Department of Statistics

Graduate Program Handbook

REQUIREMENTS FOR GRADUATE DEGREES

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Preface

The Department of Statistics offers graduate programs leading to the Master of Science degree (with thesis and non-thesis options) and the Doctor of Philosophy degree with five concentrations or "tracks". The following pages describe specific requirements for each degree. Together with the Graduate Catalogue and the Policies and Procedures Manual of the Graduate School, this information should provide a clear and precise understanding of both university and departmental requirements for graduate degrees in statistics. In those cases where university rules and department policies do not precisely coincide, the more stringent requirements apply.

This manual is available on the Department of Statistics' web site at

www.stat.vt.edu/graduate/grad-handbook.pdf.

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Checklists of Requirements

MS Requirements

To receive the MS degree in statistics the student must:

- Successfully complete the course requirements of 34 credit hours consisting of ten three-hour courses (six MS core courses and four elective courses), stat 5014 (statistical software), and stat 5024 (collaboration course). (These requirements are usually completed by the end of the student's third semester).
- Establish an advisory committee (by mid spring semester, first year).
- Complete an approved plan of study (by mid spring semester, first year).
- Pass the qualifying examination at the MS level (given in May after the week of finals, end of first year).
- Participate in statistical collaboration through SAIG (usually in third semester).
  - Prepare a "collaboration project."
- Pass the oral examination (by late fall semester, second year).
- Complete, submit, and have approved Master's thesis (if the thesis option is selected).

PhD Requirements

To receive the PhD degree in statistics the student must:

- Successfully complete the requirement of 48 course credit hours including the six MS core courses, four 6000-level courses, stat 5014 (statistical software), and stat 5024 (collaboration course). The four 6000-level courses must include at least one of 6105 (advanced probability) or 6114 (advanced inference).
- Select an advisory committee.
- Complete an approved plan of study in one of the five areas of concentration.
- Pass the qualifying process at the PhD level.
- Participate in statistical collaboration for at least three semesters.
- Teach at least one statistics course.
- Prepare a proposal.
- Pass the proposal presentation (the preliminary exam).
- Give an oral presentation of the dissertation topic to the department. In that semester, register for STAT 5924.
- Pass the final examination.
- Complete, submit, and have approved the doctoral dissertation.

The individual components of these checklists are described in the sections that follow.

Planning the Program

Advisory Committee (MS & PhD)

The advisory committee serves to approve the plan of study, monitor progress and offer advice as needed. The committee also serves as the examining committee for the final oral examination. For doctoral students, and Master's students electing the thesis option, the committee chairman is the director of the research project for the dissertation/thesis.

Students in the MS program must have an advisory committee of at least three faculty members. Doctoral committees must have at least four faculty members. Technically, the Graduate School upon recommendation of the department head appoints the committee. In practice, the student and the Department's Graduate Committee actually choose the student's MS committee with the student picking the chair of the committee and the Graduate Committee picking the other two members.

The procedure for selecting the MS Advisory Committee is as follows:

The student selects the Chair of their MS Committee. The Chair may or may not be the student's advisor. The Graduate Committee will then select the remaining two members of the MS Committee by a process that will consider variety of faculty areas of expertise regarding the core courses and an equitable distribution of faculty membership on the committees, accounting for faculty members' current service loads. So that this process will proceed in a timely fashion, the Graduate Program Director will set a date by which all MS candidates must have their Committee Chair selected.

For doctoral students, and Master's students electing the thesis option, the student should confer with the committee chairperson (their dissertation advisor) to select those faculty members best able to contribute constructively to the proposed research topic. The student and/or committee chairperson should confer with the Director of Graduate Programs on the availability and appropriateness of members serving on the advisory committee.

The student's temporary advisor (appointed by the department to assist in initial registration) need not be included. The committee chairman must be a full-time resident faculty member.

Timing of committee selection is the same as that for the plan of study, as the committee's first official function is to approve the plan of study. Specifically, Master's students must establish a committee prior to completing 15 semester hours at this university (typically during the spring semester), and PhD students should select a committee prior to completing 15 hours beyond the Master's degree. There is no specific form to complete when selecting a committee; the student should have the Chair of the committee and the Director of Graduate Programs sign the plan of study before it is submitted.

Changes in committee membership can be requested by submitting a form available in the graduate program office, Hutcheson 406-A.

Required Courses (MS & PhD)

MS Core Courses

The following courses are required of all Master's students:

Fall	STAT 5034, Inference Fundamentals, 3 hours
	STAT 5044, Regression and ANOVA. 3hours
	STAT 5104, Probability and Distribution Theory, 3 hours
	STAT 5014, Introduction to Statistical Program Packages, 1 hour, P/F only
Spring	STAT 5114, Statistical Inference, 3 hours
	STAT 5124, Linear Models Theory, 3hours
	STAT 5204, Experimental Design and Analysis I, 3 hours
	STAT 5024, Effective Communication in Statistical Collaboration 3 hours, A-F.

Note: Introduction to Statistical Program Packages (STAT 5014) may be omitted, at the discretion of the Director of Graduate Programs, for students already proficient with SAS, R, and Latex.

PhD Core Courses

Flexibility is provided to the graduate program through the following five Ph.D. areas of concentration: General Statistical Methodology and Theory; Biostatistics/Bioinformatics; Computational Statistics; Environmental Statistics; and Business, Government and Industrial (BIG) Statistics. The General Statistical Methodology and Theory area of concentration encompasses the general pursuit of research in statistical theory and methods, allowing considerable freedom in choice of coursework within and outside the department. The Biostatistics/Bioinformatics, Computational, Environmental, and BIG areas of concentration offer more specialized statistical training geared toward application areas in which the department has particular expertise. These latter four areas of concentration require more specialized coursework and research focus to be decided by the student and her/his advisory committee. A thorough description of each of the areas of concentration is given in the Appendix.

Doctoral students, regardless of area of concentration, are expected to complete the entire set of MS core courses listed above, unless equivalent courses are approved for transfer credit.

All PhD students are required to take four 6000-level statistics courses from an approved list of courses.

All PhD students must take at least one of STAT 6105 (advanced probability) or STAT 6114 (advanced inference).

Note:

Oral Presentation (Graduate Seminar) Requirement: Doctoral students must also register for STAT 5924 (Graduate Seminar, 1 hour, P/F) during the semester in which the oral presentation is delivered.

Plan of Study (MS & PhD)

The plan of study is a list of all courses that the student plans to take in fulfillment of degree requirements. For doctoral students, the expected date (semester/year) for completing the preliminary examination must also be submitted with the plan of study.

General Requirements

All courses on the plan of study must be taken on a letter grade (A-F) basis unless they are only offered pass/fail. (Note: Students required to take advanced calculus and/or linear algebra may not include these courses on the plan of study.) Courses on the plan of study may not be audited. Any course on the plan of study (and/or any course in statistics) must be repeated if a grade below "C-" is earned. The overall GPA for all courses on the plan of study must be at least 3.0.

All courses in statistics must be at the graduate level (numbered 5000 and above). A maximum of 3 hours may be taken at the 4000 level if these courses are: (i) outside of statistics, (ii) approved for graduate credit, and (iii) deemed appropriate by the student's advisory committee.

