
SPH BS856	Adaptive Designs for Clinical Trials	Alt Springs (odd years)
SPH BS857	Analysis of Correlated Data	Spring
SPH BS858	Statistical Genetics I	Fall
SPH BS859	Applied Genetic Analysis	Alt Springs (odd years)
SPH BS860	Statistical Genetics II	Alt Springs (even years)
SPH BS861	Applied Statistics in Clinical Trials II	Spring
SPH BS901**	Directed Study in Biostatistics	TBD
SPH BS902**	Directed Research in Biostatistics	TBD
SPH EP854*	Modern Epidemiology	Fall

* Must obtain permission from academic advisor and/or instructor to take this course as an elective.

Only one of these two courses may count as an elective

** A maximum of 4 credits is allowed across these two courses.

MA PROGRAM REQUIREMENTS AND POLICIES

Residency Requirements: Students must be registered in both the semester in which the last degree requirements are completed and in the preceding semester. For example, if a student plans to complete their degree requirements in the Spring of 2018, s/he must be registered in both Spring 2018 and Fall 2017.

Grade Requirements: Students must earn a grade of B- or better in all courses applied to the degree.

Qualifying Examinations:

The MA candidate must satisfactorily pass two comprehensive written examinations upon completion of coursework. These will require proficiency in the material covered in the six core courses.

The Biostatistics Theory Qualifying Examination is given in the spring semester. Candidates must satisfactorily answer four of six questions based on material covered in MA581 and MA582. The Biostatistics Applied Qualifying Examination is given in December and in April each year. Candidates must satisfactorily answer a total of four questions based on material covered in MA575, BS805, and BS852 with at least one question from each of the three course areas.

Students can use one single-sided reference sheet (printer size [8.5in x 11in] or smaller, handwritten or typed) in the Applied examination. A reference sheet is not allowed in the Theory examination. The reference sheet will be collected at the end of the exam.

Students are strongly urged to meet with their advisors to discuss preparation for the Qualifying Examinations. Students are allowed two attempts to pass a Qualifying Exam. The Biostatistics Qualifying Exam Committee will evaluate requests by students to take an exam for the third time on a case-by-case basis.

Important Note: For May graduates only, diplomas will be available at the commencement ceremonies. Otherwise, approximately one month following the date of graduation and depending on a student's preference, the diploma is either available for pick-up from the Diploma Office at the Office of the University Registrar, 881 Commonwealth Avenue, or it will be mailed to the address specified on the Diploma Dispersal form that is submitted with the Diploma Application.

Policies

All students must adhere to all Boston University Graduate School of Arts & Sciences academic policies; and the University's Administrative Policies. Note that this information may change at any time.

MA GRADUATION

Please review the detailed graduation timeline and procedures on the GRS Dissertation and Graduation Procedures webpage. Note that several steps, including the Intent to Graduate form, must be taken well in advance of the intended graduation date. It is the student's responsibility to keep track of all graduation procedures.

Master of Arts students in Biostatistics are eligible and invited to participate in both the GRS and SPH Commencement ceremonies. Many students choose to participate in only the SPH ceremony. Students must register in advance for each Commencement ceremony in which they plan to participate. Information and instructions about Commencement will be sent directly from SPH and GRS. It is the student's responsibility to keep track of all Commencement ceremony procedures.

Section 4

PhD Degree Requirements

OVERVIEW OF THE PHD DEGREE

The PhD program in Biostatistics is geared towards the graduate student who seeks a career as a professional, academic, or industrial biostatistician in biomedical or epidemiologic sciences. The program meets the needs of the health professional who wishes to continue with public health training to achieve a higher and more specialized degree and also of the statistician who wishes to specialize in statistical methods for biomedical or epidemiologic applications.

PHD LEARNING OUTCOMES

A candidate for a Doctor of Philosophy degree in Biostatistics is expected to demonstrate mastery of knowledge in biostatistics and to synthesize and create new knowledge, making an original and substantial contribution to the field in a timely fashion by:

- Demonstrating mastery at a doctoral level of biostatistical theory and application through high achievement in course work and on written comprehensive examinations.
- Making an independent, original, and substantial contribution to the field of biostatistics, assessed through an oral defense of the dissertation work.
- Demonstrating commitment to advancing the values of scholarship by keeping abreast of current advances in the field of biostatistics and showing commitment to personal professional development through engagement in professional societies and publication.
- Conducting scholarly work in a professional and ethical manner guided by the principles of the profession.

PHD DEGREE REQUIREMENTS

The Graduate School of Arts & Sciences requires all students pursuing a Doctor of Philosophy in Biostatistics to:

- Complete the 64-credit (post-BA), or 32-credit + co-requisites (post-MA) curriculum
- Fulfill the Residency Requirement
- Fulfill the Grade Requirement
- Pass both Qualifying Examinations
- Attend seminars and presentations as described below.
- Complete a dissertation that conforms to program and Graduate School requirements (outlined below)
- Pass the Final Oral Defense Examination
- Fulfill the teaching requirement by working as a Biostatistics TA for at least 1 semester
- Complete the PhD degree within 7 years of matriculation to the program

Additionally, students in Dissertation Phase are required to:

- Present the status of their dissertation research once per year
- Meet with their full dissertation committee at least twice per year
- Submit dissertation progress reports twice per year

Review all GRS requirements for doctoral students here.

PHD CURRICULUM

The intent of the curriculum is to provide a firm foundation in biostatistics and mastery of a broad range of applied techniques. Students in the PhD program entering with only a bachelor's degree must complete a total of 64 credits.

Students entering the PhD program with MA degrees may be accepted into an eight-course (32 credits) post-Master's PhD program. However, they may be required to take additional co-requisites if there are deficiencies in their backgrounds. For post-Master's PhD students, the core courses required will be determined at the start of their program by the Co-Directors. The remaining courses must come from the list of Biostatistics (either BS or MA) or Elective courses.

Course #	Course Title	When Offered
1. Ten Core Courses, required (40 credits):		
CAS MA575	Linear Models	Fall
CAS/MET MA581	Probability	Fall
CAS/MET MA582	Mathematical Statistics	Spring
SPH EP770	Concepts and Methods in Epidemiology	Fall/Spring
SPH BS805	Interm. Statistical Computing & Applied Regression	Fall/Spring/Summer
SPH BS852	Statistical Methods in Epidemiology	Fall/Spring
SPH BS853	Generalized Linear Models with Applications	Spring
SPH BS857	Analysis of Correlated Data	Spring
GRS MA781	Estimation Theory	Fall
GRS MA782	Hypothesis Testing	Spring
2. At least 12 credits from the following Biostatistics courses: :		
SPH BS722	Design and Conduct of Clinical Trials	Fall/Spring
SPH BS728	Public Health Surveillance, a Methods Based Approach (2 credits)	Fall
SPH BS775	Applications of Statistical Methods in Clinical Research	Alt Springs (even years)
SPH BS810	Meta-analysis for Public Health and Medical Research	Fall
SPH BS820	Logistic Regression/Survival Analysis	Spring
SPH BS821	Categorical Data Analysis	Fall
SPH BS825	Advanced Methods in Infectious Disease Epidemiology (2 credits)	Fall
SPH BS831	Genomics Data Mining and Statistics (2 credits)	Spring
SPH BS845	Applied Statistical Modeling and Programming in R	Fall
SPH BS849	Bayesian Modeling for Biomedical Research and Public Health (2 credits)	Spring
SPH BS851	Applied Statistics in Clinical Trials I	Fall/Spring
SPH BS854	Bayesian Methods in Clinical Trials	Alt Falls

		(odd years)
SPH BS856	Adaptive Design for Clinical Trials	Alt Springs (even years)
SPH BS858	Statistical Genetics I	Fall
SPH BS859	Applied Genetic Analysis	Alt Springs (odd years)
SPH BS860	Statistical Genetics II	Alt Springs (even years)
SPH BS861	Applied Statistics in Clinical Trials II	Spring
3. The remaining courses may be selected from the above series of courses or from the following Elective Courses. One elective may be in the biological sciences[#] (12 credits):		
CAS MA511	Introduction to Analysis I	Fall
CAS MA512	Introduction to Analysis II	Spring
CAS MA555	Numerical Analysis I	Spring
CAS MA556	Numerical Analysis II	Fall
CAS MA576	Generalized Linear Models	Spring
CAS MA578	Bayesian Statistics	Spring
CAS MA583	Introduction to Stochastic Practices	Spring
CAS MA585	Time Series Modeling and Forecasting	Spring
CAS MA588	Nonparametric Statistics	Spring
CAS MA589	Computational Statistics	Fall
CAS MA685	Advanced Topics in Statistics	Fall/Spring
GRS MA703	Statistical Analysis of Network Data	Alt Falls (odd years)
GRS MA711	Real Analysis	Fall
GRS MA750	Nonparametric and Semiparametric Data Modeling	Fall
GRS MA751*	Statistical Machine Learning	Spring
GRS MA779	Probability Theory I	Fall
GRS MA780	Probability Theory II	Spring
GRS MA882	Seminar: Statistics	Spring
CAS CS542*	Machine Learning	Fall, Spring, Summer
SPH BS715	Practical Skills for Biostatistics Collaboration (1cr)	Spring
SPH BS901**	Directed Study in Biostatistics	TBD
SPH BS902**	Directed Research in Biostatistics	TBD
SPH EP854[‡]	Modern Epidemiology	Fall
SPH EP855[‡]	Advanced Epidemiology Seminar: Issues in Study Design	Spring

* Only one of these two courses may be taken as an elective.
** Limit of 4 credits among the two. Post-Bachelor's PhD students may petition Co-Directors to allow more than 4 credits.
‡ Only one of these two courses may count as an elective.

