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 four 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. All requirements, both university and departmental, must be specified. Thus, where university rules and department policies do not precisely coincide, the more stringent requirements apply.

This manual is distributed during orientation to all entering graduate students in the Department of Statistics. The requirements listed in this document apply to the entering graduate class of August 2008.

(Revised March, 2009)

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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), stat 5024 (consulting course), and stat 5984 (special topics). (usually completed by the end of the student's third semester).
- select an advisory committee (by mid spring semester, first year)
- complete an approved program of study (by mid spring semester, first year)
- pass the qualifying process at the MS level (given in May, first year)
- participate in statistical consulting (usually in third semester)
- pass the final 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 course requirements of 59 credit hour consisting of 18 three-hour courses (including the six MS core courses and four 6000-level courses), stat 5014 (statistical software), stat 5024 (consulting course), and two sections of stat 5984 (special topics) (usually completed by the end of the student's tenth semester).
- select an advisory committee
- complete an approved program of study in one of the four doctoral tracks
- pass the qualifying process at the PhD level
- participate in statistical consulting for at least three semesters
- prepare a proposal
- pass the proposal defense
- give oral presentation
- 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 program 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, but in practice the student actually chooses the committee and asks each member individually whether he or she would be willing to serve. For doctoral students, and Master's students electing the thesis option, the student should confer with the committee chairperson 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 Graduate Administrator 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 program of study, as the committee's first official function is to approve the program of study. Specifically, Master's students must select 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 all members of the committee sign the program of study before it is submitted.

Changes in committee membership can be requested by submitting a form available in the graduate program office, Hutcheson 405-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. 3 hours
STAT 5104, Probability and Distribution Theory, 3 hours
STAT 5014, Introduction to Statistical Program Packages, 1 hours, P/F only

Spring
STAT 5114, Statistical Inference, 3 hours
STAT 5124, Linear Models Theory, 3 hours
STAT 5204, Experimental Design and Analysis I, 3 hours
STAT 5024, Effective Communication in Statistical Consulting, 2 hour, P/F only

In addition, all Master's students are required to pass one section of Special Topics in Statistics (Stat 5984, 1 hour). Usually, the Special Topics in Statistics course is taken in the second fall semester.

Note: The seminar on computing (STAT 5014) may be omitted, at the discretion of the Graduate Program Director, for students already proficient with the computing facilities at Virginia Tech and already familiar with the SAS package.

PhD Core Courses

Flexibility is provided to the graduate program through four Ph.D. concentrations or "tracks", which include the Traditional Track, the Industrial Track, the Bioinformatics Track, and the Environmental Track. The Traditional Track encompasses the general pursuit of research in statistical theory and methods, allowing considerable freedom in choice of coursework within and outside the department. The Industrial, Bioinformatics, and Environmental Tracks offer more specialized statistical training geared towards applications areas in which the department has particular expertise. In accord with their specialized nature, these three tracks are more stringent in requirements for relevant coursework than the Traditional Track. A thorough description of each of the tracks is given in the Appendix.

Doctoral students, regardless of track, are expected to complete the entire set of MS core courses listed above, unless equivalent courses are approved for transfer credit. All PhD students must complete two sections of Special Topics in Statistics (Stat 5984, 1 hour each).

All PhD students, regardless of track, must take:

Spring STAT 6114, Advanced Topics in Statistical Inference, 3 hours.

All PhD students, regardless of track, are required to take four 6000-level statistics courses from an approved list of courses. These courses, which vary by track, and other requirements for the individual tracks are given at url http://www.stat.vt.edu/students/courses.html#gcourses.

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.

Program of Study (MS & PhD)

The program 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 program of study.

General Requirements

All courses on the program 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 program of study.) Courses on the program of study may not be audited. Any course on the program of study (and/or any course in statistics) must be repeated if a grade below "C-" is earned. The overall QCA for all courses on the program 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 4 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.

