Statistics and Actuarial Science

Chair

• Joseph B. Lang

Undergraduate majors: statistics (B.S.); actuarial science (B.S.)
Undergraduate minor: statistics
Graduate degrees: M.S. in actuarial science; M.S. in statistics; Ph.D. in statistics
Faculty: http://www.stat.uiowa.edu/people
Web site: http://www.stat.uiowa.edu

The Department of Statistics and Actuarial Science offers undergraduate majors, an undergraduate minor, and graduate degree programs. The department partners with the Departments of Computer Science and Mathematics to offer the undergraduate Certificate in Large Data Analysis and with the Departments of Geographical and Sustainability Sciences, Political Science, and Sociology to offer the Certificate in Social Science Analytics. It offers courses that undergraduate students in all majors may use to satisfy the General Education Program Quantitative or Formal Reasoning requirement.

Probability and statistics is an important scientific discipline essential to all fields of study that rely on information obtained from data. In a world bombarded with numerical information, informed decisions rely on the ability to separate fact from fiction by applying valid statistical analyses and visualizations. Statisticians can provide crucial guidance in determining what information is reliable and which predictions may be trusted. They often help search for clues to the solution of a scientific mystery and sometimes keep investigators from being misled by false impressions.

The work of a statistician may range from the theoretical (developing new methodologies and statistical theory) to the applied (working with scientists and decision makers to collect, analyze, and interpret data). Regardless of the areas in which they work, statisticians need strong mathematical, computational, and communication skills. Because uncertainty and data arise in many settings, statisticians have the opportunity to work on a variety of projects in industry, education, government, and research. Thousands of statisticians work in medicine, law, agriculture, public policy, marketing, manufacturing, engineering, and other fields in the social and natural sciences. The diversity of applications is an exciting aspect of the field and is one reason why the demand for well-trained statisticians continues to be strong.

An actuary is a business executive, professionally trained in the mathematical sciences. Actuaries specialize in the evaluation of financial risk—most often in the context of life, health, and casualty insurance, where they design, analyze, and refine varied programs to meet the insurance needs of society. Many actuaries are employed by insurance companies, where they have responsibilities for all phases of the development and maintenance of their company's products. They have considerable influence on the financial soundness of their company through work in pricing insurance policies and in compiling data for financial statements.

Many actuaries are employed as consultants. Their actuarial services are used by smaller insurance companies and by individual employers who need actuarial guidance in establishing insurance and retirement programs for their employees. A growing number of actuaries work in the areas of asset/liability management and risk management. Some of these actuaries are employed by investment and consulting firms; others are employed by insurance companies.

Actuaries have been called financial architects and social mathematicians, because their combined analytical and business skills help solve a growing variety of financial and social problems. The actuarial profession is a demanding yet rewarding career choice.

Graduates of the Department of Statistics and Actuarial Science have enjoyed great success in finding employment at all levels of the profession's fields.

Undergraduate Programs of Study

• Major in statistics (Bachelor of Science)
• Major in actuarial science (Bachelor of Science)
• Minor in statistics

Bachelor of Science: Statistics

The Bachelor of Science with a major in statistics requires a minimum of 120 s.h., including at least 47 s.h. of work for the major. Students must maintain a g.p.a. of at least 2.00 in all courses for the major and in all UI courses for the major. They also must complete the College of Liberal Arts and Sciences General Education Program.

Students complete 10 core courses that provide essential instruction in statistical methods, applications, and theory. In addition, they concentrate on an area of interest by completing four courses in one of the major's three emphasis tracks: statistics in business, industry, government, and research; statistical computing and data science; or mathematical statistics.

The major in statistics requires the following course work.

CORE COURSES

All students complete the following 10 core courses.

Computer science:

CS:1210 Computer Science I: Fundamentals 4 s.h.
Mathematics—all of these:

MATH:1850 & MATH:1860 Calculus I-II 8 s.h.
MATH:2700 Introduction to Linear Algebra 4 s.h.
MATH:2850 Calculus III 4 s.h.

Statistics—all of these:

STAT:2010 Statistical Methods and Computing 3 s.h.
STAT:3100-STAT:3101 Introduction to Mathematical Statistics I-II 6 s.h.
STAT:3200 Applied Linear Regression 3 s.h.
STAT:3210 Experimental Design and Analysis 3 s.h.