[#] Given the large number of biology courses, a comprehensive list is not provided here. Please contact the Program Co-Directors to seek permission for a specific course in the biological sciences.

Specialization Areas

Students in the PhD program may also select one of three areas of specialization by completing the nine core courses, at least one of the courses in the MA series above, and three courses from the four listed within a specific area as follows

Analysis of Observational Studies	
SPH EP813	Intermediate Epidemiology
SPH BS820	Logistic Regression/Survival Analysis
SPH BS857	Analysis of Correlated Data
SPH BS810	Meta-analysis for Public Health and Medical Research
Clinical Trials*	
SPH BS722	Design and Conduct of Clinical Trials
SPH BS810	Meta-analysis for Public Health and Medical Research
SPH BS851	Applied Statistics in Clinical Trials I
SPH BS854	Bayesian Methods in Clinical Trials
SPH BS856	Adaptive Designs for Clinical Trials
SPH BS861	Applied Statistics in Clinical Trials II
Statistical Genetics**	
SPH BS831	Genomics Data Mining and Statistics
SPH BS858	Statistical Genetics I
SPH BS859	Applied Genetic Analysis
SPH BS860	Statistical Genetics II

*Students who are particularly interested in this area may want to consider the Graduate Certificate in Modern Biostatistics in Clinical Trials

**Students who are particularly interested in this area may want to consider the Graduate Certificate in Statistical Genetics

PHD ADVISING SYSTEM

Academic Advisor. Upon entry into the Biostatistics Program, each student will be appointed an Academic Advisor from the Biostatistics faculty. This person will act as the student's primary academic advisor and a general point of contact within the department until the student identifies a thesis advisor.

RA or TG Advisor. In addition to the academic advisor, each doctoral student will be assigned either a Research Assistantship (RA) advisor or a Training Grant (TG) advisor at the start of the program. This advisor will oversee the assistantship or training grant placement for the upcoming year. Students should work with their RA/TG advisor in addition to the academic advisor when finalizing a course schedule, in case there are classes that would be particularly relevant to the Assistantship or Training Grant that the RA/TG advisor recommends.

Thesis Advisor. Each PhD student will identify one or more research advisors within 6 months of entering dissertation phase. Students are encouraged to identify their

research advisors early in the program, based upon published research, academic advising, teaching, working group affiliation, or other criteria relevant to the student's research interests. Thesis advisors are selected by mutual agreement between the student and advisor. Once identified, the student should notify the Program Manager of his/her thesis advisor and this person should be clearly listed on all dissertation progress updates. The primary thesis advisor may be a faculty member from outside the Biostatistics Department if approved by GRS; in this case, the second reader on the dissertation committee must be a Biostatistics faculty member. The thesis advisor takes the place of the academic advisor for students in dissertation phase.

PHD PROGRAM REQUIREMENTS AND POLICIES

Residency Requirements: The minimum residency requirement is the equivalent of 2 consecutive regular semesters of full-time graduate study at Boston University. Students who have completed their course requirements must register each subsequent semester for BS980 Continuing Study/Dissertation Seminar until they have completed all requirements for the degree. Upon written petition and appropriate cause, students will be allowed up to 2 semesters of leave of absence.

Students must be registered in both the semester in which the last degree requirements are completed and in the preceding semester. For example, if a student plans to complete their degree requirements in Spring of 2018, s/he must be registered in both Spring 2018 and Fall 2017. If a student plans to defend in Summer 2018, s/he must be registered in Spring 2018 and Summer 2018. Any student who plans to defend in early fall should meet with GRS Records to discuss their plans.

A full explanation of GRS residency requirements can be found here.

Grade Requirements: Students must earn a grade of B- or better in all courses applied to the degree.

Teaching Requirements: Starting in fall 2016, one semester of teaching has been added as a curriculum requirement for the PhD program. Students must complete the teaching requirement before defending their dissertation. Students complete the teaching requirement by working as a Teaching Assistant or Co-Instructor for a Biostatistics course for at least one semester.

Seminar and Presentation Attendance Requirement:

1. **Seminars**: All PhD students must attend at least 4 qualifying seminars per semester (fall and spring). Eligible events include: Biostatistics Lunchtime Seminar Series, working group meetings, Biostatistics Student Association (BSA) and Boston University Student Chapter of the American Statistical Association (BUSCASA) seminars, Department of Mathematics and Statistics seminars, and biostatistics-related seminars of the Boston University Clinical and Translational Science Institute (CTSI). A sample of upcoming events that count towards this requirement will be included in the departmental newsletter throughout the academic year.
2. **Presentations**: Doctoral students must also attend doctoral student thesis presentation sessions each semester (fall and spring). Both the regularly scheduled dissertation research presentation sessions and dissertation defenses can be used to fulfill this requirement. **Students in coursework phase** must attend at least one doctoral student presentation session each semester (fall and spring). **Students in dissertation phase** must attend at least three doctoral student presentation

sessions each semester (fall and spring), not including their own presentation session.

3. **L. Adrienne Cupples Award**. All doctoral students are required to attend the L. Adrienne Cupples Award presentation and associated student meeting in the spring semester.

The Program Manager will track compliance with these requirements, which are also reviewed by the Biostatistics Program Advisory Committee. Students who do not attend the required number of events each semester will be required to make a special presentation in the spring.

Responsible Conduct of Research (RCR) Requirement

The Biostatistics department requires all doctoral students who entered the program in Fall 2014 or later to complete the University's Responsible Conduct of Research training each year. In addition, students who started the program prior to Fall 2014 and are funded by an NIH training grant or NSF grant are required to complete the RCR training each year. The University will email students information about the training and a link to the online training modules.

Awarding the MA Degree to Doctoral Students

Students accepted to the 64-credit doctoral program in Fall 2017 or later, will be awarded the MA and PhD degrees simultaneously upon the completion of the doctoral program. Any student who withdraws from the doctoral program prior to completion can petition the Biostatistics Program Advisory Committee to receive their Master of Arts degree. These requests will be considered by the Committee on a case-by-case basis.

Qualifying Examinations

The doctoral candidate must satisfactorily pass two comprehensive written examinations upon completion of coursework. These will require proficiency in material covered in the nine core courses. Students can use one single-sided reference sheet (printer size [8.5in x 11in] or smaller, handwritten or typed) for both examinations. The reference sheet will be collected at the end of the exam.

The Statistical Theory Qualifying Examination is given each year in the fall semester. Candidates must answer a total of four of six questions based on material covered in MA781 and MA782. The Applied Statistics Qualifying Examination is given each year in December and in April. Candidates must satisfactorily answer one of two questions based on material covered in BS853, plus a total of four questions based on material covered in MA575, BS805, and BS852, with at least one question from each of the three course areas.

Students are strongly urged to meet with their advisors to discuss preparation for the Qualifying Examinations. Students are allowed two attempts to pass a Qualifying Exam. The Biostatistics Qualifying Exam Committee will evaluate requests by students to take an exam for the third time on a case-by-case basis.

Access to Department

All Biostatistics doctoral students will have after-hours access to the Biostatistics Department on the 3rd floor of the Crosstown building, to use the student workstations outside of normal business hours.

Policies

All students must adhere to all Boston University Graduate School of Arts & Sciences academic policies; and the University's Administrative Policies. Note that this information may change at any time.

Dissertation Requirements

Dissertation Phase: Students enter dissertation phase after completing all of their required coursework and passing both Qualifying Exams. Students may officially audit one class per semester in dissertation phase. Students in dissertation phase are required to fulfill additional requirements as outlined below.

Dissertation: Upon successful completion of the Qualifying Examinations and required coursework, doctoral students select thesis advisors who will guide them through their dissertation research. The PhD dissertation provides students with the opportunity to design, conduct, and report on independent, original research in biostatistics. The dissertation consists of original research in the development of statistical methodology for biomedical or epidemiologic applications. The dissertation must be an original contribution to the body of knowledge in biostatistics. It is expected that the dissertation content will address a relevant question in statistical methodology and will pose a new approach, extend an existing approach, or provide novel application of an existing method. Dissertations will often utilize simulation, but simulation studies without methodological development or a theoretical component are not sufficient. Additionally, simulations are not required and use of real data sets in combination with theoretical work may suffice.