Masters Requirements

For the Master's degree the program 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 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 elective 3 hrs
Stat 5014 1 hr	Stat 5024 2 hr	Special Topics 1 hr
Total 10 hrs	**Total 11 hrs**	**Total 13 hrs**

Doctoral Requirements

A program of study for the doctoral degree requires at least 90 semester hours, including at least 59 hours in actual course work (not research credits), and at least 12 hours of course work in statistics at the 6000 level. The program 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 VPI&SU, then hours earned under STAT 5994 may be included). The course requirement for the Ph. D. is to pass 24 hours above the number of hours required by the M.S. pass plus one hour for a second, required Special Topics course. This means that the number of courses required for the Ph.D. is eight three hour courses above the M.S. degree and one more Special Topics course (for a total of two Special Topics courses). All of the eight three hour courses must be graded on the A-F scale. Four of these eight courses must be at the 6000 level (with 6105 and 6114 required for the Traditional Track and only 6114 required for the Bioinformatics or the Environmental or the Industrial Tracks). Specific requirements for each track are listed in the Appendix.

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 17 of this document.

Procedure for the Program of Study

For the MS degree the program of study must be submitted to the Graduate School prior to completing 15 credit hours at this university (typically during the spring semester). For the PhD degree the program 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 program of study and discuss it with the advisor. After agreement has been reached the student should complete the program of study form, printing neatly, obtain the signatures of all advisory committee members, and return the form to Hutcheson 405A where it will be checked by the Graduate Administrator for accuracy of contents prior to being submitted electronically for Graduate School approval.

Changing the Program of Study

The composition of a student's advisory committee may be changed if the student alters the originally approved research topic. 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 program of study require the approval of each member of the student's advisory committee. It should be noted that once a course on the program of study has been taken for a grade, it must remain on the program.

Forms for making changes to a student's program of study are available in the Graduate Program Office, Hutcheson 416-C.

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 are not appropriate. 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 QCA.

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 program 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, from all departmental sources.

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 in excess of a 50% 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 75% 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 program of study, examinations, and so on. To help ensure timely progress, the department encourages regular meetings of students with their graduate 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: after the completion of the spring semester 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 in the spring of their first year, and doctoral students entering with a Master's degree from another university take the examination in either the fall or spring of their first year at Virginia Tech, but no later than two semesters after entering the graduate program.

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 of 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 of 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 kept in the secretary's office in 405-A. You may stop by and check out the notebooks to make copies if you wish.

Format of the Qualifying Examination

The Qualifying Exam Committee, usually consisting of the professors who taught the MS core courses, 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)
5034 Inference Fundamentals and 5044 Regression and ANOVA

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

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

The time limits indicated are *absolute maximums*. The exams will typically be given on Monday, Wednesday, and Friday in a single week. The spring exam is usually given during the first week after the university commencement. The fall exam is usually given in late November.

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 graduate administrator indicating the result earned on the examination, and the level of qualification. Any student desiring to take the exam a second 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 graduate administrator 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 QCA 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 graduate administrator 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 may not be scheduled prior to the second half of the semester in which all course requirements (according to the program 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: "*defending*" *student enrollment*.

Defending Student Enrollment

Eligibility: Defending student status 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 20 class days of the term. If the defense is later, minimum registration is for 3 hours.

Procedure: 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 (Room 101 Sandy Hall). They will then complete a special drop/add form, and register in the Graduate School Programs and Clearances Office for either Grad 6864, Defending Masters Student, or Grad 7864, Defending Doctoral Student. After registration students will take the drop/add form to Student Accounts where they will receive an invoice for payment of tuition for one credit hour at the Cashiers Office. Students may pick up their examination card, on the day of the examination, by returning their ***Cash Register receipt*** and a copy of the drop/add form to the Programs and Clearances Office, Graduate School. Students ***may not*** use these courses on their program of study. Students will be graded for one hour, one credit as an equivalent credit course (R) grade. Students who fail or who do on take their examination when scheduled must resign and reregister for a second defense. The tuition paid is non-refundable and must be paid for each subsequent registration.

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). Then a form for scheduling the examination should be picked up in Hutcheson 405-A, signed by the advisor, and returned to 405-A in time to be sent to the Graduate School at least two weeks prior to the date requested. The student should also pick up an "Application for Degree" card at the same time which must be filled out and returned with the oral final form.

On the day of the examination the student must pick up an *examination card* at the Graduate School. At the completion of the examination the card will be signed by the examining committee and must be returned to the Graduate School as soon as possible.

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 the 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.

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 is a fail, the candidate may elect to 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.

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 Defense

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 defense.

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 Defense

The proposal defense (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 examination 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. The details of this procedure are the same as those outlined for scheduling the final examination for the MS degree, non-thesis option.

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 Defense

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 vote.

If the result is a pass the student will proceed with work on their dissertation and, at the appropriate times, 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.