The department recommends that well-prepared students who elect the mathematical statistics track take STAT:4100 Mathematical Statistics I and STAT:4101 Mathematical Statistics II in place of STAT:3100.

**Emphasis Tracks**

Students choose one of the following tracks and must complete at least four courses in that track.

**STATISTICS IN BUSINESS, INDUSTRY, GOVERNMENT, AND RESEARCH TRACK**

The statistics in business, industry, government, and research track emphasizes statistical applications and data analysis. It is appropriate for students interested in careers as applied statisticians.

This course:

STAT:5810 Research Data Management 3 s.h.

Three of these:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT:3620 Quality Control</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:4520 Bayesian Statistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:5400 Computing in Statistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6220 Statistical Consulting</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6510 Applied Generalized Regression</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6530 Environmental and Spatial Statistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6540 Applied Multivariate Analysis</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6560 Applied Time Series Analysis</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>BIOS:5730 Biostatistical Methods in Categorical Data</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>BIOS:6310/STAT:6550 Introductory Longitudinal Data Analysis</td>
<td>3 s.h.</td>
</tr>
</tbody>
</table>

**STATISTICS COMPUTING AND DATA SCIENCE TRACK**

The statistical computing and data science track emphasizes statistical applications and requires additional course work in computing. It prepares students for statistical work that requires computing expertise for data management, analysis, and reporting.

Both of these:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT:5810 Research Data Management</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>CS:2230 Computer Science II: Data Structures</td>
<td>4 s.h.</td>
</tr>
</tbody>
</table>

Two of these:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT:4520 Bayesian Statistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:5400 Computing in Statistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6220 Statistical Consulting</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6510 Applied Generalized Regression</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6530 Environmental and Spatial Statistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6540 Applied Multivariate Analysis</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6560 Applied Time Series Analysis</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>BIOS:6310/STAT:6550 Introductory Longitudinal Data Analysis</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>CS:3700 Elementary Numerical Analysis</td>
<td>3 s.h.</td>
</tr>
</tbody>
</table>

**MATHEMATICAL STATISTICS TRACK**

The mathematical statistics track provides a solid foundation in statistical theory and applications. It requires additional course work in mathematics and is good preparation for graduate study in statistics.

This course:

MATH:3770 Fundamental Properties of Spaces and Functions I 4 s.h.

Three of these:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT:4100-STAT:4101 Mathematical Statistics I-II</td>
<td>6 s.h.</td>
</tr>
<tr>
<td>STAT:4520 Bayesian Statistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6220 Statistical Consulting</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6300-STAT:6301 Probability and Stochastic Processes I-II</td>
<td>6 s.h.</td>
</tr>
<tr>
<td>STAT:6510 Applied Generalized Regression</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6530 Environmental and Spatial Statistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6540 Applied Multivariate Analysis</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:6560 Applied Time Series Analysis</td>
<td>3 s.h.</td>
</tr>
</tbody>
</table>

Students who use STAT:4100 Mathematical Statistics I and STAT:4101 Mathematical Statistics II to satisfy the core requirements may not use those courses to satisfy the track requirement.

**Bachelor of Science: Actuarial Science**

The Bachelor of Science with a major in actuarial science requires a minimum of 120 s.h., including 59 s.h. of work for the major. Students must maintain a g.p.a. of at least 2.00 in all courses for the major and in all UI courses for the major. They also must complete the College of Liberal Arts and Sciences General Education Program.

The program prepares students for careers as actuaries. It also helps them learn material that is included in professional examinations administered by professional organizations such as the Society of Actuaries and the Casualty Actuarial Society.

Students take a variety of actuarial science courses. They prepare for business aspects of the actuarial profession by studying accounting, law, finance, insurance, and economics. They also complete courses that enhance important communication skills, such as writing and speaking, as part of their General Education Program requirements.

**ADMISSION TO THE MAJOR**

Due to the demanding nature of the actuarial science major and the difficulty of the professional examinations, the department maintains a selective admission program for actuarial science. Students must apply and be admitted to the major.

Students interested in becoming actuaries should declare an interest in actuarial science as their major when they enter the University of Iowa. Ordinarily, students apply for admission to the actuarial science major in the fall semester of their sophomore year, after they have taken MATH:3770 Fundamental Properties of Spaces and Functions I or MATH:2850 Calculus III, and STAT:3100 Introduction to Mathematical Statistics I. Students should apply no later than the end of the spring semester of their junior year.