Students must register for STAT 5924 – Graduate Seminar every semester.

Students on assistantship must return to campus one week before the start of classes.

Masters Course Requirements

For the Master's degree the plan of study must include at least 34 semester hours, of which at least 31 hours must be in statistics. Students electing the thesis option must include 6 to 10 hours of STAT 5994, Research and Thesis. Students selecting the non-thesis option cannot include Research and Thesis hours on the programs of study. A typical schedule of courses, by semester, is listed in the table below.

Example Schedule for Typical MS Student

Fall, first year		**Spring, first year**		**Fall, second year**	
Stat 5014	1 hr	Stat 5024	3 hr	Stat elective	3 hrs
Stat 5034	3 hrs	Stat 5114	3 hrs	Stat elective	3 hrs
Stat 5044	3 hrs	Stat 5124	3 hrs	Stat elective	3 hrs
Stat 5104	3 hr	Stat 5204	3 hrs	Stat elective	3 hrs
Stat 5924	1 hr				
GRAD 5004	1 hr				
Total	**12 hrs**	**Total**	**12 hrs**	**Total**	**12 hrs**

Doctoral Course Requirements

A plan of study for the doctoral degree requires at least 90 semester hours, including at least 48 hours in actual course work (not research credits), and at least 12 hours of course work in statistics at the 6000 level. The plan must also include 30 to 60 hours of research credits (typically STAT 7994, Research and Dissertation, but, if a Master's thesis was completed at Virginia Tech, then hours earned under STAT 5994 may be included). The 48 course credit hours must be graded on the A-F scale. Four of these courses must be at the 6000 level and must include at least one of STAT 6105 (advanced probability) or STAT 6114 (advanced inference).

Internship in Statistics (Stat 5754)

Students may use the Internship in Statistics course for one of the elective three-hour courses for the MS degree and, under appropriate circumstances, two three-hour electives for the Ph.D. degree. Details concerning this course may be found on page 18 of this document.

Procedure for the Plan of Study

For the MS degree the plan of study must be submitted to the Graduate School prior to completing 15 credit hours at Virginia Tech (typically during the spring semester). For the PhD degree the plan must be submitted prior to completing 15 hours beyond the Master's (for PhD students who have earned the MS in statistics at another institution, this is also typically during the spring semester).

A tentative list of electives to be offered in the summer and in the fall semester of the second year will be distributed during the spring semester.

Each student should first choose an advisor (chairperson of the advisory committee), then plan a tentative plan of study and discuss it with the advisor. After agreement has been reached the student should complete the plan of study form, obtain the signatures of the chair and the Director of Graduate Programs, and return the form to Hutcheson 406A where it will be submitted electronically for Graduate School approval.

Changing the Plan of Study

If necessary, the composition of a student's advisory committee may be changed. Such committee changes should be discussed with the committee chairperson and must be approved by all members of the old committee as well as the new committee. Replacement members of an advisory committee, due to resignations, leaves, and so on, require the approval of each new committee member.

Changes in the courses on a student's plan of study require the approval of each member of the student's advisory committee. It should be noted that once a course on the plan of study has been taken for a grade, it must remain on the plan of study.

Forms for making changes to a student's plan of study are available in the Graduate Program Office, Hutcheson 406-A.

Transfer Credit (MS & PhD)

As many as 15 semester hours (five three-credit courses), obtained at an accredited institution other than Virginia Tech, may be considered for transfer toward the MS degree. The number of credits earned at Virginia Tech that may be transferred toward the MS degree is unlimited, but subject to approval of the Director of Graduate Programs and the student's advisory committee. Transfer credit in the doctoral program is limited to a maximum of 27 semester hours (nine three-credit courses). Only course work can be transferred; research hours cannot be transferred. Transfers credits must correspond to grades of “B” or better, have been earned while a graduate student in good standing, and are acceptable for graduate credit at the "home" institution. Grades of "P" are not acceptable unless the course was offered only on a pass/fail basis. All transfer courses must be acceptable to the student's advisory committee and must have been completed within the prescribed time limits for the degree sought. Transferred courses count only as credit hours and are not included in the calculation of the GPA.

In general, courses will be accepted for transfer by the Department of Statistics if they satisfy the requirements above, are appropriate for a graduate degree in statistics, and were offered at a level of rigor deemed consistent with our own graduate program. The liberal limit for transfer credit at the PhD level usually allows students completing

the Master's degree at another institution to submit for transfer virtually all of the credits earned for course work on the Master's degree. When appropriate, transfer credit may even be substituted for required courses.
To show transfer credits on the plan of study the courses are listed on the form with a footnote indicating the institution at which these credits were earned. Credits earned under a quarter system are converted to semester hours by multiplying by 2/3.

Financial Support

The Department of Statistics strives to provide financial support for graduate students *who are qualified and who continue to make satisfactory progress on their approved degree program*. Judgment of satisfactory progress is based on coursework, performance in assistantship duties, research production, and participation in colloquia and other departmental programs for student enrichment. Additionally, certain forms of financial assistance require specific obligations on the student's part. For example, a graduate student must be enrolled for at least 12 credit hours to be eligible for a tuition waiver. Most bank loans require an enrollment of at least 12 credit hours.

The Department of Statistics works within constraints on the amount of funding that can be given to any graduate student. Except in rare cases, the following limitations will apply:

1. A graduate student enrolled to receive a Master's degree in Statistics will be funded (counting all sources of funding) for at most the first three semesters of enrollment.

2. A graduate student enrolled to receive a PhD degree in Statistics will normally be funded up (counting all sources of funding) to the first seven (7) semesters, from all departmental sources, if the student enters the program with a Master's degree in Statistics from an institution other than Virginia Tech. Students who are not finished but are making satisfactory progress may be funded for a final eighth semester at a reduced funding level. Final semester funding will depend on availability.

3. A graduate student enrolled to receive both Master's and PhD degrees in Statistics will normally be funded up (counting all sources of funding) to the first nine (9) semesters, from all departmental sources. Students who are not finished but are making satisfactory progress may be funded for a final tenth semester at a reduced funding level. Final semester funding will depend on availability.

For purposes of the above: (i) funding of a 50% or greater assistantship will be considered "a semester of support", and (ii) funding for summer sessions is not counted because this funding is provided by different administrative units and is more limited in amount. Currently, funding for one summer session each year at 50% to 100% of stipend level is usually available to those graduate students who are funded during the Fall and Spring semesters.

The above limitations on funding should be considered by the student when planning the plan of study, examinations, and so on. To help ensure timely progress, the department encourages regular meetings of students with their advisory committees.