Oral Presentation (PhD)

Prior to scheduling the dissertation defense the student must give an oral presentation of the dissertation topic. The purpose of the presentation is to inform the faculty and students of 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 within the department and would generally be included on the regular colloquium calendar. The oral presentation may immediately precede the final oral examination. In any event, 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 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 examination.

Final Examination (PhD)

Successful completion of an approved program of study and a passing grade on the oral preliminary examination are prerequisites to scheduling the defense of dissertation (final examination).

Scheduling the Examination

When a PhD candidate has completed his or her dissertation research and has produced a final copy of the dissertation in a neat, legible form, it must first be approved for defense by the candidate's advisor. Following this approval, a typed copy of the dissertation must be delivered to each member of the examining committee. Each member of the examining committee must be allowed not less than two weeks to evaluate the dissertation and approve it for defense. When all members have indicated approval for defense, the defense may be schedules.

Scheduling of the defense is the responsibility of the candidate. The procedure is the same as that outlined on page 9 for scheduling the final examination for the Master's degree with the thesis option, and is subject to the rules specified in the Policies and Procedures manual of the Graduate School.

See also the discussion of **Defending Student Enrollment** on page 12.

Format of the Examination

The candidate will be given not more than fifty minutes to present the highlights of his or her dissertation. The floor will then be open for questions by the examining committee. Questions will relate to the dissertation as presented or as written.

Faculty will be invited and may attend and participate in the examination, but the result will be determined by a vote of the examining committee only. The Graduate School, as explained in the Policies and Procedures manual, restricts attendance at the examination by other graduate students.

Possible Results of the Examination

In order to pass, a candidate is allowed at most one negative vote.

There are two types of pass and two types of fail:

1. The candidate has passed the examination and

    a. the dissertation is approved

    b. the dissertation is approved subject to revisions. In this event, the cover page of the dissertation will not be signed until the revisions have been satisfactorily completed.

2. The candidate has failed the examination. One more defense may be scheduled after a waiting period of no less than one full semester (15 weeks).

    A failure can occur for two major reasons and the candidate will be advised in detail concerning his or her specific case:

    a. although the dissertation is satisfactory, the candidate has failed to demonstrate adequate understanding of its contents.

    b. the dissertation is unsatisfactory. The examining committee will provide written comments, explaining why it is unsatisfactory and suggesting possible improvements.

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

Additional Requirements

Consulting (MS & PhD)

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

Master's students must participate for one semester in statistical consulting activities and doctoral students for three semesters. Those students earning both MS and PhD degrees in our department will participate for a total of four semesters.

The consulting requirement is liberally interpreted in two respects. First, comparable specialized activity, such as teaching or work on certain research projects, may be considered the professional equivalent of consulting experience. Second, the amount of time, which must be devoted to consulting in any particular term, is unspecified. In general, graduate assistants may assume that the consulting 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 consulting projects.

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 a 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 Department of Statistics at Virginia Tech (evaluated by the student's program advisor); the seminar will be scheduled in the outreach series. The written report must be approved by the advisor prior to presentation of either seminar. The final grade will be a combination of these two evaluations determined by the student's program advisor.

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 34 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, insuring 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 received 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 advisor 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 advisor 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 (QCA) of at least 3.0 for all courses on the program of study and for all courses taken as a graduate student. Any course on the program of study (and/or any course in statistics) must be repeated if a grade below "C" is earned. Students whose overall QCA falls below 3.0 are not eligible for assistantships.

Time Limits (MS & PhD)

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 VPI&SU.

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, three graduate student awards are offer annually: one in academics, one in teaching, and one in service.

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 award listed below includes 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 **Boyd Harshbarger Award** is given annually for superior academic performance by a first year student. The award is named after our department's founder and first department head. 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

Ph.D. Traditional Track

(1) To give the graduates of this program a widely based knowledge of the methods and theory of statistical science, preparing them to enter an applications-based field of their choosing.
(2) To train academic and nonacademic research statisticians who can not only manage and interpret data from a wide variety of sources, but who can develop new methodologies for novel situations.