Students admitted to the actuarial science major usually have completed at least 40 s.h. at the University or at
another postsecondary institution, including a three- or four-course calculus sequence, a course in linear algebra, and a calculus-based course in probability and statistics. The admission decision is based on the student's performance in these courses and other courses relevant to success in the major. The student's grades from semester to semester also are considered. ACT or SAT scores are considered in evaluating transfer students. Factors such as work ethic, enthusiasm, and commitment also may be considered. Students who do well in the prerequisite math courses tend to be the most successful in actuarial science.

For application forms and more information about selective admission, contact the Department of Statistics and Actuarial Science.

COURSES REQUIRED FOR THE MAJOR

The major in actuarial science requires the following course work. Permission to substitute course work taken at another institution for required courses at the University of Iowa is decided case by case; students should contact the department.

Computer science:

CS:1210 Computer Science I: Fundamentals 4 s.h.

Economics—both of these:

ECON:1100 Principles of Microeconomics 4 s.h.
ECON:1200 Principles of Macroeconomics 4 s.h.

Mathematics—all of these:

MATH:1850 & MATH:1860 Calculus I-II 8 s.h.
MATH:2700 Introduction to Linear Algebra 4 s.h.
MATH:2850 Calculus III 4 s.h.
MATH:3770 Fundamental Properties of Spaces and Functions I 4 s.h.

Statistics and actuarial science—all of these:

ACTS:3080 Mathematics of Finance I 3 s.h.
ACTS:4130 Quantitative Methods for Actuaries 3 s.h.
ACTS:4180 & ACTS:4280 Life Contingencies I-II 6 s.h.
ACTS:4380 Mathematics of Finance II 3 s.h.
STAT:3100-STAT:3101 Introduction to Mathematical Statistics I-II 6 s.h.
STAT:4100-STAT:4101 Mathematical Statistics I-II 6 s.h.

In exceptional cases, the advisor may grant permission to waive STAT:3100 Introduction to Mathematical Statistics I and/or STAT:3101 Introduction to Mathematical Statistics II.

Students may choose to complete ACTS:6580 Credibility and Survival Analysis and ACTS:6480 Loss Distributions (both courses) instead of ACTS:4380 Mathematics of Finance II, except honors students, who must complete all three courses.

Joint B.S./M.S. in Statistics

The joint Bachelor of Science/Master of Science in statistics is for eligible students who seek to complete both the B.S. and the M.S. at the University of Iowa in five years. Students in the joint program must complete all requirements for each degree. A traditional M.S. in statistics requires completion of 32 s.h. of graduate-level course work. The B.S./M.S. program permits students to count 12 s.h. of credit (four courses) toward the requirements for both degrees. To complete the M.S., an additional 20 s.h. of course work is required. The four courses that count toward both degrees must be taken during the fourth year of undergraduate study, after admission to the joint program, and must satisfy degree requirements of both the B.S. and the M.S. in statistics.

Joint B.S./M.P.H. with Quantitative Methods Subprogram

Bachelor of Science students majoring in statistics who are interested in earning a Master of Public Health degree with quantitative methods (biostatistics) subprogram may apply to the joint B.S./M.P.H. program offered by the College of Liberal Arts and Sciences and the College of Public Health. The program permits students to count 12 s.h. of credit toward the requirements for both degrees, enabling them to begin the study of public health before they complete the bachelor's degree. For information about the public health program, see “Quantitative Methods Subprogram” in the Master of Public Health Program section of the Catalog.

Four-Year Graduation Plan

The following checkpoints list the minimum requirements students must complete by certain semesters in order to stay on the University's Four-Year Graduation Plan. (Courses in the major are those required to complete the major; they may be offered by departments other than the major department.)

Much of the course work in statistics and in actuarial science is sequential, so students must begin requirements for the major as soon as possible. Individual study plans must be made carefully. Students who first enroll for a spring semester must consult their advisor to confirm a four-year plan.

B.S.: Statistics

Courses must be taken in sequence, so students must begin work early.