The dissertation must meet all formatting requirements specified by GRS. Within these requirements, two approaches to the dissertation are allowed. The first is a single body of work comprehensively addressing one problem. The second format consists of two or three problems in a single area of research. For either format, the content of the dissertation should be at least equal to the content of three journal articles. The format of the dissertation (single body of work versus multiple related problems) should be agreed upon by consensus of the student, the major advisor and the committee members.

Dissertation Prospectus: Each doctoral student will work with a thesis advisor to develop a dissertation prospectus. The prospectus cannot be submitted until after all coursework is complete and the student has passed both Qualifying Examinations, and must be submitted at least six months prior to the scheduled dissertation defense. The prospectus will be reviewed and evaluated by the department; once approved, the department will submit a Dissertation Prospectus Approval to GRS on the student's behalf. GRS instructions for the Prospectus are available here. Examples of past students' prospectuses are available from the department to model appropriate formatting.

Dissertation Progress: Doctoral students in the dissertation phase of the program are required to meet with their dissertation committee at least twice per year. It is beneficial to have at least three committee members in attendance at each meeting, particularly as the dissertation nears completion. Progress on the dissertation will be closely monitored by the committee and co-directors through progress update forms submitted in October and May each year. Any student who fails to meet with their committee and submit the dissertation progress update on time will be prevented from registering for the subsequent semester until the progress update has been submitted. See detailed timeline starting on page 20 of this document.

Doctoral Dissertation Presentations: Presentations of doctoral student dissertation research in progress will be held regularly throughout the fall and spring semesters. Students in dissertation phase must (a) present the status of their thesis work to students and faculty at least once per year and (b) attend at least 3 other doctoral dissertation presentation sessions or thesis defenses per semester (fall and spring). **There are no exceptions.** Any student who does not comply with the doctoral dissertation presentation requirements (presenting and attending other presentations) will be required to make an additional presentation in the spring semester.

Prepare a scholarly manuscript for publication. All doctoral students graduating in Spring 2019 and thereafter are required to have submitted at least one first-author paper based on their dissertation to a peer-reviewed journal for publication prior to the dissertation defense. The article must conform to the requirements of a specific statistical or otherwise appropriate journal. The dissertation committee must confirm that this submission has occurred prior to the defense being scheduled.

Final Oral Defense Examination: Each doctoral candidate will present an oral defense of the dissertation before a five-member doctoral committee.

Time Limits: The PhD program must be completed within seven years after the first registration for doctoral study. All doctoral students are expected to adhere to Biostatistics Program guidelines regarding the following milestones in their programs of study toward degree completion:

- Successfully complete all core courses no later than 3 years after matriculation.
- Pass at least one (Theoretical or Applied) Biostatistics Qualifying Examination no later than 3 years after matriculation.
- Pass both Qualifying Exams no later than 4 years after matriculation.
- Establish the members of the dissertation committee no later than 6 months after passing the final Qualifying Exam and completing required coursework.

PHD GRADUATION

Please review the detailed graduation timeline and procedures on the GRS Dissertation and Graduation Procedures webpage. Note that several steps, including the Intent to Graduate form, must be taken well in advance of the intended graduation date. It is the student's responsibility to keep track of all graduation procedures.

Doctoral students in Biostatistics are eligible and invited to participate in both the GRS and SPH Commencement ceremonies. Many students choose to participate in only the SPH ceremony. Students must register in advance for each Commencement ceremony in which they plan to participate. Information and instructions about Commencement will be sent directly from SPH and GRS. It is the student's responsibility to keep track of all Commencement ceremony procedures.

Section 5 Administrative Timeline & Progress to Degree

TIMELINE TO DOCTORAL DEGREE

Students are responsible for monitoring the progress of their program with the help of their academic advisor. The following are steps students should take to completing their PhD Dissertation. Students should direct questions to the one of the Co-Directors.

Years 1-4	Complete coursework Sit for Qualifying Exams o Applied Qualifying Exam offered in April and December. o Theory Qualifying Exam offered in October.
Dissertation Phase (after completing all coursework and qualifying exams)	Identify dissertation advisor, topic, and timeline to completion within 6 months of entering dissertation phase. Identify full committee within the first year of dissertation phase. o A Committee consists of five members. At least two members, including the chair and either the first or second reader, must be Biostatistics Department faculty members. If a committee member does not have a BU faculty appointment, the student must file a Special Service Appointment form with the Program Manager. Once the full committee has been selected, meet with the full committee at least twice per year throughout the remainder of dissertation phase. Fulfill doctoral dissertation presentation requirements o Present dissertation research at least once per year. The abstract and summary should be sent to Howard Cabral (hjcab@bu.edu) at least one week before the presentation. o Attend at least 3 doctoral student dissertation presentations per semester (fall and spring)
7-9 months prior to defense	Prepare Dissertation Prospectus and submit to committee for feedback and approval Submit approved prospectus and signed Dissertation Prospectus Approval Form to Program Manager at least 6 months prior to defense Review dissertation formatting requirements and sample pages
4-5 months prior to graduation	Submit Intent to Graduate form to GRS
3 months prior to defense	First draft of dissertation should be submitted to readers. Schedule an Appointment at GRS to review format of dissertation
1 month prior to defense	Submit one article based on the dissertation to a peer-reviewed journal for consideration of publication and be listed as first author. The dissertation advisor must sign off on fulfillment of this requirement. Submit dissertation abstract to committee for approval. Schedule individual meetings with members of the committee to discuss the

	content and presentation of material in the dissertation.
3 weeks prior to defense	Submit Schedule of Final Oral Examination with Abstract Approval to Program Manager Submit draft of dissertation to Program Manager. You will be notified if the format is approved or if any changes are required by GRS. Provide a final copy of dissertation to each member of the committee. Select a Chair from the members of your Committee and notify GRS of the name of the Chair. The Chair must be a member of the Biostatistics program faculty (Math or Biostatistics Department). Appropriate paperwork will be sent to Chair in advance of the defense.
Day of defense	Prepare and bring appropriate signature pages according to GRS specifications for the defense. Present dissertation using a PowerPoint or similar electronic presentation.
After defense	Submit final approved dissertation electronically to the ETD Administrator and make an appointment with GRS Records to submit required materials in person. Submit a final electronic copy of the dissertation to the Co-Directors of the Program. Complete an exit interview form and meeting with one of the Co-Directors within one month of program completion.

Section 6 Course Descriptions

BIOSTATISTICS COURSE DESCRIPTIONS

Comprehensive and up to date course descriptions can be found on: https://www.bu.edu/phpbin/course-search/index.php.

SPH BS 715 - Practical Skills for Biostatistics Collaboration
This course will focus on skills required for effective research collaboration with investigators from various disciplines. Emphasis will be on the development of skills to communicate effectively with biostatistician and non-biostatisticians collaborators, to write data collection and statistical analysis plans for grants and/or publications, and to organize results in appropriate visual displays and tables. Other issues, including techniques to work efficiently in multi-disciplinary research teams (e.g constructing timelines and deliverables,) will also be discussed. Weekly discussions will address challenges in collaborative research, along with approaches, skills and guidelines necessary to overcome these challenges. Students will have hands-on experience with case studies of particular data sets or projects, development of analysis plans, and dissemination of the analysis results. Grad Prereq: The biostatistics MPH core requirement. [1cr.]

SPH BS 722 - Design and Conduct of Clinical Trials
This course covers the development, conduct, and interpretation of clinical trials. It is suitable for concentrators in any department. Topics include principles and practical features such as choice of experimental design, choice of controls, sample size determination, methods of randomization, adverse event monitoring, research ethics, informed consent, data management, and statistical analysis issues. Students write a clinical trial protocol during the semester.
Prereq: The MPH biostatistics concentration core courses or SPH PH717 or consent of the instructor [4 cr.]

SPH BS 728 - Public Health Surveillance, a Methods Based Approach
Thacker wrote, "Surveillance is the cornerstone of public health practice." This course will provide an introduction to surveillance and explore its connections to biostatistics and public health practice. Topics will include complex survey design, weighted sampling, capture-recapture methods, time series analyses and basic spatial analyses. Students will learn about available surveillance data, how to analyze these data, and how to write about their findings. Additionally students will propose a new surveillance system or modification of an existing system. This class carries Epidemiology concentration credit.
Prereq: The MPH biostatistics concentration core courses or SPH BS740 or SPH PH717 or consent of the instructor; SPH BS723 is strongly recommended [2 cr.]