Program:

The program starts with the current Statistics M.S. curriculum, which is designed to be finished in eighteen months. PhD students in the Traditional Track are required to take:

Fall STAT 6105, Measure and Probability, 3 hours

Spring STAT 6114, Advanced Topics in Statistical Inference, 3 hours

and two more 6000-level statistics courses in addition to STAT 6105 and 6114. These courses may be chosen from the entire list of 6000-level courses offered by the department, and in conjunction with the student's advisory committee. They are required to complete three sections of Special Topics in Statistics (Stat 5984, 1 hour each). Other requirements are the general departmental requirements for a PhD as described elsewhere in this document, and those imposed by the graduate school.

The traditional track is designed to provide maximum flexibility for students wishing to design a particular course of study that does not fit within the framework of the three specialized tracks. As such, it is very important that the student, in conjunction with his/her advisor and the advisory committee, plan carefully a program of study that provides a coherent set of courses supporting his/her career goals and objectives. By deliberating carefully and choosing wisely you will construct a program that will serve you well for your entire professional career.

Ph.D. Track in Bioinformatics

Program Goals:

(1) To give the graduates of this program an adequate knowledge of statistical, computational and experimental methods, techniques and tools for the design and analysis of biological 'omics' (genomics, proteomics, metabolomics, phenomics) experiments, so that they may have successful academic careers in research institutions and universities or successful technical careers in industry.

(2) To train academic and industrial research statisticians who can manage and interpret biological 'omics' data and who can work with scientists from various disciplines related to Genetics, Bioinformatics and Biology.

Program Requirements:

The program starts with the ***current Statistics M.S. curriculum***, which is designed to be finished in eighteen months. In addition, five courses are currently required in the ***Bioinformatics track in Statistics core curriculum***: STAT 5504 Multivariate Statistical Methods, STAT 5444 Bayesian Statistics, STAT 5564 Statistical Genetics, GBCB 5314 Paradigms for Bioinformatics, and CSES 5844 Plant Genomics. In the case where not all of these courses can be offered, the Director of Graduate Programs in Statistics can grant dispensation for substitute courses. In the first year, students in this track are required to take all the M.S. core courses in statistics plus two more bioinformatics core courses (these can be taken later for students coming into the program with a M.S. degree obtained elsewhere). All the students in this track must pass the Statistics Qualifying Examinations at the Ph.D. level after the first year.

Besides the Statistics M.S. core curriculum and *Bioinformatics track in Statistics* core curriculum, the University requires all graduate students in the Bioinformatics track in Statistics to take ***two core curriculum courses plus the seminar in the University-wide Ph.D. program in Genetics, Bioinformatics and Computational Biology (GBCB)***:

(1) Two courses , one from each of two of the three secondary tracks* , for a statistics student (2×3c)
(2) GBCB 5004 Seminar in Genetics, Bioinformatics and Computational Biology (1c)

* The secondary tracks for a Statistics student are Computer Science (CS), Mathematics (Math), and Life Sciences (LS). A student who has fulfilled the *Bioinformatics track in Statistics* core curriculum has also fulfilled the GBCB LS course requirement but still needs to fulfill the GBCB CS (or Math) requirement. This can be accomplished by choosing from the following courses with consent from the advisor:

- CS 5114: Theory of Algorithms
- CS 5124: Algorithms in Bioinformatics
- CS/Math 5485: Numerical Analysis and Software
- CS/Math 5486: Numerical Analysis and Software
- CS 5614: Database Management Systems
- CS 5804: Introduction to Artificial Intelligence
- CS 6104: Algorithms in Structural Bioinformatics
- CS 6104: Systems Biology and Drug Discovery
- CS 6604: Data Mining
- Math 5515/16: Continuous / Discrete Mathematical Models

A different, suitable course can be chosen with consent from the advisor.

Lastly, students in the *Bioinformatics track in Statistics* are required to take ***four 6000-level courses in Statistics***. STAT 6114 (Advanced Inference) is required. The remaining three courses can currently be chosen, with consent from the advisor, from the following courses: STAT 6424 (Multivariate Statistical Analysis), STAT 6514 (Advanced Topics in Regression), STAT 6494 (Advanced Bayesian Statistics), STAT 6504 (Experimental Design

and Analysis), STAT 6404 (Advanced Topics in Nonparametric Statistics), STAT 6414 (Time Series Analysis II), STAT 6105 (Measure and Probability).

Students in the Bioinformatics Track will be required to take only one section of Stat 5984 (Special Topics in Statistics) instead of two.