Before the fifth semester begins: at least four courses in the major, including MATH:1850 Calculus I, MATH:1860 Calculus II, and STAT:2010 Statistical Methods and Computing

Before the seventh semester begins: seven or eight courses in the major and at least 90 s.h. earned toward the degree

Before the eighth semester begins: nine or ten courses in the major

During the eighth semester: enrollment in all remaining course work in the major, all remaining General Education courses, and a sufficient number of semester hours to graduate

B.S.: Actuarial Science

Before the third semester begins: MATH:1860 Calculus II and MATH:2700 Introduction to Linear Algebra

Before the fifth semester begins: MATH:2850 Calculus III, MATH:3770 Fundamental Properties of Spaces and Functions I, STAT:3100 Introduction to Mathematical

Before the seventh semester begins: STAT:4101 Mathematical Statistics II, ACTS:4130 Quantitative Methods for Actuaries, ACTS:4180 Life Contingencies I, ACTS:4380 Mathematics of Finance II, and at least 90 s.h. earned toward the degree

Before the eighth semester begins: ACTS:4280 Life Contingencies II

During the eighth semester: enrollment in all remaining course work in the major, all remaining General Education courses, and a sufficient number of semester hours to graduate

Honors in the Major

Students majoring in statistics or in actuarial science have the opportunity to graduate with honors in the major. Departmental honors students must maintain a g.p.a. of at least 3.40 in their major and a cumulative University of Iowa g.p.a. of at least 3.33.

To graduate with honors in the statistics major, students must complete an honors project or a suitable alternative. Statistics honors students should consult with the statistics honors advisor.

To graduate with honors in the actuarial science major, students must complete the following five courses in addition to all courses required for the major.

ACTS:6480 Loss Distributions 3 s.h.
ACTS:6580 Credibility and Survival Analysis 3 s.h.
STAT:4510 Regression, Time Series, and Forecasting (or STAT:3200 and STAT:6560) 3 s.h.
MATH:3600 Introduction to Ordinary Differential Equations 3 s.h.
FIN:3300 Corporate Finance 3 s.h.

Actuarial science honors students may not elect to complete ACTS:6580 Credibility and Survival Analysis and ACTS:6480 Loss Distributions instead of ACTS:4380 Mathematics of Finance II in fulfilling requirements for the actuarial science major. They must complete ACTS:4380 as part of the major, and they must complete ACTS:6580 and ACTS:6480 for honors credit.

In addition to honors in their majors, undergraduate students have a variety of opportunities for honors study and activities through membership in the University of Iowa Honors Program; visit Honors at Iowa to learn about the University’s honors program.

Minor: Statistics

The minor in statistics requires a minimum of 15 s.h. in statistics courses taken at the University of Iowa. At least 12 s.h. must be taken in courses numbered 3000 or above (selected from the lists below). They must maintain a cumulative g.p.a. of at least 2.00 in all courses for the minor and in all UI courses for the minor. Course work in the minor may not be taken pass/nonpass.

The minor requires the following course work.

One of these:
STAT:2010 Statistical Methods and Computing 3 s.h.
STAT:4200 Statistical Methods and Computing 3 s.h.

One of these:
STAT:3200 Applied Linear Regression 3 s.h.
STAT:4510 Regression, Time Series, and Forecasting 3 s.h.

A maximum of one of these:
STAT:3101 Introduction to Mathematical Statistics I 3 s.h.
STAT:3120 Probability and Statistics 4 s.h.
STAT:4100 Mathematical Statistics I 3 s.h.

A maximum of one of these:
STAT:3101 Introduction to Mathematical Statistics II 3 s.h.
STAT:4101 Mathematical Statistics II 3 s.h.

A maximum of three of these:
STAT:3210 Experimental Design and Analysis 3 s.h.
STAT:3620 Quality Control 3 s.h.
STAT:4520 Bayesian Statistics 3 s.h.
STAT:5810 Research Data Management 3 s.h.
STAT:6300 Probability and Stochastic Processes I 3 s.h.
STAT:6510 Applied Generalized Regression 3 s.h.
STAT:6530 Environmental and Spatial Statistics 3 s.h.
STAT:6550 Introductory Longitudinal Data Analysis 3 s.h.
STAT:6560 Applied Time Series Analysis 3 s.h.
BIOS:5730 Biostatistical Methods in Categorical Data 3 s.h.