Requirements for Degree Candidacy

Qualifying Process (MS & PhD)

The Department of Statistics employs a single qualifying process for both Master's and doctoral students, a major (but not sole; see below) component being the qualifying examination on the MS core courses the examination is designed to test the student's understanding of the content in the MS core courses and may lead to qualification at either the MS or PhD level. This examination is generally offered twice each year: in May after the week of final exams, and again near the end of the fall semester. Students are required to take the examination the first time it is offered after they complete the core courses, or equivalent course work elsewhere. Thus, Master's students must generally take the examination at the end of the student’s first year after the week of final exams in May. Doctoral

students entering with a Master's degree from another university take the examination at the end of their first fall semester or at the end of the student's first year after the week of final exams in May, but no later than two semesters after entering the graduate program. **A student may take the qualifying examination no more than two times.**

Students having taken the basic courses within the department will automatically know the range of topics subject to examination. Students entering the department with advanced standing from another university who do not take the basic courses here are advised to find out the content of these courses as soon as possible. Sources for this information include (i) the professors who have most recently taught the courses or who will teach them during the current year, (ii) department syllabi for these courses, and (iii) class notes from students who have taken the courses. On the basis of this information the student and his or her advisor can determine whether the student should take or audit certain of the basic courses prior to attempting the qualifying examination. The previous examinations from years past are available on a Google Drive and are available to Department of Statistics' students upon request.

Format of the Qualifying Examination

The Qualifying Exam Committee, usually consisting of the professors who taught the MS core courses and the Director of Graduate Programs, will administer the examination. There are three separate four-hour written examinations, each covering two of the MS core courses, as follows:

I. Application of Statistical Theory and Methods (4 hr exam)
5034 Inference Fundamentals and 5044 Regression and ANOVA

II. Probability Theory and Statistical Inference (4 hr exam)
5104 Probability and 5114 Inference

III. Linear Models and Design (4 hr exam)
5124 Linear Models and 5204 Experimental Design I

The time limits indicated are *absolute maximums*. The exams will typically be given on Monday, Wednesday, and Friday in a single week. The exam is usually given after the week of final exams in May. The exam is offered again toward the end of fall semester and is usually given in late November or early December, the first week after the Fall Break.

For each part of the exam, students will be required to answer several questions. If the questions are unequal in value, relative weights will be given. In scoring, each of the three parts of the exam will be equal in value. Decisions regarding the MS-level pass will be based on a student's total score. In order to pass at the PhD level, however, a student must produce both a high total score and satisfactory scores in <u>each</u> of the three parts of the Qualifying Examination.

Each student will receive a letter from the Director of Graduate Programs indicating the result earned on the examination, and the level of qualification. Any student desiring to take the exam a second time, and final time, must take the entire exam, even if the first exam was only unsatisfactory in a single area.

Results of the Qualifying Process

The final decision of the Qualifying Process will be determined from a combination of inputs, including

a. the results of the qualifying examinations of the MS core courses (this will be the major input),

b. performance in coursework

c. performance in assistantship duties

d. attendance of colloquia and other departmental programs for student enrichment

e. an assessment by the faculty on the potential to do creative research necessary to complete a doctoral dissertation.

Inputs (b), (c), and (d) are listed to indicate that information in addition to the results of qualifying examinations may be used by the faculty in arriving at the final decision in the Qualifying Process. It is anticipated that in most cases, the results of only the qualifying examinations will be sufficient to make the decision. When the results of the qualifying examinations do not lead to a clear-cut decision, additional inputs (such as those listed in (b), (c), (d), and perhaps others) will be used, in individual cases, to arrive at the final decision.

The possible decisions of the Qualifying Process are:

1. The student has passed at the PhD qualifying level and is therefore qualified to proceed towards a doctoral degree. If the student is a candidate for a Master's degree, he or she is also eligible to take the Master's final examination.

2. The student has passed at the PhD qualifying level subject to a specified condition, which must be removed within the timeframe specified if the doctoral degree is sought. Such a condition will usually be remedial course work, or reading assignments evaluated by his or her advisor. If the student is a candidate for a Master's degree, he or she is, without condition, eligible to take the Master's final examination. (This decision will be rendered only rarely.)

3. The student has passed at the Master's qualifying level and may take the Master's final examination. He or she may also repeat the qualifying examination in an attempt to qualify at the PhD level. The letter from the Director of Graduate Programs will indicate areas that need improvement, and the faculty recommendation on whether or not the student should attempt the examination again. Except in extenuating circumstances, a student must have a GPA of 3.5 or better to repeat the qualifying examination for a PhD qualifying pass.

4. The student has passed at the Master's qualifying level, subject to a specified condition which must be removed before taking the Master's final examination. Such a condition will usually consist of reading assignments evaluated by his or her advisor. Except for this condition, (3) above applies. (This decision will be rendered only rarely.)

5. The student has failed at the Master's qualifying level. The letter from the Director of Graduate Programs will indicate areas that need improvement, and the faculty recommendation on whether or not the student should attempt the examination again.

Note: A student may take the qualifying examination no more than two times.

Final Examination (MS, non-thesis option)

The final examination represents the last requirement for the MS degree in statistics under the non-thesis option.

Eligibility

Qualifying at the MS level (or higher) is a prerequisite for this examination. The examination must be scheduled after the second half of the semester in which all course requirements (according to the plan of study) will be completed. In general, students must be registered for at least 3 hours during the term in which the final examination is administered. An exception is made under certain circumstances: see “Start of Semester Defense Exception Request Enrollment.”

Start of Semester Defense Exception Request Enrollment

Start of Semester Defense Exception Request (SSDER) enrollment, formerly referred to as Defending Student Status enrollment, is available to those graduate students who have fulfilled all course and residency requirements and have completed all requirements for the thesis or dissertation except for the final defense. Eligible students may not hold an assistantship. Minimum registration is for 1 hour and the defense must occur within the first 15 class days of the term. Eligibility for SSDER may be found at

http://graduateschool.vt.edu/forms/academics/Start_Semester_Defense_Exception.pdf

Prior to the beginning of the term in which the defense is to occur, defending students must complete an eligibility certification form and return it to the Graduate School Programs and Clearances Office. The form is available at http://graduateschool.vt.edu/forms/academics/Start_Semester_Defense_Exception.pdf. The cost associated with of SSDER may be found at http://www.bursar.vt.edu/students_parents/defending_status.php.

Scheduling the Examination

Scheduling the examination is the responsibility of the candidate. A time must be chosen agreeable to the members of the examining committee (which is generally the same as the advisory committee) and at a time when the department Conference Room is available. The student must then request permission, via the internet, to take the examination from the Graduate School. **This request must be made at least two weeks before the examination date.** The Department of Statistics' Graduate Coordinator should be contacted for details concerning this request.

Format of the Examination

This is an oral examination in which the candidate is expected to demonstrate a general proficiency in statistics at the Master's level, including the ability to communicate knowledge orally. The candidate is responsible for material related to all courses taken, including those in current term.

Faculty will be invited and may attend and participate in the examination, but the result will be determined by vote of the examining committee only.

There are three possible formats to the oral examination, which may be chosen by the candidate. **Option 1** comprises a Technical Question and Answer (Q&A), where the committee members present statistical scenarios and/or technicalities to the examinee. **Option 2** and **Option 3** are presentation type exams, where the student will present for ~30 minutes of a topic of their choosing. The oral examination options are detailed below.