The ***proposal defense***, based on the dissertation topic, is required. The ***final examination*** toward the doctorate is the oral defense of the dissertation. The ***topic(s) of the dissertation*** must be related to the Bioinformatics track and must be approved by the dissertation committee members. The committee should consist of five faculty members including at least one member from outside of the Statistics Department with expertise in Genetics, Bioinformatics and Computational Biology.

Duration of the program: Students should finish all of the coursework in four years, and they should expect to complete their research project and dissertation in the fifth year.

Example of a Bioinformatics Statistics Ph.D Curriculum

First Year

Fall			Spring		
STAT5034	Inference Fundamentals	3	STAT5024	Stat. Consulting	2
STAT5044	Reg. and ANOVA	3	STAT5114	Stat. Inference	3
STAT5104	Prob. and Dist. Theory	3	STAT5124	Lin. Model Theory	3
STAT5014	Intro. to Stat. Prog.	1	STAT5204	Exp. Design & Analysis	3
GBCB5314	Paradigms for Bioinformatics	3			

Qualifying Exams to be taken after the Spring semester.

Second Year

Fall			Spring			Summer	
STAT5504	Multivariate Statistics	3	STAT6114	Adv. Inference	3	Dissertation research proposal preparation	
STAT5444	Bayesian Statistics	3	STAT5564	Statistical Genetics	3		
STAT5514	Regression. Analysis	3	STAT6424	Advanced Multivariate	3		
CSES/GBCB 5844	Plant Genomics	3	STAT6494 or CS/Math/LS core	Advanced Bayesian	3		

Third Year

Fall			Spring			Summer	
CS/Math/LS core or Stat/CS/Math/ GBCB elective		3	STAT6514	Adv. Topics in Reg.	3	STAT7994	Research & Dissertation
STAT5984	Special Topics	1	STAT6494 or CS/Math/LS core or Stat/CS/Math/ GBCB elective	Advanced Bayesian	3		
GBCB 5004	Seminar	1					
STAT 7994	Research & Dissertation		STAT 7994	Research & Dissertation			

Fourth Year

Fall			Spring			Summer	
STAT7994	Research & Dissertation		STAT7994	Research & Dissertation		STAT7994	Research & Dissertation

Ph.D. Track in Industrial Statistics

Goals:

(1) To give the graduates of this program an appropriate combination of statistical and industrial systems backgrounds so that they may have successful technical careers in industry or successful academic careers doing research in industrial statistics

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

Program:

The program starts with the current M.S. curriculum, which is designed to be finished in eighteen months. The first year is exactly the same, including the Qualifying Examination. Students must pass the Qualifying Examination at the Ph.D. level after the first year.

The program will require STAT 5354 (Structured Process Improvement) in the fall of the second year and will restrict the possible electives to either STAT 5474 (Statistical Quality Control) or STAT 5574 (Response Surface Methodology I). The purpose of the problem-solving course is to prepare students to lead improvement projects in industry.

Upon completion of the M.S., or possibly later depending on the year of entry into the program, students are strongly encouraged to enter an extended internship program with one of the department's corporate partners.

Students are required to take the following four 6000-level courses in statistics: STAT 6114 (advanced Inference), STAT 6504 (Advanced Design), STAT 6574 (Advanced RSM), and STAT 6494 (Advanced Quality Control). The two required written Ph.D. preliminary exams could both be on combinations of courses in Group C: Methods and Applications. As an additional requirement, students are required to take three 5000-level courses in the Department of Industrial & Systems Engineering. Possible courses are listed at the end of this proposal.

Students should finish all coursework in the fourth year. The topic of the dissertation must be determined by the student's committee to be in the area of industrial statistics. Exceptional students should finish their Ph.D. by the end of the fourth year. More typically, they will finish sometime in the fifth year.

Industrial Statistics Ph.D. Curriculum (Entry in Odd Year)

First Year

Fall (Odd)			Spring (Even)		Summer	
STAT 5034	Inference Fundamentals		STAT 5114	Stat. Inference		STAT Elective
STAT 5044	Reg. and ANOVA		STAT 5124	Linear Models Theory	STAT 5984	Special Topics (1)
STAT 5014	Intro. Stat. Prog. Pack.		STAT 5204	Exp. Des. & Analysis I		
STAT 5104	Prob. & Dist. Theory		STAT 5024	Seminar In Stat. Consulting		

Second Year

Fall (Even)			Spring-Summer	
STAT 5514	Regression Analysis		STAT 5904	Industrial Internship (6 hrs.)
STAT 5354	Structured Process Improvement			
STAT 5474 or STAT 5574	Stat. Q. C. or Response Surface I			
STAT 5984	Special Topics (1)			