Related Certificate: Large Data Analysis

The Certificate in Large Data Analysis can be earned in addition to a B.S. degree in statistics. The certificate focuses on handling, processing, and extracting information from large data sets. As computers have become faster and smaller, more information can be gathered and used for a large range of applications, such as for weather forecasting; identifying people and trends utilizing Facebook or other social media; understanding the genome; and searching for disease causes and cures, as well as many other areas of study. The certificate is interdisciplinary, requiring courses from three areas of study—computer science, mathematics, and statistics. Computer science teaches students how to handle large amounts of data and how to implement the algorithms to process them while statistics helps students to understand what can and cannot be legitimately inferred from the data. Mathematics focuses on algorithms and methods for connecting these important areas of data collection.

Related Certificate in Social Science Analytics

The Department of Statistics and Actuarial Science collaborates with the Departments of Geographical and Sustainability Sciences, Political Science, and Sociology to offer the undergraduate program in social science analytics; see Social Science Analytics in the Catalog.
Graduate Programs of Study

• Master of Science in statistics
• Master of Science in actuarial science
• Doctor of Philosophy in statistics

**Master of Science: Statistics**

The Master of Science in statistics requires 32 s.h. of graduate credit. The program prepares students for careers as professional statisticians or for entry into the Ph.D. program. It includes a solid foundation in statistical computing, statistical modeling, experimental design, and mathematical statistics plus electives in statistical methods and/or theory. Students have the opportunity to concentrate on theory or applications or a combination of the two.

In addition to required course work, students must pass the two-part graduate core examination and complete the M.S. creative component. The examination and creative component constitute the M.S. final (comprehensive) examination required by the Graduate College.

M.S. students in statistics must maintain a g.p.a. of at least 3.00 in all work toward the degree and in additional relevant course work. Students must take a computer programming proficiency test during the first semester of study; those who display inadequate programming skills are assigned activities to build their proficiency.

The Master of Science program in statistics requires the following work.

**STATISTICS COURSES**

All of these:

- STAT:5090 ALPHA Seminar 1 s.h.
- STAT:5100-STAT:5101 Statistical Inference I-II 6 s.h.
- STAT:5400 Computing in Statistics 3 s.h.
- STAT:6220 Statistical Consulting 3 s.h.
- STAT:6300 Probability and Stochastic Processes I 3 s.h.
- STAT:6990 Readings in Statistics (two consecutive enrollments) 2 s.h.

At least 7 s.h. from these:

- STAT:4520 Bayesian Statistics 3 s.h.
- STAT:5120 Mathematical Methods for Statistics 3 s.h.
- STAT:6301 Probability and Stochastic Processes II 3 s.h.
- STAT:6510 Applied Generalized Regression 3 s.h.
- STAT:6530 Environmental and Spatial Statistics 3 s.h.
- STAT:6540 Applied Multivariate Analysis 3 s.h.
- STAT:6547 Nonparametric Statistical Methods 3 s.h.
- STAT:6560 Applied Time Series Analysis 3 s.h.
- STAT:6970 Topics in Statistics 3 s.h.
- A Ph.D.-level course numbered 7000 or above, including seminar courses 1-3 s.h.

M.S. students planning to enter the doctoral program may wish to include STAT:5120 Mathematical Methods for Statistics in their course selections, since it is part of the required Ph.D. core.

**MASTER OF SCIENCE FINAL EXAMINATION**


Final examinations are offered the week before classes begin in August and in January. Study guides are available in the department office. Students who do not succeed the first time they take the exam may repeat it once.

Students must complete all requirements and be granted the Master of Science degree within one calendar year of passing the M.S. final examination; those who do not meet this deadline are required to take the exam again.

Students entering the Ph.D. program, who will choose either biostatistics, probability/mathematical statistics, or statistical modeling and computing as their concentration area, and who already have taken the equivalent of the first-year courses, may take the M.S. final examination in statistics before beginning further studies.

**CREATIVE COMPONENT**

Students must also complete a creative component that is related to their application and career interests. Students wishing to qualify for the Ph.D. program are encouraged to write a research-oriented creative component. The creative component entails writing an 8-15 page report on a suitable topic, under an advisor’s supervision (with two consecutive 1 s.h. enrollments in STAT:6990 Readings in Statistics, normally during the fall and spring semesters of the second year). A draft of the paper should be completed by the end of the first enrollment in STAT:6990, and polished by early- to mid-semester in the second enrollment. The paper is then presented orally in a public seminar. A faculty committee, in consultation with the creative component advisor, evaluates the work and the presentation, and assigns a grade of satisfactory or unsatisfactory.