SPH BS 775 - Applications of Advanced Statistical Methods in Clinical Research
This course provides a non-technical (no computer programming) overview of concepts in statistical methods used for clinical research and their applications. Each week, students read a methodologic article and a clinical research article. The first portion of the class is a didactic presentation; the second portion is a discussion of the clinical research article, incorporating the concepts discussed in the didactic presentation. Students explore statistical test selection, alternative tests or approaches. Students examine interpretations of scientific articles in the lay press. [4 cr.]

SPH BS 805 - Intermediate Statistical Computing and Applied Regression Analysis

This course is a sequel to BS723. Emphasis is placed on the use of intermediate-level programming with the SAS statistical computer package to perform analyses using statistical models with emphasis on linear models. Computing topics include advanced data file manipulation, concatenating and merging data sets, working with date variables, array and do-loop programming, and macro construction. Statistical topics include analysis of variance and covariance, multiple linear regression, logistic regression, survival analysis, the analysis of correlated data, and statistical power. Includes a required lab section.
Prereq: SPH BS703 or SPH BS723 or consent of the instructor [4 cr.]

SPH BS 810 - Meta-Analysis for Public Health & Medical Research
Meta-analysis is the statistical analysis of research findings and is widely used in public health and medical research. Typically meta-analysis is employed to provide summary results of the research in an area, but other uses include exploratory analyses to find types of subjects who best respond to a treatment or find study-level factors that affect outcomes. The course will cover the theory and use of the most common meta-analytic methods, the interpretation and limitations of results from these methods, diagnostic procedures, and some advanced topics with a focus on public health application. Grading will be based on homework, an exam and a project. [4 cr.]
Prereq: SPH BS704 or SPH PH717, and SPH BS723; or consent of the instructor [4 cr.].

SPH BS 820 - Logistic Regression and Survival Analysis
This course provides basic knowledge of logistic regression and analysis of survival data. Regression modeling of categorical or time-to-event outcomes with continuous and categorical predictors is covered. Checking of model assumptions, goodness of fit, use of maximum likelihood to determine estimates and test hypotheses, use of descriptive and diagnostic plots are emphasized. The SAS statistical package is used to perform analyses. Grading will be based on homework and exams.
Prereq: The MPH biostatistics concentration core courses or SPH PH717; and BS723 or BS852. [4 cr.]

SPH BS 821 - Categorical Data Analysis
This course focuses on the statistical analysis of categorical outcome data. Topics include the binomial and Poisson distributions, logistic and Poisson regression, nonparametric methods for ordinal data, smoothed regression modeling, the analysis of correlated categorical outcome data, cluster analysis, missing data and sample size calculations. The course emphasizes practical application and makes extensive use of the SAS programming language.
Prereq: SPH BS704 or SPH PH717, and SPH BS723; or consent of the instructor [4 cr.].

SPH BS 825 - Advanced Methods in Infectious Disease Epidemiology
This course aims to introduce students to statistical and mathematical methods used in infectious disease epidemiology. Students will be able to evaluate and appraise the literature in this field, be able to select which methods to use in different circumstances, implement some methods in simple situations and we will provide sufficient background reading that students can further examine methods that are of particular interest. This will be a hands-on course involving class discussions, computer lab sessions and a class debate on a controversial topic in infectious disease epidemiology.
Prereq: SPH EP755 and SPH BS730 (or SPH BS723 with consent of the instructor) [2 cr.]

SPH BS 831 – Genomics Data Mining and Statistics
In this course, students will be presented with the methods for the analysis of gene expression data measured through microarrays. The course will start with a review of the basic biology of gene expression and an overview of microarray technology. The course will then describe the statistical techniques used to compare gene expression across different conditions and it will progress to describe the analysis of more complex experiments designed to identify genes with similar functions and to build models for molecular classification. The statistical techniques described in this course will include general methods for comparing population means, clustering,

classification, simple graphical models and Bayesian networks. Methods for computational and biological validation will be discussed. [2 cr.]

SPH BS 845 - Applied Statistical Modeling and Programming in R
This course covers applications of modern statistical methods using R, a free and open source statistical computing package with powerful yet intuitive graphic tools. R is under more active development for new methods than other packages. We will first review data manipulation and programming in R, then cover theory and applications in R for topics such as linear and smooth regressions, survival analysis, mixed effects model, tree based methods, multivariate analysis, boot strapping and permutation.
Prereq: SPH BS723 or SPH BS730 or consent of the instructor [4 cr.].

SPH BS 849 – Bayesian Modeling for Biomedical Research & Public Health
The purpose of this course is to present Bayesian modeling techniques in a variety of data analysis applications, including both hypothesis and data driven modeling. The course will start with an overview of Bayesian principles through simple statistical models that will be used to introduce the concept of marginal and conditional independence, graphical modeling and stochastic computations. The course will proceed with the description of advanced Bayesian methods for estimation of odds and risk in observational studies, multiple regression modeling, loglinear and logistic regression, hierarchical models, and latent class modeling including hidden Markov models and application to model-based clustering. Applications from genetics, genomics, and observational studies will be included. These topics will be taught using real examples, class discussion and critical reading. Students will be asked to analyze real data sets in their homework and final paper. [2 cr.]

SPH BS 851 - Applied Statistics in Clinical Trials I
This is an intermediate statistics course, focused on statistical issues applicable to analyzing efficacy data for clinical trials. Topics include design and analysis considerations for clinical trials, such as randomization and sample size determination, and the application of statistical methods such as analysis of variance, logistic regression and survival analysis to superiority and non-inferiority clinical trials. This course includes lectures and computer instructions. Upon completion of the course, the student will be able to have a working knowledge of how to collect and manage clinical trial data; will be to analyze continuous, dichotomous, and time-to-event clinical trial data; and will be able to contribute to the statistical portions of a clinical trial study design. The student will also gain the overall knowledge required to interpret clinical trial statistical results.
Grad Prereq: The MPH biostatistics concentration core courses or SPH PH717; and SPH BS723; or consent of the instructor [4 cr.].

SPH BS 852 - Statistical Methods in Epidemiology
This course covers study design and intermediate-level data analysis techniques for handling confounding in epidemiologic studies. Confounding is carefully defined and distinguished from interaction. Course content covers stratification and multivariable techniques for controlling confounding in both matched and independent sample study designs, including analysis of covariance, logistic regression, and proportional hazards models. Model fit and prediction are discussed. Students are required to apply these methods with the aid of computerized statistical packages.
Prereq: The MPH biostatistics concentration core courses or SPH PH717; and SPH BS723 or SPH BS730; or consent of the instructor [4 cr.].

SPH BS 853 - Generalized Linear Models with Applications
This course introduces statistical models for the analysis of quantitative and qualitative data, of the types usually encountered in health science research. The statistical models discussed include: Logistic regression for binary and binomial data, Nominal and Ordinal Multinomial logistic regression for multinomial data, Poisson regression for count data, and Gamma regression for data with constant coefficient of variation. All of these models are covered as special cases of the Generalized Linear Statistical Model, which provides an overarching statistical framework for these models. We will also introduce Generalized Estimating Equations (GEE) as an extension to the generalized models to the case of repeated measures data. The course emphasizes practical applications, making extensive use of SAS for data analysis.

Grad Prereq: The biostatistics and epidemiology MPH core course requirements and BS805 or consent of the instructor [4 cr.].

SPH BS 854 - Bayesian Methods in Clinical Trials

Bayesian statistical methods use prior information or beliefs, along with the current data, to guide the search for parameter estimates. In the Bayesian paradigm probabilities are subjective beliefs. Prior information/ beliefs are input as a distribution, and the data then helps refine that distribution. The choice of prior distributions, posterior updating, as well as dedicated computing techniques are introduced through simple examples. Bayesian methods for design, monitoring analysis for randomized clinical trials are taught in this class. These methods are contrasted with traditional (frequentist) methods. The emphasis will be on concepts. Examples are case studies from the instructors' work and from medical literature. R will be the main computing tool used.
Prereq: SPH BS851 or SPH BS861 or consent of the instructor [4 cr.].

SPH BS 856 - Adaptive Designs for Clinical Trials

An adaptive design is a clinical trial design that allows modification to aspects of the trial after its initiation without undermining the validity and integrity of the trial. Adaptive designs have become very popular in the pharmaceutical industry because they can increase the probability of success, considerably reduce the cost and time of the overall drug development process. With a recent rapid development in this area, there is a high demand for statisticians proficient in designing and conducting adaptive clinical trials. Students will learn different (both frequentist and Bayesian) adaptive designs and gain hands-on experiences on adaptive randomization, adaptive dose-finding, group sequential, and sample-size reestimation designs.
Grad Prereq: SPH BS851 [4 cr.].