Option 1 (Technical Q&A): The candidate is responsible for answering technical statistical questions that are prepared by the committee. While they will not prepare a presentation in advance of the exam for **Option 1**, they are responsible for answering questions that may concern any area of concentration. For example, a committee member may pose questions concerning theory, modelling, computation, and/or a data inference (hypothetical or real), and the candidate will be evaluated based solely on their answers/explanations. The candidate is allowed to use the white/chalk board to explain technical issues; however, a key component is to understand technical questions and/or recognize modeling/design scenarios and devise appropriate solutions. Typically, members of the committee will iterate their questions in order to assess the candidates understanding of the material and ability to communicate solutions.

Option 2 (Presentation on a Data Analysis): The candidate will prepare a data analysis and (~30 minute) presentation of their choosing, based on a data-driven question/scenario. In addition, the candidate will provide a 1-2 paragraph abstract for their presentation. The presentation should detail: 1) the question that the analysis aims to answer, 2) the data and any statistical issues that arise in the collection process, 3) background on the field where the data/question arose, 4) a statistical analysis with methodological/computational details, 5) and conclusions, results, and next steps for the analysis. After the (~30 minute) presentation, committee members will iterate questions pertaining to the proposed analysis. Typically, committee members will ask about methodological, computational, and interpretive aspects of the analysis.

Option 3 (Presentation on a Theoretical/Methodological Paper): The candidate will present on a Theoretical/Methodological paper that has been previously published in a statistical (or highly related) journal. The presentation will include: 1) background on the topic of interest, 2) a literature review that details previous solutions to the topic, 3) theoretical details and/or proof of the method/theorem, 4) and applications/extensions of the solution to future research questions. Committee members will ask questions about technical details and/or applications of the topic.

For options 2 and 3, the chairperson of the Oral Exam Committee will need to approve the abstract (for Option 2) or journal paper (Option 3) before the exam may be scheduled (at least 2 weeks in advance). In addition, since the oral exam is designed to assess general knowledge of statistics, for Options 2/3, committee members may ask questions that are not directly related to any presented materials.

Possible Results of the Examination

The candidate may pass or fail the examination, according to the majority vote of the examining committee.

If the result is a pass, the Master's degree will be conferred upon completion of any outstanding course work, and satisfaction of all Graduate School requirements.

If the result of the exam is an M.S. *fail*, the candidate may elect to repeat the examination after 15 weeks have elapsed, as required by Graduate School policy. **The oral examination may be repeated only one time.**

The *Policies and Procedures* manual should be consulted for details of Graduate School requirements.

Final Examination (MS, thesis option)

With the exception of submitting the approved thesis to the Graduate School, the final examination is the last requirement for the MS degree in statistics under the thesis option. Qualifying at the MS level (or higher) is a prerequisite for this examination.

Scheduling of the examination is the responsibility of the candidate and must follow the same procedures and requirements as for the non-thesis option. In addition, a typed copy of the thesis must be delivered to each member of the advisory committee at least two weeks prior to the examination date.

Format of the Examination

The candidate will be given not more than thirty minutes to present the highlights of his or her thesis. The floor will then be opened for questions by the advisory committee which acts as the examining committee. Questions will relate to the thesis either as presented or as it appears in writing.

Faculty will be invited and may attend and participate in this examination, but the result will be determined by majority vote of the examining committee only.

Possible Results of the Examination

1. The candidate has passed the examination and the thesis is approved.

2. The candidate has passed the examination and the thesis is approved subject to revisions. In this event the cover page of the thesis will not be signed until the revisions are completed.

3. The candidate has failed the examination. This may occur for two reasons:

a. Although the thesis is satisfactory the candidate has failed to demonstrate adequate understanding of the work contained therein. The examination may be repeated one time, using the same thesis, but after a period of no less than 15 weeks.

b. The thesis itself is inadequate. The candidate will be informed how the thesis may be made adequate and may repeat the examination one time, after a period of no less than 15 weeks.

The Policies and Procedures manual should be consulted for details of Graduate School requirements.

Preliminary Examination (PhD)

The Proposal and the Proposal Presentation

As set forth in the Graduate Catalog, each PhD student is required to take a preliminary examination to evaluate their progress in the chosen field of study, i.e., to evaluate their knowledge in advanced areas of probability and statistics and preparation for research toward a dissertation.

The Department of Statistics administers this examination through the dissertation proposal and the proposal presentation.

The Proposal

The dissertation proposal presents the student's proposed dissertation topic. The proposal should contain a thorough literature review of related methods with discussion of their advantages and disadvantages, and a presentation of the student's proposed methodology and theory with methods for their evaluation. The student is expected to demonstrate excellent technical writing skills in the preparation of this document. A poorly written proposal can be cause for failure regardless of technical excellence.

The student is strongly encouraged to seek advice from their dissertation advisor on the proper format for a proposal. The student is also encouraged to examine previous successful proposals as examples.

Upon approval of the proposal by the dissertation advisor, the student may schedule the proposal defense.

Procedure and Format of the Proposal Presentation

The proposal presentation (called the Oral Preliminary Examination by the Graduate School, a requirement for admission to candidacy for the doctoral degree) is taken only after the student has received approval of the proposal by the dissertation advisor. The dissertation advisory committee acts as the examining committee.

Scheduling of the presentation is the responsibility of the student. A time agreeable to the members of the advisory committee must be chosen and the Graduate School must be notified at least 14 days in advance. Requesting the date is accomplished by using the Electronic Signature System (https://gradexam.stl.vt.edu/pages/login.php).

The candidate will be given not more than fifty minutes to present the highlights of their proposal. The floor will then be open for questions by the examining committee. Although emphasizing questions related to the student's proposal, the examination may also include questions of a more general statistical nature.

Possible Results of the Proposal Presentation

The student will pass or fail the proposal defense according to the vote of the examining committee. In order to pass, a candidate is allowed at most one negative (unsatisfactory) vote.

If the result is a pass the student will proceed with work on their dissertation and, at the appropriate time, schedule the oral presentation and final defense (see below).

If the result is fail, the student may elect to repeat the proposal defense one time, after a period of no less than one full semester (15 weeks).

The *Policies and Procedures* manual of the Graduate School should be consulted for details of Graduate School requirements.

Final PhD Oral Examination Guidelines

Preamble

The Final Oral Exam is a formal part of all PhD programs at Virginia Tech. Students **must** read the "Examinations" section of the on-line Graduate School Policies and Procedures found at: http://www.grads.vt.edu/graduate_catalog/poli/UIPo.jsp

Purpose of the Final Exam

The purpose of the Final Exam is to determine whether a student demonstrates intellectual and professional aptitudes consistent with individuals who already hold a PhD degree in Statistics. The courses listed on the student's Plan of Study provide the educational foundation for the degree, while the Dissertation describes the student's research accomplishments in a scholarly context. In the Final Exam, the Advisory Committee assesses the originality, correctness, and importance of the dissertation, as well as the student's ability to communicate those findings and to grasp their significance. The oral exam format allows these qualities to be assessed through direct, interactive questioning.

Graduate School Policies and Their Interpretation

Enrollment. A Final Exam can only be held during a term in which the student is enrolled. With prior permission from the Graduate School, Final Exams may be held during Exam Week. Students who do not wish to enroll for the minimum 3 credits merely to hold the Final Exam should consult the Graduate Catalog section that describes "Defending Student Status" (DSS). The DSS policy allows a student to be registered for (and to pay for) only one credit hour, even during a summer session, providing certain conditions are met.