For students wishing to qualify for the Ph.D. program, the creative component represents one piece of the body of work used to determine Ph.D. qualification. The creative component must be satisfactorily completed within one calendar year of passing the M.S. final examination; failure to meet this deadline requires reexamination of the student.

**Master of Science: Actuarial Science**

The Master of Science program in actuarial science requires 36 s.h. of graduate credit. The program prepares students for actuarial careers by emphasizing the theory that underlies risk processes and the application of this theory to practical problems of insurance pricing and management. It also helps them learn material that is included in professional examinations administered by professional organizations such as the Society of Actuaries and the Casualty Actuarial Society.
Students enter the Ph.D. program in one of two tracks:

1. Other languages.
   - Advanced study in a language other than English to learn non-English language skills necessary for reading and communicating with scholars in other fields of knowledge, to acquire the credentials for work in international organizations, and to prepare for future work in foreign countries.
   - Students may take courses in other departments to relate an area of specialization to other fields of knowledge.

   - A student who chooses this area of specialization must complete at least 3 s.h. of graduate credit in mathematics concentration area, or the student is not admitted into the Ph.D. program.
   - A student who chooses this area of specialization must also complete at least 2 s.h. of graduate credit in computer science concentration area, or the student is not admitted into the Ph.D. program.

Students complete the program by passing the Ph.D. final (comprehensive) examination and writing and defending a dissertation. Students usually complete the program three years after earning the M.S. degree.

A program that does not conform to the requirements described below is of high quality may be approved by the department chair.

Ph.D. students in statistics must maintain a g.p.a. of at least 3.00 in all work toward the degree and in additional relevant course work.

Each semester a Ph.D. student in statistics registers for at least 6 s.h., he or she must include at least one 2 s.h. course offered by the department, excluding STAT:6990 Readings in Statistics and STAT:7990 Reading Research.

The Doctor of Philosophy in statistics requires the following work.

**STATISTICS COURSES**

**Biostatistics, Probability/Mathematical Statistics, or Statistical Modeling and Computing Concentration Area**

Students in the biostatistics, probability/mathematical statistics, or statistical modeling and computing concentration area must complete the following core courses from the M.S. in statistics program.

All of these:

- STAT:5090 ALPHA Seminar 1 s.h.
- STAT:5100-STAT:5101 Statistical Inference I-II 6 s.h.
- STAT:5400 Computing in Statistics 3 s.h.
- STAT:6220 Statistical Consulting 3 s.h.
- STAT:6300 Probability and Stochastic Processes I 3 s.h.
- STAT:6990 Readings in Statistics (two consecutive enrollments) 2 s.h.
**Actuarial Science/Financial Mathematics Concentration Area**

Students in the actuarial science/financial mathematics concentration area must complete the following core courses from the M.S. in actuarial science program.

One of these sequences:

- STAT:4100-STAT:4101 Mathematical Statistics I-II
- STAT:5100-STAT:5101 Statistical Inference I-II

(for well-prepared students)

All of these:

- ACTS:3080 Mathematics of Finance I 3 s.h.
- ACTS:4130 Quantitative Methods for Actuaries 3 s.h.
- ACTS:4180 & ACTS:4280 Life Contingencies I-II 6 s.h.
- ACTS:4380 Mathematics of Finance II 3 s.h.
- ACTS:6160 Topics in Actuarial Science arr.
- ACTS:6480 Loss Distributions 3 s.h.
- ACTS:6580 Credibility and Survival Analysis 3 s.h.
- STAT:4510 Regression, Time Series, and Forecasting 3 s.h.

A course approved by the advisor 3 s.h.

**All Concentration Area Courses**

Additional Ph.D. core course work, regardless of concentration area—all of these:

- STAT:5120 Mathematical Methods for Statistics 3 s.h.
- STAT:7100-STAT:7101 Advanced Inference I-II 6 s.h.
- STAT:7200 Linear Models 4 s.h.
- STAT:7300 Foundations of Probability I 3 s.h.
- STAT:7400 Computer Intensive Statistics 3 s.h.
- STAT:7990 Reading Research 18 s.h.
- Seminars, chosen from STAT:7190 or STAT:7290 or STAT:7390 2 s.h.