SPH BS 857 - Analysis of Correlated Data

The purpose of this advanced seminar is to present some of the modern methods for analyzing tricorrelated observations. Such data may arise in longitudinal studies where repeated observations are collected on study subjects or in studies in which there is a natural clustering of observations, such as a multi-center study of observations clustered within families. Students start with a review of methods for repeated measures analysis of variance and proceed to more complicated study designs. The course presents both likelihood-based methods and quasi-likelihood methods. Marginal, random effects and transition models are discussed. Students apply these methods in homework assignments and a project. [4 cr.]

SPH BS 858 - Statistical Genetics I

This course covers a variety of statistical applications to human genetic data, including collection and data management of genetic and family history information, and statistical techniques used to identify genes contributing to disease and quantitative traits in humans. Specific topics include basic population genetics, linkage analysis and genetic association analyses with related and unrelated individuals.
Prereq: SPH BS723 or SPH BS730, or equivalent as determined by instructors [4 cr.]

SPH BS 859 - Applied Genetic Analysis

Statistical tools such as linkage and association analysis are used to unravel the genetic component of complex disease. Investigators interested in the genetic analysis of complex traits need a basic understanding of the strengths and weaknesses of these methodologies. This course will provide the student with practical, applied experience in performing linkage and association analyses, including genome-wide analyses. Special emphasis is placed on understanding assumptions and issues related to statistical methodologies for genetic analysis to identify genes influencing complex traits. Students will use specialized genetics software for homework assignments. [4 cr.]

SPH BS 860 - Statistical Genetics II

This course covers current topics in statistical genetics, with emphasis on how statistical techniques can be used with various types of genetics data for mapping genes responsible/contributing to complex human diseases. Topics such as genetics map functions, gene mapping in experimental organisms, advanced linkage analysis methods, statistical approaches

for the analysis of genome-wide high density SNP scans in unrelated and family samples will be discussed. [4 cr.]

SPH BS 861 - Applied Statistics in Clinical Trials II
This course covers a variety of biostatistical topics in clinical trials, including presentation of statistical results to regulatory agencies for product approval, analysis of safety data, intent-to-treat analyses and handling of missing data, interim analyses and adaptive designs, and analyses of multiple endpoints. Upon completion of the course, students will be able to make and defend decisions for many study designs and for issues faced when analyzing efficacy and safety data from clinical trials. Students will also be able to present, in a written format following standard guidelines accepted by the clinical trials' community, results of such efficacy and safety analyses to the medical reviewers and statistical reviewers of regulatory agencies.
Prereq: BS851 or consent of the instructor [4 cr.].

SPH BS 901 – Directed Study in Biostatistics
Directed Studies provide the opportunity for students to explore a special topic of interest under the direction of a full-time SPH faculty member. Students may register for 1, 2, 3, or 4 credits of BS901 by submitting a paper registration form and a signed directed study proposal form. Directed studies with a non-SPH faculty member or an adjunct faculty member must be approved by and assigned to the department chair. The Directed Study Proposal Form lists the correct course number per department; students are placed in a section by the Registrar's Office according to the faculty member with whom they are working. Students may take no more than eight credits of directed study, directed research, or practica courses during their MPH education. [Var. cr.]

SPH BS 902 – Directed Research in Biostatistics
Directed Research sections in Biostatistics provide the opportunity for students to explore a special topic of Biostatistics research under the direction of a full-time SPH faculty member. Students may register for 1, 2, 3, or 4 credits. Directed studies with a non-SPH faculty member or an adjunct faculty member must be approved by and assigned to the department chair. To register, students must submit a paper registration form and signed directed research proposal form. Students are placed in a section by the Registrar's Office according to the faculty member with whom they are working. Students may take no more than eight credits of directed study, directed research, or practica courses during their MPH education. [Var. cr.]

SPH BS 980 - Continuing Study in Biostatistics
Doctoral students in Biostatistics register each summer and fall for Continuing Study in Biostatistics until they have graduated from their doctoral program. Students will participate in a dissertation workshop and other activities while they are preparing their dissertation. Students are charged for 2 credits equivalent of tuition and for medical insurance. They are certified full time. Students must be registered for this course at GRS.
Prereq: For students in the doctoral program in Biostatistics who are approved for dissertation work. Students must be registered for this course by the GRS Registrar [0 cr.].

MATHEMATICS COURSE DESCRIPTIONS

CAS MA 511 – Introduction to Analysis I
Fundamental concepts of mathematical reasoning. Properties of the real-number system, elementary point-set theory, metric spaces. Limits, sequences, series, convergence, uniform convergence, continuity. Differentiability for functions of a single variable, Riemann-Stieltjes integration.
Prereq: CAS MA 225 or CAS MA 230 [4 cr.].

CAS MA 512 – Introduction to Analysis II
Background of CAS MA 511 used to develop further topics of calculus. Exponential and logarithmic functions, Taylor series, power series, real analytic functions. Differential and integral calculus for functions of several variables. Line and surface integrals, divergence theorem, Stokes's theorem, inverse and implicit function theorems, change of variables. Fourier analysis.

Prereq: CAS MA 511 [4 cr.].

CAS MA 555 – Numerical Analysis I
Numerical solutions of equations, iterative methods, analysis of sequences. Theory of interpolation and functional approximation, divided differences. Numerical differentiation and integration. Polynomial theory. Ordinary differential equations.
Prereq: CAS MA 225 or CAS MA 230 [4 cr.].

CAS MA 556 – Numerical Analysis II
Numerical linear algebra; norms, elimination methods, error analysis, conditioning, eigenvalues, iterative methods, least squares and nonlinear functional minimization. Partial differentiation equation boundary value and initial value problems. Finite element methods. Legendre and Chebyshev polynomials. Treatment in greater depth of selected topics from CAS MA 555.
Prereq: CAS MA 555 and CAS MA 242 or CAS MA 442; or consent of the instructor [4 cr.].

CAS MA 575 – Linear Models
This course covers the general linear model, generalized inverse, quadratic forms and their distributions, least-square estimation, estimable function, Gauss-Markov Theorem, confidence region, test of linear hypothesis, and prediction.
Prereq: one semester each of college-level linear algebra and applied statistics, or CAS MA582, or consent of the instructor [4 cr.].

CAS MA 576 – Generalized Linear Models
This continuation of CAS MA 575 covers analysis of variance, analysis of repeated measures, random-effect models, regression with random coefficients, multivariate models, two-stage linear models, and generalized estimating equations.
Prereq: CAS MA575 or consent of the instructor [4 cr.].

CAS MA 578 – Bayesian Statistics
This course covers principles and methods of Bayesian statistics including subjective probability, Bayes rule, posterior distributions, and predictive distributions. Computationally based inference using Monte Carlo integration, Markov chain simulation, hierarchical models, mixture models, model checking, and methods for Bayesian model selection are also covered.
Prereq: Probability (CAS MA581), Mathematical Statistics (CAS MA582), or consent of the instructor [4 cr.].

CAS MA 581 - Probability
This course covers basic probability, conditional probability, independence, discrete and continuous random variables, mean and variance, functions of random variables, and moment generating functions. Jointly distributed random variables, conditional distributions, independent random variables, methods of transformations, law of large numbers, and the central limit theorem are also covered.
Prerequisite: One semester of college-level multivariable calculus or consent of the instructor [4 cr.].

CAS MA 582 - Mathematical Statistics
The goal of this course is to provide a basic foundation in mathematical statistics. Topics include: point estimation including unbiasedness, efficiency, consistency, sufficiency, minimum variance unbiased estimator, the Rao-Blackwell theorem, and the Rao-Cramer inequality. The course also covers maximum likelihood and method of moment estimations; interval estimation; tests of hypothesis, uniformly most powerful tests, uniformly most powerful unbiased tests, likelihood ratio test, and the chi-square test.
Prereq: CAS MA581 [4 cr.].

CAS MA 583 - Introduction to Stochastic Processes
This course provides a working knowledge of basic concepts and techniques of stochastic processes as they are most often used to construct models for a variety of problems of practical interest. Topics include Markov Chains, Poisson processes, birth and death processes, queuing theory, renewal processes, and reliability.

Prereq: CAS MA581 or consent of the instructor [4 cr.].

CAS MA 585 - Time Series and Forecasting
Autocorrelation and partial autocorrelation functions; stationary and nonstationary processes; ARIMA and Seasonal ARIMA model identification, estimation, diagnostics, and forecasting. Modeling financial data via ARCH and GARCH models. Volatility estimation; additional topics, including long-range dependence and state-space models.
Prereq: CAS MA581 or consent of the instructor [4 cr.].

CAS MA 588 - Nonparametric Statistics
This course examines theory and logic in the development of nonparametric techniques including order statistics, tests based on runs, goodness-of-fit, rank-order (for location and scale), measures of association, analysis of variance, asymptotic relative efficiency.
Prereq: CAS MA582 or equivalent, or consent of the instructor [4 cr.].