Scheduling the Final Exam. Ph.D. students must have the dissertation ready for defense (as judged by Advisory Committee members having read the document and signed the examination scheduling request) and the student must be able to complete all other degree requirements within the semester when the examination is held: all coursework on the Plan of Study will need to be completed with grades of C- or higher and both the Plan of Study GPA and the overall GPA must be a 3.0 or higher by the end of the semester. Because problems with deficient grades or credits may require retaking courses or adding credits, the Plan of Study should be examined at the beginning of the semester in which a student plans to take the Final Examination.

Two Week Rule. The Graduate School requires that the student request a Final Examination date no later than two weeks before the requested exam date. Requesting the date is accomplished by using the Electronic Signature System (https://gradexam.stl.vt.edu/). There are no exceptions to this two-week rule.

Upon validation of the Final Exam date, the Graduate School will issue by campus email a Final Exam notification listing the date and time of the Final Exam to the student and all Advisory Committee members.

Unscheduled Exams. The Final Exam may *not* be conducted if the student's Advisory Committee has not received notification from the Graduate School that the exam has been scheduled. *There are no exceptions to this policy*.

Latest Possible Proposal Presentation. Graduate School policy requires that students pass their Proposal Presentation (referred to by the Graduate School as the Preliminary Exam) at least six months before the Final

Exam. Students need to plan their Proposal Presentation carefully to avoid violation of this policy.

Committee Attendance. Graduate School policy requires that the Advisory Committee be comprised of no fewer than four professors. These are the professors that will use the Electronic Signature System (https://gradexam.stl.vt.edu/) to grade the student's Final Exam performance as satisfactory or unsatisfactory.

Professors Must Review the Dissertation. Before requesting a Final Exam date using the Electronic Signature System, all members of the Advisory Committee will have read the dissertation and found it ready for defense. This implies that those professors have had adequate time to review the dissertation. See "Deadline Recommendations" below. Note well: The Advisory Committee, by agreeing to meet for the Final Exam, are not certifying the originality, correctness, or importance of the work; rather, they are acknowledging that the document is readable and consistent, and thus ready to defend.

Oral Presentation (PhD)

Prior to the Final Exam the student must give a colloquium presentation of the dissertation topic. This should be scheduled as part of the Department's regular colloquium series, if possible. The purpose of the presentation is to inform the faculty and students in the department and to prepare the doctoral candidate for the colloquium generally required as part of most job interviews. The presentation is open to all faculty and students. The oral presentation may immediately precede the Final Exam. It is strongly recommended that each student, in consultation with his or her advisor, schedule the oral presentation prior to any actual job interviews.

The student must register for STAT 5924, Graduate Seminar for 1 hour, P/F, during the term in which he/she makes the Oral Presentation. The Advisory Committee makes evaluation of this presentation and the result (either pass or fail) is assigned as the grade for STAT 5924.

Upon passing the oral presentation and completion of the dissertation the student is free to schedule the Final Exam following the guidelines as set below.

The Final Exam (PhD)

Time Allotted for Exam. It is not uncommon for an exam to last three hours. It is recommended that rooms be reserved for that length of time.

Deadline Recommendations. Meeting the Two-Week Rule can require considerable lead time. Though individual circumstances may vary, most candidates should plan for a timeline at least as lengthy as that described next. A student planning to take the Final Exam in a given semester should give their Advisor (Chair of the Advisory Committee) a substantially complete document a minimum of **eight weeks prior to the desired Final Exam date.** The eight weeks allow for:

- Two weeks for the student's Advisor to read/review the document.
- Two weeks for the student to make the changes suggested by the Advisor.
- Two weeks for Advisory Committee members to read the dissertation after the Advisor and student agree that it is ready to move forward.
- Two weeks advance notice is required by the Graduate School for scheduling the exam. The Final Exam cannot be scheduled until all members of the Advisory Committee have read the dissertation and agreed that it is ready to defend.

Thus, students should give a nearly completed version of the dissertation to the Advisor eight weeks prior to the desired exam date and should give their *final* dissertation version to their Advisory Committee members **at least four weeks** before the planned exam date. There is, however, no guarantee that the intended exam date can be achieved; should your committee members encounter problems with the dissertation, further time may be required. It is the responsibility of the Chair of the student's Advisory Committee to carefully review and critique the dissertation before it is submitted to the Advisory Committee.

It is highly recommended that PhD students working on their dissertations meet on a regular basis with their Advisor (perhaps weekly) and with their Advisory Committee (perhaps once per semester) to present progress toward completion, discuss new developments, and discuss issues yet to be addressed. If such meetings are regularly held and dissertation chapters reviewed carefully by the Advisor as they are completed, it is possible to reduce the later time required to critically review the dissertation.

Guidelines for the Final Exam

Exam Coverage. The Final Exam is based primarily on the dissertation. However, the Final Exam is comprehensive, and questions of a general nature are permissible.

Refreshments. Students should *not* bring refreshments to their exams.

PowerPoint**.** Students should prepare their presentations in presentation software such as PowerPoint or LaTeX Beamer or similar software. The student's goal should be to summarize their main accomplishments and highlight technical details, assuming that their professors have already become acquainted with the literature background from the written document. The presentation should not be a repeat of a departmental or general seminar, because the audience is not a general audience. The audience is a committee of accomplished scholars who will want to know if the student has grasped the full significance of their findings and has critically evaluated the potential weaknesses of their own work.

Room Scheduling. Schedule the Conference Room by signing up for the room using the Google calendar under the email address Hutch406Avt@gmail.com . The required password may be obtained from the department's Head Secretary.

Reminding the Committee. Students should send an email reminder to their Advisory Committee members the day before the Final Exam.

Executing the Exam. All graduate examinations are open to the faculty and faculty members are encouraged to attend and participate in such meetings. The student's presentation, should consume about 45 minutes, excluding interruptions for questions. The student should expect questions during the presentation and additional questions (including any comprehensive questions) following the presentation, for whatever time the Committee deems appropriate. The Committee will then convene privately (the student and any other parties present but not on the Committee will exit the room) to determine the result of the exam, after which they will convey the result to the student and use the Electronic Signature System (https://gradexam.stl.vt.edu/pages/login.php) to indicate the student's Final Exam performance as satisfactory or unsatisfactory within 24 hours of the Final Exam.

To pass the Final Exam, the student is allowed at most one Unsatisfactory vote. If a student fails this exam, one full semester (a minimum of 15 weeks) must elapse before the second examination is scheduled. No more than two opportunities to pass the PhD Final Exam are allowed. A student failing to pass the PhD Final Exam two times will be dismissed from graduate studies by the Graduate School.

Additional Requirements

Statistical Collaboration (MS & PhD)

Whether they work in government, industry or academia, graduates of statistics programs are invariably asked to participate in some form of statistical collaboration as a portion of their job responsibilities. Thus, the department requires all graduate students to participate in collaboration projects through the Statistical Applications and Innovations Group (SAIG). Employers of previous graduates have remarked that such collaboration experience is an invaluable feature of our graduate program.