**CONCENTRATION AREAS**

Students take at least four courses in one of the following concentration areas; at least two of the four courses must be at the Ph.D. level (numbered 5000 or above).

**Statistical Modeling and Computing**

Statistical modeling and computing emphasizes the theory and application of a broad array of statistical models, such as linear, generalized linear, nonlinear, categorical, spatial, correlated response, and nonparametric regression models. This concentration area prepares students to specify and choose appropriate models; fit the models using available statistical software; and make sound statistical conclusions and interpretive statements. It is excellent preparation for students interested in academic, industrial, or government positions that involve data modeling and analysis.

- STAT:6510 Applied Generalized Regression 3 s.h.
- STAT:6530 Environmental and Spatial Statistics 3 s.h.
- STAT:6540 Applied Multivariate Analysis 3 s.h.
- STAT:6560 Applied Time Series Analysis 3 s.h.
- STAT:6970 Topics in Statistics 3 s.h.
- STAT:7510 Analysis of Categorical Data 3 s.h.

- STAT:7520 Bayesian Analysis 3 s.h.
- STAT:7560 Time Series Analysis 3 s.h.

**Probability/Mathematical Statistics**

Probability/mathematical statistics emphasizes a broad, solid foundation in techniques and underpinnings of mathematical statistics. Its focus on breadth and depth is intended to produce well-rounded, knowledgeable scholars. It is excellent preparation for academic positions in mathematical statistics and industrial or government positions that require broadly trained statisticians with a strong understanding of statistical theory.

- STAT:6301 Probability and Stochastic Processes II 3 s.h.
- STAT:7301 Foundations of Probability II 3 s.h.
- STAT:7520 Bayesian Analysis 3 s.h.
- STAT:7560 Time Series Analysis 3 s.h.

**Biostatistics**

Biostatistics emphasizes exposure to various biostatistical methods, such as survival analysis, categorical data analysis, and longitudinal data analysis. It prepares students for consulting and other positions in industry.

- STAT:6530 Environmental and Spatial Statistics 3 s.h.
- STAT:6540 Applied Multivariate Analysis 3 s.h.
- STAT:7510 Analysis of Categorical Data 3 s.h.
- STAT:7570 Survival Data Analysis 3 s.h.
- BIOS:7310 Longitudinal Data Analysis 3 s.h.

**Actuarial Science/Financial Mathematics**

Actuarial science/financial mathematics emphasizes the theory of actuarial science, finance, and risk management. It is excellent preparation for academic positions in universities that offer actuarial science programs and for positions in the insurance, pension, and financial industries. Most students who choose this concentration area are admitted after earning an M.S. in actuarial science at the University of Iowa.

- STAT:6301 Probability and Stochastic Processes II 3 s.h.
- STAT:7560 Time Series Analysis 3 s.h.
- FIN:7130 Finance Theory II 3 s.h.

**PH.D. FINAL EXAMINATION**

Students typically take the Ph.D. final (comprehensive) examination at the beginning of the third year of graduate study, during the week before fall classes begin. Students who do not succeed the first time they take the exam may repeat it once.

The comprehensive examination consists of a written core examination and an oral examination in two of the following four areas:

- statistical inference (topics in STAT:5100 Statistical Inference I, STAT:5101 Statistical Inference II, and STAT:7100 Advanced Inference I);
- linear models (topics in STAT:7200 Linear Models);
courses

Undergraduate Duplication and Regression Policy

Undergraduate students should be aware of the duplication and regression policies concerning the following courses.

Students may earn credit for only two of these:

- STAT:1010 Statistics and Society
- STAT:1030 Statistics for Business, or
- STAT:2010 Statistical Methods and Computing

Credit for STAT:1010 Statistics and Society may be earned only if the course is taken before any of these:

- STAT:1020 Elementary Statistics and Inference (same as PSQF:1020)
- STAT:1030 Statistics for Business, or
- STAT:2010 Statistical Methods and Computing

Students may receive credit for only one course from each of these pairs:

- STAT:2010 Statistical Methods and Computing and
- STAT:4200 Statistical Methods and Computing
- STAT:3100 Introduction to Mathematical Statistics I and
- STAT:3120 Probability and Statistics, and
- STAT:3510 Biostatistics and STAT:4143 Introduction to Statistical Methods

Students may not take STAT:3101 Introduction to Mathematical Statistics II and STAT:4101 Mathematical Statistics II at the same time and get credit for both (nor go back to STAT:3101 Introduction to Mathematical Statistics II after taking STAT:4101 Mathematical Statistics II).