Third Year

Fall (Odd)			Spring (Even)			Summer
STAT 5474 or STAT 5574	Stat. Q. C. or Response Surface I		STAT 6494	Advanced Q.C.		STAT Elective
ISE	ISE Elective		STAT 6114	Advanced Inference		
STAT 6504	Advanced Design		STAT 6574	Advanced RSM		
			STAT 5984	Special Topics (1)		

Fourth Year

Fall (Even)			Spring (Odd)			Summer
	ISE Elective			ISE Elective		STAT 7994
STAT 7994	Research & Dissertation		STAT 7994	Research & Dissertation		

Industrial Statistics Ph.D. Curriculum (Entry in Even Year)

First Year

Fall (Even)			Spring (Odd)			Summer
STAT 5034	Inference Fundamentals		STAT 5114	Stat. Inference		STAT or ISE Elective
STAT 5044	Reg. and ANOVA		STAT 5124	Linear Models Theory	STAT 5984	Special Topics (1)
STAT 5014	Intro. Stat. Prog. Pack.		STAT 5204	Exp. Des. & Analysis I		
STAT 5104	Prob. & Dist. Theory		STAT 5024	Seminar In Stat. Consulting		

Second Year

Fall (Odd)			Spring (Even)			Summer
STAT 5514	Regression Analysis		STAT	Advanced Q.C. or Advanced RSM		STAT Elective
STAT 5354	Structured Process Improvement		STAT 6114	Advanced Inference		
STAT 5474 or STAT 5574	Stat. Q. C. or Response Surface I		STAT 5984	Special Topics (1)		
STAT	Special Topics (1)		ISE	Elective		

Third Year

Fall (Even)			Spring (Odd) and Summer			
STAT	Stat. Q. C. or Response Surface I		STAT 5904	Industrial Internship		
ISE	Elective					
STAT 6504	Advanced Design					

Fourth Year

Fall (Odd)			Spring (Even)			Summer
	ISE Elective		STAT	Advanced Q. C. or RSM		STAT 7994
STAT 7994	Research & Dissertation		STAT 7994	Research & Dissertation		

New Courses:

5354 Structured Process Improvement

5904 Projects and Reports (Industrial Internship)

Students will work for eight months at a Corporate Partner under the supervision of an industrial mentor. Ideally, the student will become certified as a Black Belt under the company's certification program. Students must submit a written report of their project to his/her supervisor and to his/her advisory committee. The student must also make formal oral presentations at both the company and at Virginia Tech. The advisory committee and industrial mentor will determine the grade jointly.

Graduate Courses in Industrial & Systems Engineering Department:

5015-5016 Management of Change, Innovation, and Performance in Organizational Systems

5124 Management of Quality & Reliability

5134 Management Information Systems

5204 Manufacturing Systems Engineering

5405-5406 Optimization

5424 Simulation I

5434 Economic Evaluation of Industrial Projects

Ph.D. Track in Environmental Statistics

Goals:

(1) To give the graduates of this program 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:

Masters degree in Statistics with an Environmental Statistics Option: A Masters degree in statistics with an environmental statistics option will provide the student with strong program in statistics with an emphasis on special methods used in environmental analysis. The basis of this will be core set of courses required for Masters degree in Statistics plus addition courses on environmental statistics. The degree will require 30 semester hours, including at least 25 semester hours of work within the department. Students should expect to complete the master's degree in 18 months of graduate study.

The program will require a course on "Environmental Problem-Solving Using Statistics" (tentative title) in the fall of the second year and will restrict the possible electives to Bayesian Statistics, Bioassay, Spatial Statistics, Computation Statistics or Multivariate Methods. The purpose of the problem-solving course is to prepare students to lead improvement projects in environmental sciences.

Ph.D. degree in Statistics with an Environmental Statistics emphasis: For the Ph.D. program, each student must complete a minimum of 90 credit hours of graduate study (beyond the baccalaureate) of which approximately 30 will be research and dissertation credits, including a master's thesis if appropriate. This will usually require four to five years for a student with no previous graduate training in statistics. In addition to the required core courses for the Masters Degree, the core courses for the Ph.D. program are Advanced Topics in Statistical Inference. Also, the student will be expected to complete advanced course work in appropriate areas of concentration, to be chosen by the student in conjunction with his other advisory committee.