Masters' students must participate for one semester in statistical collaboration activities and doctoral students for three semesters.

The collaboration requirement is liberally interpreted in two respects. First, comparable specialized activity, such as work on certain research projects, may be considered the professional equivalent of the collaboration experience. Second, the amount of time, which must be devoted to collaboration in any particular term, is unspecified. In general, graduate assistants may assume that the collaboration requirement will be satisfied if they conscientiously complete their assigned duties. Graduate students not on university support will specifically be asked to participate in appropriate collaboration projects, generally requiring approximately five hours per week of collaboration activity.

Each semester of participation in SAIG is completed by the student after their "collaboration project" has been evaluated and approved by the Director of SAIG. The collaboration project may, for example, be a summary of several smaller projects involving the student during the semester or a more detailed report of a more substantial project.

Internship in Statistics

The Internship in Statistics course (stat 5754) is a variable credit (from 1 to 3 hours) course, to be taken by statistics students who intern at an appropriate company or government agency performing statistical analysis under supervision of a corporate, or government, affiliate faculty member. The Internship in Statistics course may also be taken by students working on an approved data-based grant project in another department on campus or on an interdisciplinary grant project involving statistics and another department on campus. In this case, the affiliate faculty member will be the student's supervisor on the project. This will be an optional course that may be taken for credit once by undergraduate or masters students, and twice by doctoral students.

The course will be graded on the A-F scale, where grades are assigned on the basis of an evaluation of the work performed on the job, a written report, and a seminar. The affiliate faculty supervisor will make the evaluation of job performance. The written report and the seminar will provide a detailed, technical presentation of at least one project completed during the internship. Both the written report and the seminar will be presented to the corporation, or government agency or other department, (evaluated by the affiliate faculty member) and to the Department of Statistics at Virginia Tech (evaluated by the student's internship mentor, a faculty member in the department who has agreed, at the request of the student, to evaluate the student's oral presentation and written report); the seminar will be scheduled in the outreach series. The written report must be approved by the internship mentor prior to presentation of either seminar. The final grade will be a combination of these two evaluations determined by the student's internship mentor.

The written report and the seminar must be presented within the first month of the completion of the internship. Typically, this will be in the semester immediately following completion of internship responsibilities. Students will register for this Internship Course in the term when they submit their written report and present their seminar, not during the period of internship.

It is envisioned that the internship course can be applied in a variety of ways. For example, an undergraduate student might intern prior to his or her junior or senior years. A student with a B.S. degree in statistics can intern prior to the beginning of the M.S. program. A graduate student could intern after the first year of courses in the M.S. program. A Ph. D. student could intern several times.

For the M.S. student, one intern course will count up to three hours toward the 35 hours required for the M.S. degree. For the Ph.D. student, up to six hours of intern credit may be counted towards the doctorate. In this case, the two sets of hours for intern credit must occur in separate semesters. With these restrictions, the department is not limiting the amount of time a student may work as an intern, but limiting the number of credits of intern work that may be counted toward a degree.

Full credit for the internship is considered to be one credit hour for each month of full-time intern experience or

equivalent. A summer internship is worth up to three credits. Similarly, a seven-month internship (from January to August, for example) is worth up to six credits. To receive full credit on the basis of time, it is expected that a B. S. student perform B. S. level statistics while working as an intern and an M. S. student and a Ph. D. student perform graduate level work. The required report and seminar should reflect the level of work performed by the student during the internship. If the internship is structured with a corporate faculty affiliate, who monitors the work, ensuring that the internship is a true learning experience for the student and proper oral and written presentations are satisfactory, then it is reasonable to give the full credit based on time. Otherwise, less than full credit may be given. For example, a Ph. D. student who only performs routine data analysis using SAS will likely receive less than full credit even if these tasks were performed in a highly satisfactory manner.

It is the student's responsibility to find a faculty sponsor for the internship who will serve as advisor and mentor throughout. The student must convince his or her mentor of the suitability of the proposal internship prior to its inception, and of the appropriateness of the work accomplished at the internship's completion. Regular communication with the faculty mentor is expected.

The Internship Course should be approved by the student's advisor and the affiliate faculty member, both in terms of the expected number of credits and the expected level of work required by the intern, prior to the internship. The actual number of credits earned for the intern experience may be higher or lower than the expected amount, depending on the actual work performed during the internship.

Grade Point Average (MS & PhD)

Students should be alerted to the fact that the Graduate School requires each graduate student to maintain a grade point average (GPA) of at least 3.0 for all courses on the plan of study and for all courses taken as a graduate student. Any course on the plan of study (and/or any course in statistics) must be repeated if a grade below "C-" is earned. Students whose overall GPA falls below 3.0 are not eligible for assistantships.

Time Limits (MS & PhD)

According to Graduate School rules, all requirements for the MS degree must be completed within 5 years, for the PhD degree within 7 years. These limits apply to transfer credit as well as to credits earned at Virginia Tech.

Revalidation of Course Work

Coursework that was taken outside of the time limits can be revalidated. The responsibility for revalidation lies with the student's advisory committee and the department. Revalidation is sometimes accomplished by means of an oral or written examination given by the advisory committee.

The committee may elect to incorporate the revalidation examination within the written qualifying examination or the oral final examination for the M.S. degree or within the oral preliminary examination for the Ph.D. degree, for example.

Student Awards

Our graduate students play a major role in helping the Department of Statistics make worthwhile and valuable contributions to the three areas of research, teaching, and service. The quality of the department depends greatly on the quality of our graduate students.

To help express appreciation for our graduate students' contributions to the department's success, seven graduate student awards are offered annually.

With these awards comes a certificate and the recipient's name is placed on a plaque, which is displayed outside the main office door. Additionally, the first five awards listed below include a sizable financial gift while the other two

awards include a book of the recipients' choice.

The **Jean Dickenson Gibbons Statistics Award** is given annually to the outstanding new PhD candidate in statistics. Dr. Gibbons received her PhD from our department in 1962 and had an illustrious career as a professor of statistics. The **Raymond H. Myers Award** is given annually to the most outstanding student in the area of design of experiments and linear models. Dr. Myers was a long-time member of our department with an international reputation in response surface methodology. The **Rose Costain Award** is given annually to the graduate student who exhibits outstanding citizenship in the department. Mrs. Costain worked in the department of 17 years in various administrative duties including assistant to the Graduate Administrator and editorial assistant for several journals. The **Boyd Harshbarger Award** is given annually for superior academic performance by a first-year graduate student. The award is named after our department's founder and first department head. The **John Bartko Ph.D. '62 Award** is given annually for outstanding collaboration/consulting by a graduate student. Dr. Bartko received his PhD from our department in 1962 and had an illustrious career at the National Institutes of Health National Institute of Mental Health. The **Jesse C. Arnold Award** is given annually for outstanding teaching by a graduate teaching assistant. Dr. Arnold was our department's second department head. The **Klaus Hinkelmann Award** is given annually for outstanding service by a graduate student to the department. Dr. Hinkelmann was our department's third department head.

The awards are presented at the annual Corporate Partner Dinner during the Corporate Partner Conference.