CAS MA 589 – Computational Statistics
Topics from computational statistics that are relevant to modern statistical applications: random number generation, sampling, Monte Carlo methods, computational inference, MCMC methods, graphical models, data partitioning, and bootstrapping. Emphasis on developing solid conceptual understanding of the methods through applications [4 cr.].

GRS MA 685 - Advanced Topics in Applied Statistics Analysis
Topics covered in GRS MA 684 are examined at a more advanced level: canonical correlation, multivariate analysis of variance, multivariate regressions, categorical dependent variables techniques, discriminant analysis, principal-axes, rotations, factor scores, cluster analysis, power analysis, and extensive use of statistical software.
Prereq: CAS MA684 or consent of the instructor [4 cr.].

GRS MA 703 – Statistical Analysis of Network Data
Methods and models for the statistical analysis of network data, including network mapping and characterization, community detection, network sampling and measurement, and the modeling and inference of network and networked-indexed processes. Balance of theory and concepts, illustrated through various applications.
Prereq: CAS MA575 orGRS MA681 or consent of the instructor.

GRS MA 711 – Real Analysis
Measure theory and integration on measure spaces, specialization to integration on locally compact spaces, and the Haar integral. Lp spaces, duality, and representation theorems. Introduction to Banach and Hilbert spaces, open mapping theorem, spectral theorem for Hermitian operators, and compact and Fredholm operators.
Prereq: CAS MA 512 or substantial mathematical experience [4 cr.].

GRS MA 750 – Nonparametric and Semiparametric Data Modeling
Introduces theory and methods of non- and semiparametric data analysis. Topics include scatterplot smoothers, bias/variance trade-off, selection of smoothing parameter, generalized additive model, smoothing spline, and Bayesian nonparametric models. Applications in various fields are discussed.
Prereq: CAS MA575 and CAS MA581, or consent of the instructor [4 cr.].

GRS MA 751 - Statistical Machine Learning
Foundations and applications of statistical machine learning. Supervised and unsupervised learning. Machine classification and regression methods, regularized basis methods, kernel methods, boosting, neural networks, support vector machines, and graphical models.
Prereq: CAS MA575 and CAS MA581, or consent of the instructor [4 cr.].

GRS MA 779 – Probability Theory I
Introduction to probability with measure theoretic foundations. Fundamentals of measure theory. Probability space. Measurable functions and random variables. Expectation and conditional

expectation. Zero-one laws and Borel-Cantelli lemmas. Chracteristic functions. Modes of convergence. Uniform integrability. Skorokhod representation theorem. Basic limit theorems.
Prereq: CAS MA 511 or consent of the instructor [4 cr.].

GRS MA 780 – Probability Theory II
Probability topics important in applications and research. Laws of large numbers. Three series theorem. Central limit theorems for independent and non-identically distributed random variables. Speed of convergence. Large deviations. Laws of the iterated logarithm. Stable and infinitely divisible distributions. Discrete time martingales and applications.
Prereq: GRS MA 711 [4 cr.].

GRS MA 781 - Estimation Theory
This course provides a review of probability, populations, samples, sampling distributions, delta theorems; parametric point estimation, Rao-Cramer inequality, sufficient statistics, Rao-Blackwell theorem, maximum likelihood estimation, least squares estimation, general linear model of full rank, confidence intervals, Bayesian analysis, and decision theory.
Prereq: CAS MA581, CAS MA582, or consent of the instructor [4 cr.].

GRS MA 782 - Hypothesis Testing
This course is an advanced course in mathematical statistics and covers the following topics: parametric hypothesis testing, uniformly and locally the most powerful tests, similar tests, invariant tests, likelihood ratio tests, linear model testing, asymptotic theory of likelihood ratio, and chi-squared test, Logit and log-lin analysis of contingency tables.
Prereq: Estimation Theory (GRS MA781) or consent of the instructor [4 cr.].

GRS MA 882 – Seminar: Statistics
Advanced seminar in topics in statistics of current research interest.
Prereq: GRS MA 782 [4 cr.].

EPIDEMIOLOGY COURSE DESCRIPTIONS

SPH EP 770 – Concepts and Methods in Epidemiology
This course further develops comprehension and application of epidemiologic concepts and methods introduced in the MPH Quantitative Core (PH717). Topics include elements of study design, data analysis, and inference in epidemiologic research, including issues related to bias, confounding, and stratified analysis. This course emphasizes practical knowledge and focuses on developing basic skills in critical evaluation and communication of epidemiologic data. Workshops will use data from epidemiologic studies to reinforce concepts and build critiquing skills. This course is designed for MPH students in the Epidemiology and Biostatistics Certificate.
Prereq: SPH PH717 or an equivalent [4 cr.].

SPH EP 854 - Advanced Epidemiology (formerly Modern Epidemiology)
This course covers the theory and application of key principles and methods of epidemiologic research in depth. The topics include causal models, confounding, randomization, interaction, statistical analysis and inference, and causal inference. Special emphasis is given to the meaning and interpretation of p-values, confidence intervals, and likelihoods. Alternative approaches are identified for selecting and interpreting measures of disease frequency and measures of effect. Guidance is offered for determining objectives and strategies in study design and analysis, especially for case-control research. Methods are presented for the assessment and control of confounding, misclassification bias, and selection bias. Strengths and weaknesses of standardization, pooling, modeling, and exposure-response analysis are reviewed. Formerly called "Modern Epidemiology."
Prereq: Masters students must obtain permission of instructor, mfox@bu.edu, before registering for course [4 cr.].

SPH EP 855: Advanced Epidemiology Seminar: Issues in Study Design

This course is structured around reading and discussing both historical and current methodological papers. The first section of the course focuses on papers by early theoreticians and methodologists. The second section focuses on contemporary methodologic questions. Substantive areas may evolve and vary over time. Recent topics have included case-control studies, study efficiency, measures of effect, exposure misclassification, sensitivity analysis, casual diagrams, and direct and indirect effects.

Prereq: Primarily for doctoral students. MPH students must have completed EP854 and have consent of the instructor [4 cr.].

Section 7

Biostatistics Program Faculty

The Department of Biostatistics faculty is committed to the roles of teacher and mentor both inside and outside of the classroom. Their research brings depth and a real-life context to the classroom. The department's faculty has analyzed the multigenerational risk factors that contribute to heart disease, which led to a predictive tool for physicians to determine treatment strategies for patients with cardiovascular disease. In partnership with other academic institutions, members of the department have isolated and identified key factors that contribute to higher incidences of breast cancer and other diseases in African-American women. In addition, the department has designed and implemented an important comparative study that pinpoints risk factors for Alzheimer's disease. Members of the department are also actively engaged in clinical trials and methods for public health surveillance, designed to improve clinical treatments and aid the public health delivery system to identify disease hotspots.

Faculty bios can be found here and information about faculty research can be found on the Research section of our website.

Biostatistics Department Faculty

Faculty Name	Title	Areas of Expertise	Courses Taught	Email and Office
Josee Dupuis, PhD	Professor and Chair, Biostatistics Department	Statistical genetics	BS715 Practical Skills for Biostatistics Collaboration BS860 Statistical Genetics II	dupuis@bu.edu CT324
Alexa Beiser, PhD	Professor of Biostatistics; Associate Chair for Education, Biostatistics Department; Professor of Neurology	Analysis of longitudinal cohort data; survival analysis; lifetime risk analysis; statistical computing		alexab@bu.edu CT325
Howard Cabral, PhD	Professor of Biostatistics, Co-Director of Biostatistics Graduate Program	Analysis of longitudinal data, analysis of ordinal data, clinical trials, statistical computing, effects of missing data on estimation, and ethics in statistical practice.	BS805 Intermediate Statistical Computing and Applied Regression Analysis	hjcab@bu.edu CT310
Debbie Cheng, ScD	Professor of Biostatistics	Design and analysis of clinical trials, longitudinal data analysis, alcohol, substance use, and HIV/AIDS research.	BS722 Design and Conduct of Clinical Trials	dmcheng@bu.edu CT319
L. Adrienne Cupples, PhD	Professor of Biostatistics, Executive Co-Director of Biostatistics Program, Co-Director of Training Grant	Statistical methods for observational Studies, survival analysis, statistical genetics		adrienne@bu.edu CT347
Serkalem Demissie, PhD	Associate Professor of Biostatistics	Statistical genetics; statistical computing; epidemiology; genome wide association study, meta-analysis, and multiple testing; modeling and clustering temporal data for gene expression experimental study		demissie@bu.edu CT315
Anita DeStefano, PhD	Professor of Biostatistics, Director of the Graduate Certificate in Statistical Genetics	Statistical genetics	BS401 Survey in Biostatistical Methods	adestef@bu.edu CT314
Gheorghe Doros, PhD	Professor of Biostatistics, Director of the Graduate Certificate in Biostatistics in Modern Clinical Trials	Censored data, data analysis, asymptotics, nonparametric estimation, and clinical trails	BS853 Generalized Linear Models with Applications, BS854 Bayesian Methods in Clinical Trials	doros@bu.edu CT331
Susan Fish, PharmD	Professor of Biostatistics	Clinical trials, human subjects research, research ethics, study designs	BS722 Design and Conduct of Clinical Trials	sfish@bu.edu CT330
David Gagnon, PhD, MD	Research Professor of Biostatistics	Statistical computing, longitudinal data analysis, pharmacoepidemiology, survival analysis, categorical data analysis, phenotyping, machine learning, classification, validation studies, natural language processing, Bayesian analysis, and MCMC methods.	BS775 Applications of Advanced Statistical Methods in Clinical Research, BS821 Categorical Data Analysis, BS852 Statistical Methods in Epidemiology	gagnon@bu.edu CT328