Students are required to take four 6000-level courses in statistics. Only STAT 6114 (advanced Inference) is required. We anticipate students will take 6000 level classes in Multivariate Methods, Bayesian Statistics or Regression. Other combinations may be substituted at the discretion of the student's committee. As an additional requirement, students are required to take three 5000-level courses in the electives from partnering departments. Possible courses are listed below.

Students should finish all coursework in the fourth year. Exceptional students should finish their Ph.D. by the end of the fourth year. More typically, they will finish sometime in the fifth year.

Environmental Statistics Ph.D. Curriculum (Entry in Odd Year)

First Year

Fall (Odd)			Spring (Even)			Summer(even)
STAT 5034	Inference Fundamentals		STAT 5114	Stat. Inference		
STAT 5044	Reg. and ANOVA		STAT 5124	Linear Models Theory		STAT 5984 Special Topics (1)
STAT 5014	Intro. Stat. Prog. Pack.		STAT 5204	Exp. Des. & Analysis I		
STAT 5104	Prob. & Dist. Theory		STAT 5024A	Seminar in Environmental Statistics		

Second Year

Fall (Even)			Spring-Summer (odd)	
STAT 5514	Regression Analysis		STAT	Elective
STAT 5XXX	"Problem Solving Course"		STAT 6514	Advanced Regression
STAT 5504	Multivariate Methods		STAT 6424	Advanced Multivariate
STAT 5904	Special Topics (1)		STAT 5594	Bioassay (summer)

Third Year

Fall (Odd)			Spring (Even)			Summer (even)
STAT 5444	Bayesian I		STAT 6444	Bayesian II		STAT Elective
	Elective		STAT 6114	Advanced Inference		
STAT	Elective		STAT	Elective		
			STAT 5984	Special Topics (1)		

Fourth Year

Fall (Even)			Spring (Odd)			Summer
	Elective			Elective		STAT 7994
STAT 7994	Research & Dissertation		STAT 7994	Research & Dissertation		

Environmental Statistics Ph.D. Curriculum (Entry in Even Year)

First Year

Fall (Even)			Spring (Odd)			Summer (odd)
STAT 5034	Inference Fundamentals		STAT 5114	Stat. Inference		Stat 5594 Bioassay
STAT 5044	Reg. and ANOVA		STAT 5124	Linear Models Theory		STAT 5984 Special Topics (1)
STAT 5014	Intro. Stat. Prog. Pack.		STAT 5204	Exp. Des. & Analysis I		
STAT 5104	Prob. & Dist. Theory		STAT 5024	Seminar In Stat. Consulting		

Second Year

Fall (Odd)			Spring (Even)			Summer (even)
	elective		STAT	elective		STAT or ISE Elective
STAT 5XXX	Problem Solving Course		STAT 6114	Advanced Inference		
	Elective		STAT 5984	Special Topics (1)		
STAT 5984	Special Topics (1)			Elective		

Third Year

Fall (Even)			Spring (Odd)			Summer (odd)
STAT 5504	Multivariate		STAT 6424	Advanced Multivariate		
STAT 5514	Regression Analysis		STAT 6514	Advanced Regression		
STAT 5444	Bayesian		STAT 6444	Advanced Bayesian		

Fourth Year

Fall (Odd)			Spring (Even)			Summer (even)
	Elective		STAT	Elective		STAT 7994
STAT 7994	Research & Dissertation		STAT 7994	Research & Dissertation		

New Courses:

5XXX "Problem-Solving Using Statistics" (The intention of the course is to look at data that arises in environmental studies. The course will be based on group projects. Specialized statistical methods will be discussed to deal with problems arising in the analysis of environmental data such as censoring, zero-heavy data, biological-environmental relationships and missing values).

5YYY Environmental Internship

Students may opt to work for eight months at an Environmental Partner under the supervision of an environmental mentor. Students must submit a written report of their project to his/her supervisor and to his/her advisory committee. The student must also make formal oral presentations at both the company and at Virginia Tech. The advisory committee and environmental mentor will determine the grade jointly. This elective will substitute for electives in other departments.

Graduate Courses in Environmental Studies from different departments:

Courses that may be used to satisfy requirements

Biology

5024: Population & Community Ecology

5034: Ecosystem Dynamics

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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

Biological Systems Engineering

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 Modelling 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 Informationsystems

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