APPENDIX: Areas of Concentration

Introduction

Our graduate program offers opportunities in five concentration areas:

- General Statistical Methodology and Theory
- Business, Industry, and Government (BIG) Statistics
- Biostatistics/Bioinformatics
- Computational Statistics
- Environmental Statistics
- Sports Analytics

To support her/his research in each area of concentration, the PhD student is expected to complete advanced course work in appropriate areas of concentration, to be chosen by the student in conjunction with her/his advisory committee. The description of each area of concentration below offers lists of suggested elective courses in the Department of Statistics and in other departments at Virginia Tech. We note that these lists are not complete and that decisions on what courses to take must be made by the student in conjunction with her/his advisory committee.

A decision related to the choice of an area of concentration is the choice of a PhD advisor. The choice of a PhD advisor is a decision that should not be rushed. However, usually the earlier a PhD student chooses an advisor the better. It is also important to note that this has to be a mutual decision, where the student chooses a faculty to be the PhD advisor and the faculty agrees to be her/his PhD advisor. PhD students should choose a PhD advisor within the first two years of graduate studies.

The choice of area of concentration and PhD advisor may be related to what type of employment the student wants to get after graduation. The student should consult with the individual faculty to obtain information on what type of jobs their students obtained upon graduation.

Employment: In addition to careers in academia, our alumni are employed by major companies and government organizations in:

- ***Information sciences and technology***
- ***Pharmaceutical***
- ***Other types of manufacturing, research and development***
- ***Government and government-related***
- ***Finance and banking***

Concentration Area: General Statistical Methodology and Theory

Description

This concentration is designed to provide maximum flexibility for students wishing to design a particular course of study that does not fit within the framework of more specialized areas of concentration. As such, it is very important that the student, in conjunction with his/her advisor and the advisory committee, carefully construct a plan of study that provides a coherent set of courses supporting his/her career goals and objectives. By deliberating carefully and choosing wisely the student will construct a program that will deliver value throughout his/her professional career.

Goals:

(1) To give students of this program a widely based knowledge of the methodology and theory of statistical science, preparing them to enter an academic environment or an application-based field of their choice.

(2) To train academic and nonacademic research statisticians who can not only manage and interpret data from a wide variety of sources, but also develop new methodologies for novel application scenarios.

Program requirements: A student in this concentration area must satisfy the general course requirements for the PhD in statistics. Most students in this concentration area take both STAT 6105- Measure and Probability and STAT 6114- Advanced Topics in Statistical Inference. If there are strong reasons for not doing this, your advisor may be able to approve an alternative route.

Suggested elective courses in the Department of Statistics are listed below. Note that this list is not a complete set. Elective coursework in any area of concentration must be defined by the student in conjunction with her/his advisory committee relative to career goals and research areas.

Suggested graduate courses in the Department of Statistics:
STAT 5304 – Statistical Computing
STAT 5404 – Nonparametric Statistics
STAT 5414 – Time Series Analysis I
STAT 5444 – Bayesian Statistics
STAT 5504 – Multivariate Statistical Methods
STAT 5514 – Regression Analysis
STAT 5525 (CS 5525) – Data Analytics I
STAT 5526 (CS 5526) – Data Analytics II
STAT 5544 – Spatial Statistics
STAT 5554 – Functional Data Analysis
STAT 5594 – Longitudinal Data Analysis
STAT 6404 – Advanced Topics in Nonparametric Statistics
STAT 6424 – Advanced Multivariate Analysis
STAT 6494 – Advanced Topics in Mathematical Statistics
STAT 6514 – Advanced Topics in Regression
STAT 6474 - Advanced Topics in Bayesian Statistics
STAT 6504 - Experimental Design and Analysis II

Concentration area: Biostatistics/Bioinformatics

Description

The area of concentration on Biostatistics/Bioinformatics provides advanced training in statistical modeling, inference, and computation for performing independent and collaborative research in biomedical and public health sciences. Students are prepared to develop methodology, lead the design and execution of studies, and analyze/interpret data in biostatistics, bioinformatics, genetics, and public health.

Goals:

(1) To give the PhD students rigorous training on theory, methods, and computational techniques so that they can develop novel statistical theory and methods, perform independent and collaborative research, and participate in biostatistics/bioinformatics practices.

(2) To train academic, clinic biostatisticians and data analysts who can work with scientists from various disciplines related to biostatistics, bioinformatics, genetics, and public health.

Program requirements: A student in this concentration area must satisfy the general course requirements for the PhD in statistics. The topic(s) of the dissertation must be related to Biostatistics/Bioinformatics theory or applications

and must be approved by the dissertation committee members.

Suggested graduate courses in the Department of Statistics:

STAT 5414 Time Series Analysis I
STAT 5434 Applied Stochastic Processes
STAT 5444 Bayesian Statistics
STAT 5504 Multivariate Statistical Methods
STAT 5514 Topics in Regression
STAT 5525 Data Analytics I
STAT 5525 Data Analytics II
STAT 5544 Spatial Statistics
STAT 5554 Functional Data Analysis
STAT 5594 Longitudinal Data Analysis
STAT 5684 Survival Analysis
STAT 6424 Multivariate Statistical Analysis
STAT 6514 Advanced Topics in Regression
STAT 6474 Advanced Topics in Bayesian Statistics
STAT 6574 Response Surface Design II
STAT 6984 Advanced Statistical Computing

Concentration Area: Business, Industry, and Government (BIG) Statistics

Goals: Our goal is to prepare Ph.D. graduates for successful statistical practice and collaborative research careers in business, industry, and government. Employment could be in a wide variety of areas such as information sciences and technology, pharmaceutical and other types of manufacturing, research and development, system testing and evaluation in the defense industry, and finance and banking. There is a focus on statistical modeling, analytics, designed experimentation, process monitoring, reliability, and process improvement which can be applied in virtually any domain, including healthcare and other service industries.

Program requirements: A student in the BIG Statistics Concentration must satisfy the general course requirements for the PhD in statistics. To support his or her research and a PhD dissertation in BIG Statistics, the student is expected to complete appropriate advanced coursework in this area of concentration. Students pursuing careers in BIG Statistics are strongly encouraged to seek opportunities that improve their communication skills related to statistical practice. These include internships, Statistical Applications and Innovations Group (SAIG) collaboration, teaching/training, and government grants. Statistical programming experience with modern computing languages including basic database knowledge, SQL (Structured Query Language), and high-performance computing are also valuable to employers in the BIG Statistics concentration area.

BIG Statistics Graduate Courses in the Department of Statistics

- STAT 5304 - Statistical Computing
- STAT 5404 - Nonparametric Statistics
- STAT 5414 - Time Series Analysis I
- STAT 5454 - Reliability Theory
- STAT 5474 - Statistical Theory of Quality Control
- STAT 5504 - Multivariate Methods
- STAT 5514 - Regression Analysis
- STAT 5525 - Data Analytics I
- STAT 5526 - Data Analytics II
- STAT 5534 - Analysis of Multivariate Categorical Data
- STAT 5554 - Functional Data Analysis
- STAT 5574 - Response Surface Design and Analysis I
- STAT 5684 - Survival Analysis
- STAT 5694 - Longitudinal Data Analysis

- STAT 5754 - Internship in Statistics
- STAT 6404 - Advanced Multivariate Analysis
- STAT 6494 - Statistical Quality Control II
- STAT 6504 - Experimental Design and Analysis II
- STAT 6514 - Advanced Topics in Regression
- STAT 6574 - Response Surface Design and Analysis II

Suggested graduate courses from other departments:

- Industrial Systems Engineering Department: coursework on optimization, simulation, and human factors.
- Computer Science Department: coursework on computational modeling, machine learning, and high-performance computing environments.
- Mathematics Department: coursework on numerical analysis.
- Students interested in Banking, Finance, and Insurance may wish to consider courses such in econometrics or financial modeling from the Economics or Business Departments.