Timothy Heeren, PhD	Professor of Biostatistics; Director of MPH Certificate in Design and Conduct of Public Health Research	Biostatistics, analysis of scaled data	BS704 Biostatistics, BS852 Statistical Methods in Epidemiology	tch@bu.edu CT309
Helen Jenkins, PhD	Assistant Professor of Biostatistics	Infectious diseases, analysis of spatial data	BS825 Advanced Infectious Disease Epidemiology BS852 Statistical Methods in Epidemiology	helenje@bu.edu CT311
Chanmin Kim, PhD	Assistant Professor of Biostatistics	Bayesian nonparametric modeling, Causal inference, Mediation analysis, Environmental health statistics and health policy evaluation.	BS730 Introduction to Statistical Computing in R	CT303
Martin Larson, SD	Research Professor of Biostatistics; Research Professor of Mathematics & Statistics; Research Associate Professor of Medicine	Analysis of 'omics' and longitudinal data, statistical genetics, missing data		mlarson@bu.edu CT-325
Michael LaValley, PhD	Professor of Biostatistics; Co-Director of MPH Certificate in Epidemiology and Biostatistics	Meta-analysis, analysis of longitudinal and correlated data, analysis of survival data, analysis of ordinal and count data, predictive modeling, and arthritis research.	BS810 Meta-Analysis for Public Health and Medical Research, BS820 Logistic Regression & Survival Analysis	mlava@bu.edu CT336C
Robert A. Lew, PhD	Associate Professor of Biostatistics	Senior Biostatistician, Veterans Affairs		rlew@bu.edu CT328
Ching-Ti Liu, PhD	Associate Professor of Biostatistics	Development of statistical/computational approaches for genetics/genomics and bioinformatics studies	BS730 Introduction to Statistical Computing in R, BS723 Intro to Statistical Computing BS806 Multivariate Analysis for Biostatisticians	ctliu@bu.edu CT329
Chunyu Liu, PhD	Research Associate Professor of Biostatistics	Statistical Genetics, mitochondrial genetics, maternal inheritance, integrative genetics and genomics.	BS805 Intermediate Statistical Computing and Applied Regression Analysis	liuc@bu.edu CT332
Sara Lodi, PhD	Assistant Professor of Biostatistics	Causal inference, comparative effectiveness, infectious diseases, clinical trials.	BS851 Applied Statistics in Clinical Trials I	CT316
Kathryn Lunetta, PhD	Professor of Biostatistics	Statistical genetics and genomics and genetic epidemiology	BS858 Statistical Genetics, BS859 Applied Genetic Analysis,	klunetta@bu.edu CT313
Joseph Massaro, PhD	Professor of Biostatistics	Pharmaceutical and biologic randomized clinical trials, medical device randomized clinical trials, non-randomized clinical trials, propensity score matching and adjustment, clinical trials in rare diseases, adaptive designs in clinical trials, non-inferiority clinical trials, and risk prediction.	BS851 and BS861 Applied Statistics in Clinical Trials I & II	jmm@bu.edu CT327

Jacqueline Milton, PhD	Clinical Assistant Professor	Statistical genetics and statistical education	BS401 Survey in Biostatistical Methods, BS704 Biostatistics, BS723 Intro to Statistical Computing, BS730 Introduction to Statistical Computing in R, PH717 Quantitative Methods for Public Health	jnmilton@bu.edu CT336E
Kerrie Nelson, PhD	Research Associate Professor	Statistical methods for reliability, modeling longitudinal and clustered data, diagnostic testing		kerrie@bu.edu CT336D
Gina Peloso, PhD	Assistant Professor of Biostatistics	Statistical genetics, mapping of complex traits, and cardiovascular risk factors	BS805 Intermediate Statistical Computing and Applied Regression Analysis BS858 Statistical Genetics I	gpeloso@bu.edu CT336
Sarah Rosner Preis, PhD	Research Associate Professor of Biostatistics	Cardiovascular and nutritional epidemiology, epidemiologic methods	BS723 Introduction to Statistical Computing	srpreis@bu.edu CT327
Paola Sebastiani, PhD	Professor of Biostatistics; Co-Director of Training Grant in Biostatistics	Bioinformatics, Bayesian modeling, experimental design, machine learning, epidemic surveillance, time series analysis	BS800 Accelerated Statistical Training BS806 Multivariable Analysis for Biostatisticians BS852 Statistical Methods in Epidemiology, BS855 Bayesian Modeling for Biomedical Research	sebas@bu.edu CT317
Lisa Sullivan, PhD	Professor of Biostatistics; Associate Dean of Education, BUSPH	Design and analysis of epidemiological studies, risk functions, clinical trials, undergraduate education	BS704 Biostatistics, PH717 Quantitative Methods for Public Health	lsull@bu.edu CT324
Fangui Sun, PhD	Research Assistant Professor of Biostatistics	Survival analysis, case-control studies, and longitudinal studies		jennysun@bu.edu CT347
Ludovic Trinquart, PhD	Assistant Professor of Biostatistics		BS723 Introduction to Statistical Computing	CT348
Yorghos Tripodis, PhD	Research Associate Professor of Biostatistics	Longitudinal Studies, Correlated Data, Instrumental Variable Models, Time series modeling, and Measurement Error models.	BS803 Statistical Programming for Biostatisticians, BS857 Analysis of Correlated Data	yorghos@bu.edu CT312
Janice Weinberg, ScD	Professor of Biostatistics	Design and analysis of clinical trials, correlated data analysis, and statistical consulting	BS722 Design & Conduct of Clinical Trials	janicew@bu.edu CT330
Laura White, PhD	Associate Professor of Biostatistics, Co-Director of Biostatistics Graduate Program	Spatiotemporal analysis, statistical modeling of disease outbreaks, infectious disease epidemiology, tuberculosis, and public health surveillance.	BS728 Public Health Surveillance, a Methods Based Approach; EP800 Microbes and Methods: Selected Topics in Outbreak Investigations	lfwhite@bu.edu CT322
Qiong Yang, PhD	Associate Professor of Biostatistics	Biostatistics, statistical genetics	BS845 Applied Statistical Modeling and Programming with R	qyang@bu.edu CT321

Mathematics and Statistics Department Faculty

Faculty Name	Title	Areas of Expertise	Courses Taught	Email and Office
Ralph D'Agostino, PhD	Professor of Mathematics & Statistics; Professor of Biostatistics; Executive Co-Director of Biostatistics Graduate Program	Longitudinal data analysis, multivariate data, analysis, biostatistics and robust procedures.		ralph@bu.edu MCS176
Luis Carvalho, PhD	Associate Professor of Mathematics & Statistics	Bayesian statistics, computational biology, and statistical inference		lecarval@math.bu.edu MCS221
Uri Eden, PhD	Professor of Mathematics & Statistics	Probability, Stochastic estimation and control, computational neural theory, neural signal processing.	MA582 Mathematical Statistics	tzvi@bu.edu MCS220
Ashis Gangopadhyay, PhD	Associate Professor of Mathematics & Statistics	Nonparametric and semiparametric models, Bayesian Markov Chain Monte Carlo techniques, financial time series modeling	MA781 Estimation Theory MA782 Hypothesis Testing	ag@bu.edu MCS231
Paola Guasoni, PhD	Adjunct Associate Professor of Mathematics & Statistics	Mathematical Finance, Probability and Stochastic Processes.		guasoni@math.bu.edu MCS233
Mamikon Ginovyan, PhD	Senior Lecturer		MA781 Estimation Theory	ginovyan@bu.edu
Thomas Kepler, PhD	Adjunct Professor of Mathematics & Statistics	Computational Biology, Biostatistics, Bioinformatics		tbkepler@bu.edu
Eric Kolaczyk, PhD	Professor of Mathematics & Statistics; Director of Statistics Program	Statistical analysis of network-indexed data, development of basic methodology and interdisciplinary, statistical multi-scale modeling		kolaczyk@bu.edu MCS223
Mark Kon, PhD	Professor of Mathematics & Statistics	Statistical and machine learning, bioinformatics/computational biology, neural networks		mkon@bu.edu MCS259
Asya Lyass, PhD	Research Assistant Professor of Mathematics & Statistics	Biostatistics		asya@bu.edu 704 Comm Ave, 509b
Konstantinos Spiliopoulos, PhD	Assistant Professor of Mathematics & Statistics	Stochastic processes, probability, mathematical finance, statistics.		kspiliop@bu.edu MCS222
Daniel Sussman, PhD	Assistant Professor of Mathematics & Statistics			sussman@bu.edu
Murad Taqqu, PhD	Professor of Mathematics & Statistics	Probability, stochastic processes, statistics.	MA681 Probability	murad@bu.edu MCS252