Concentration Area: Computational Statistics

Description

Statistical techniques tend to be highly algorithmically and computationally oriented. Abilities in numerical methods, computer programming, and algorithm construction and utilization are essential for statisticians. The Computational Track for the PhD allows the student to specialize in these abilities and to prepare for a research career in computational statistics.

Goals:

(1) To give graduates of this program the fundamentals of modern statistical computational theory, methods and techniques.

(2) To train students capable of developing new theory, methods, and techniques in computational statistics.

Program requirements: A student in this concentration area must satisfy the general course requirements for the PhD in statistics. The topic(s) of the dissertation must be related to Computational Statistics and must be approved by the student's dissertation committee.

Suggested graduate courses in the Department of Statistics:

- STAT 5304 – Statistical Computing
- STAT 5314 – Monte Carlo Methods in Statistics
- STAT 5504 – Multivariate Statistical Methods
- STAT 5444 – Bayesian Statistics
- STAT 5544 – Spatial Statistics
- STAT 5414 – Time Series Analysis I
- STAT 5525 – Data Analytics I
- STAT 5526 – Data Analytics II
- STAT 6124 – Stochastic Modeling and Inference
- STAT 6424 – Multivariate Statistical Analysis
- STAT 6494 – Advanced Bayesian Statistics
- STAT 6414 – Time Series Analysis II
- STAT 6514 – Advanced Topics in Regression
- STAT 6984 – Response Surface Methods and Computer Experiments

Concentration Area: Environmental Statistics

Goals:

(1) To give the graduates of this concentration area an appropriate combination of statistical and environmental systems backgrounds so that they may have successful technical careers in environmental organizations and companies or successful academic careers doing research in environmental statistics.

(2) To train academic environmental statisticians who can serve as better bridges between the academic and corporate worlds.

Program requirements: Students in the Environmental Concentration Area have to meet the general course requirements for the PhD in statistics. In addition, the student will be expected to do research and write a PhD dissertation in the area of Environmental Statistics.

Suggested graduate courses in the Department of Statistics:

STAT 5304 Statistical Computing
STAT 5504 Multivariate Statistical Methods
STAT 5444 Bayesian Statistics
STAT 5514 Regression Analysis
STAT 5544 Spatial Statistics
STAT 5414 Time Series Analysis I
STAT 6424 Multivariate Statistical Analysis
STAT 6514 Advanced Topics in Regression
STAT 6494 Advanced Bayesian Statistics
STAT 6504 Experimental Design and Analysis II
STAT 6404 Advanced Topics in Nonparametric Statistics
STAT 6414 Time Series Analysis II

Suggested graduate courses in Environmental Studies from other departments:

Biology
5024: Population & Community Ecology
5034: Ecosystem Dynamics
5044: Aquatic Ecotoxicology
5054: Hazard Evaluation of Toxic Chemicals

Civil Engineering
5104: Environmental Chemistry
5714: Surface Water Quality Modeling
5184: Techniques for Environmental Analysis
5194: Environmental Engineering Microbiology
5204: GIS Applications in Civil Engineering
5214: Analysis of Imaging Systems
5224: Adv. GIS Applications in Civil & Environmental Engr.
5324: Advanced Hydrology
5334: Analysis of Water Resources Systems
5344: Environmental Systems Optimization
5354 (Geol 5814): Numerical Modeling of Groundwater
5364: Water Law

Biochemistry
4204: Biochemical Toxicology
5124: Probability Models in Agricultural Engineering

5144 (Cee 5064): Knowledge-Based Expert Systems
5304: Nonpoint Source Poll
5354: Nonpoint Source Pollution Modeling
4144: Biological Systems Simulation
4304: Nonpoint Source Pollution Modeling & Management

Crop Soil and Environmental Science
5634: Soil Chemistry
5694 (Biol 5694): Soil Biochemistry
4134: Soil Genesis & Classification
4734 (Ensc 4734): Environmental Soil Chemistry

Entomology
4354 (Biol 4354): Aquatic Entomology
6164: Insecticide Toxicology
6254: Population Modeling of Insect Systems

Fisheries
5214: Wildlife Population & Habitat Analysis
5224: Wildlife Population Dynamics
5734: Fisheries & Wildlife Planning
5514: Fish Population Dynamics & Modeling
5624: Fish Health

Forestry
5104 (Geog 5104): Seminar in Remote Sensing & Geographic Information Systems
5214: Advanced Forest Inventory
5224: Forest Biometry
5254: Remote Sensing of Natural Resources

Geography
5034: Analysis of Spatial Data
5104 (For 5104): Seminar in Remote Sensing & Geographic Information Systems
5314: Advanced Spatial Analysis in Geographic Information Systems

Concentration Area: Sports Analytics

Description

The analysis of sports is a broad discipline which includes the forecasting of competitions and their outcomes, assisting in coaching decisions, managing seasonal schedules, analyzing the finances of teams and events, etc. Due to widespread interest in sporting events and their financial implications, in recent years, data has been digitally collected in order to assist in team/player decision making. The Sports Analytics Track for the PhD allows the student to specialize in analytical methods which will provide insights on how to improve team/player performances and interrelations, as well as prepare students for a career in sports analytics.

Goals:

(1) To provide Graduate Students the opportunity to collaborate on sports analytics problems at the University and beyond.
(2) To allow Graduate Students to develop metrics and analytical predictive models in order to forecast team and game performances.
(3) To train Graduate Students on collecting and maintaining high dimensional sports data for future analyses.

Program requirements: A student in this concentration area must satisfy the general course requirements for the PhD in statistics. The topic(s) of the dissertation must be related to Sports Analytics and must be approved by the student's dissertation committee

Suggested graduate courses in the Department of Statistics:

- STAT 5304 – Statistical Computing
- STAT 5314 – Monte Carlo Methods in Statistics
- STAT 5364 – Hierarchical Modeling
- STAT 5444 – Bayesian Statistics
- STAT 5544 – Spatial Statistics
- STAT 5414 – Time Series Analysis I
- STAT 5504 – Multivariate Statistical Methods
- STAT 5514 – Topics in Regression
- STAT 5525 – Data Analytics I
- STAT 5534 – Analysis of Multivariate Categorical Data
- STAT 6124 – Stochastic Modeling and Inference
- STAT 6424 – Multivariate Statistical Analysis
- STAT 6494 – Advanced Bayesian Statistics
- STAT 6414 – Time Series Analysis II
- STAT 6514 – Advanced Topics in Regression