Daniel Weiner, PhD	Associate Professor of Mathematics & Statistics	Probability, statistics.	MA581 Probability, MA582 Mathematical Statistics	weiner@bu.edu MCS246
Haviland Wright, PhD	Professor of the Practice of Statistics			hav1126@bu.edu 64 Cummington, room 233
Masanao Yajima, PhD	Associate Professor of the Practice of Statistics			
Ting Zhang, PhD	Assistant Professor of Mathematics & Statistics	Probability, statistics.	MA575 Linear Models MA782 Hypothesis Testing	tingz@bu.edu

Secondary Appointments and Adjunct Faculty

In addition to the faculty based at the School, BUSPH employs a number of experienced public health professionals from the community as adjunct faculty. These adjunct faculty bring a wealth of knowledge to the classroom as well as help build bridges between the communities that surround the Medical Campus. They often connect students with practica, research opportunities, and community events.

Faculty Name	BU Appointment	Primary Appointment/Position	Biostatistics Courses Taught	Email and Office
Mark Chang, PhD	Adjunct Professor of Biostatistics	Executive Director of Department of Biostatistics and Data Management, AMAG Pharmaceuticals	BS856 Adaptive Designs for Clinical Trials	mychang@bu.edu
Lori Chibnik, PhD	Adjunct Assistant Professor of Biostatistics	Assistant Professor of Neurology, Harvard Medical School and BWH; Assistant Professor of Epidemiology at Harvard School of Public Health; Associated Scientist at Broad Institute		chibber@bu.edu
Kimberly Dukes, PhD	Adjunct Assistant Professor of Biostatistics	President, CEO of DM-STAT, Inc.		dukeska@bu.edu
Lindsay Farrer, PhD	Professor of Biostatistics			farrer@bu.edu
Jayandra Himali, PhD	Research Assistant Professor of Biostatistics	Research Assistant Professor, Neurology, BU School of Medicine	BS723 Introduction to Statistical Computing	jhimali@bu.edu
C. Robert Horsburgh, MD, MUS	Professor of Biostatistics	Professor and Chair of Epidemiology, BUSPH		rhorsbu@bu.edu
Shih-Jen Hwang, PhD	Adjunct Research Assistant Professor of Biostatistics			hwangs2@bu.edu
William Evan Johnson, PhD	Associate Professor of Biostatistics	Associate Professor of Medicine, Division of Computational Biomedicine, Boston University School of Medicine		wej@bu.edu
Mark Logue, PhD	Research Assistant Professor of Biostatistics			loguem@bu.edu
Elena Losina, PhD	Adjunct Associate Professor	Professor of Orthopedic Surgery,		lenal@bu.edu

	of Biostatistics	Harvard Medical School		
Sandeep Menon, PhD	Adjunct Assistant Professor of Biostatistics	Director of Biostatistics, Bio-therapeutics Research, Pfizer	BS856 Adaptive Designs for Clinical Trials	sandeep.m.menon@pfizer.com
Stefano Monti, PhD	Associate Professor of Biostatistics		BS831 Genomics Data Mining and Statistics	smonti@bu.edu
Alexander Ozonoff, PhD	Adjunct Associate Professor of Biostatistics			Al.ozonoff@childrens.harvard.edu
Michael Pencina, PhD	Adjunct Professor of Biostatistics	Director of Biostatistics, Duke Clinical Research Institute		michael.pencina@duke.edu
Soe Soe Thwin, PhD	Adjunct Assistant Professor of Biostatistics	Biostatistician, Veterans Affairs		sst@bu.edu
Moshe Vardi, MD	Adjunct Assistant Professor of Biostatistics	Global Clinical Development Lead, Shire		vardi@bu.edu
Vanessa Xanthakis, PhD	Assistant Professor of Biostatistics	Instructor of Medicine, Investigator for the Framingham Heart Study, Section of Preventive Medicine and Epidemiology, Department of Medicine BUSM		vanessax@bu.edu
Bin Zhang, PhD	Adjunct Research Associate Professor of Biostatistics	Associate Professor of Genetics and Genomic Sciences, Mount Sinai		binzhang@bu.edu
Xiaoling Zhang, MD, PhD	Assistant Professor of Biostatistics	Assistant Professor of Medicine, Biomedical Genetics Section, Boston University School of Medicine		zhangxl@bu.edu

Biostatistics MA Degree Audit Sheet (32 credits)

I. MA Degree Required Courses: Six courses (24 credits)	**Semester Completed**	**Grade Earned**	**Credits Earned**
CAS MA 575 Linear Models			
CAS/ MET MA581 Probability			
CAS/ MET MA582 Mathematical Statistics			
SPH EP770 Concepts and Methods in Epidemiology			
SPH BS805 Intermediate Statistical Computing & Applied Regression			
SPH BS852 Statistical Methods in Epidemiology			
II. MA Degree Electives: Any two (8 credits)	**Semester Completed**	**Grade Earned**	**Credits Earned**
CAS MA: 576, 583, 585, 588, 589 GRS MA: 685, 751#, 781*, 782*, 861*, 881*, 882 CAS CS: 542#			
SPH BS: 715, 722, 728, 775, 810, 820, 821, 825, 831, 845, 849, 851, 853, 854, 856, 857, 858, 859, 860, 861, 901**, 902**			
SPH EP 854*			
# Only one of these two courses may count as an elective. * Must obtain permission from academic advisor to take this elective. ** Limit of 4 credits among the two.			
III. Qualifying Exams		**Date of Completion**	**Grade Earned**
Applied Qualifying Exam			
Theory Qualifying Exam			

MA Requirements Checklist:

□ Credits total: 32 MA graduate credits or approved transfer courses.
□ Grade of B- or better in all courses applied to the MA
□ Any course waivers or transfer credit approved
□ All incomplete classes completed and grades posted
□ Submitted graduation application to GRS (2-3 months prior to commencement)

Biostatistics PhD Degree Audit Sheet

I. Post- BA PhD Required Courses: Ten courses (40 credits)	**Semester Completed**	**Grade Earned**	**Credits Earned**
CAS MA 575 Linear Models			
CAS/ MET MA581 Probability			
CAS/ MET MA582 Mathematical Statistics			
SPH EP770 Concepts and Methods in Epidemiology			
SPH BS805 Intermediate Statistical Computing & Applied Regression			
SPH BS852 Statistical Methods in Epidemiology			
SPH BS853 Generalized Linear Models with Applications			
SPH BS857 Analysis of Correlated Data			
GRS MA781 Estimation Theory			
GRS MA782 Hypothesis Testing			
II. PhD Biostatistics Electives: At least 12 credits of the following Biostatistics Courses:	**Semester Completed**	**Grade Earned**	**Credits Earned**
SPH BS: 722, 728, 775, 810, 820, 821, 825, 831, 845, 849, 851, 854, 856, 858, 859, 860, 861			
III. PhD Additional Elective Courses: The remaining courses may be selected from the above series of courses or from the following Elective Courses. One elective may be in the biological sciences[#] (12 credits):	**Semester Completed**	**Grade Earned**	**Credits Earned**
CAS MA: 511, 512, 555, 556, 576, 578, 583, 585, 588, 589, 685; GRS MA: 703, 711, 750, 751*, 779, 780, 882; CAS CS : 542* SPH EP: 854[‡], 855[‡] SPH BS : 715, 901**, 902**			

* Only one of these two courses may be taken as an elective

[‡] Only one of these two courses may count as an elective.

** Limit of 4 credits among the two. Post-Bachelor's PhD students may petition Co-Directors to allow more than 4 credits.

[#] Given the large number of biology courses, a comprehensive list is not provided here. Please contact the Program Co-Directors to seek permission for a specific course in the biological sciences.

IV. Qualifying Exams	**Date of Completion**	**Grade Earned**
Applied Qualifying Exam		
Theory Qualifying Exam		

PhD Requirements Checklist:

□ Total of 32-64 PhD graduate credits or approved transfer courses
□ Grade of B- or better in all courses applied to the PhD
□ All course waivers or transfer credit approved
□ All incomplete classes completed and grades posted
□ Attended and presented at Doctoral Student Presentation Seminars
□ Submitted graduation application to GRS (2-3 months prior to commencement)