Lower-Level Undergraduate

Actuarial Science

ACTS:1001 Introductory Seminar on Actuarial Science 1 s.h.

Introduction to actuarial science; U.S. actuarial organizations and actuarial qualification process; program requirements and tips for academic success; career center, actuarial club, and internships; actuarial career; ethics; communication; introduction to actuarial computing. Requirements: actuarial science interest major and first-year standing.

Statistics

STAT:1000 First-Year Seminar 1 s.h.

Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.

STAT:1010 Statistics and Society 3 s.h.

Statistical ideas and their relevance to public policy, business, and the social, health, and physical sciences; focus on critical approach to statistical evidence. Requirements: one year of high school algebra or MATH:0100. GE: Quantitative or Formal Reasoning.
STAT:1020 Elementary Statistics and Inference
Graphing techniques for presenting data, descriptive statistics, correlation, regression, prediction; logic of statistical inference, elementary probability models, estimation and tests of significance. Requirements: one year of high school algebra or MATH:0100. GE: Quantitative or Formal Reasoning. Same as PSQF:1020.

STAT:1030 Statistics for Business
Descriptive statistics, graphical presentation, elementary probability, estimation and testing, regression, correlation; statistical computer packages. Prerequisites: MATH:1005. GE: Quantitative or Formal Reasoning.

STAT:2010 Statistical Methods and Computing
Methods of data description and analysis using SAS; descriptive statistics, graphical presentation, estimation, hypothesis testing, sample size, power; emphasis on learning statistical methods and concepts through hands-on experience with real data. Prerequisites: MATH:1005. Recommendations: undergraduate standing. GE: Quantitative or Formal Reasoning.

STAT:2020 Probability and Statistics for the Engineering and Physical Sciences
Probability, random variables, important discrete and continuous distributions, joint distributions, transformations of random variables, descriptive statistics, point and interval estimation, tests of hypotheses, regression. Prerequisites: MATH:1560.

Upper-Level Undergraduate and Graduate

Actuarial Science

ACTS:3080 Mathematics of Finance I
Mathematics of compound interest; annuities certain, amortization schedules, yield rates, sinking funds, bonds; introduction to financial derivatives. Offered fall and spring semesters. Prerequisites: STAT:3100. Requirements: grade of B- or higher in STAT:3100 or graduate standing.

ACTS:3085 Introduction to Mathematics of Finance
Mathematics of compound interest, including annuities certain, amortization schedules, yield rates, sinking funds, bonds, introduction to financial derivatives. Offered spring semesters. Prerequisites: STAT:3100. Requirements: grade of B- or higher in STAT:3100.

ACTS:3110 Actuarial Exam P Preparation
Preparation for the Society of Actuaries exam P.

ACTS:3210 Actuarial Exam FM Preparation
Preparation for the Society of Actuaries exam FM. Corequisites: ACTS:3080 or ACTS:3085, if not taken as a prerequisite.

ACTS:4110 Actuarial Exam MLC Preparation

ACTS:4130 Quantitative Methods for Actuaries
Survival distributions, life tables, and mathematics of derivatives. Offered fall and spring semesters. Corequisites: (ACTS:3080 or ACTS:3085) and (STAT:4100 or STAT:5100). Requirements: multivariate calculus and linear algebra.

ACTS:4180 Life Contingencies I
Life insurance, life annuities, benefit premiums and reserves. Offered spring semesters. Prerequisites: ACTS:4130 and (ACTS:3080 or ACTS:3085) and (STAT:4100 or STAT:5100). Requirements: grade of C+ or higher in ACTS:4130, and grade of C+ or higher in ACTS:3080 or ACTS:3085.

ACTS:4280 Life Contingencies II
Continuation of ACTS:4180; net and gross premium reserves, multistate models, universal life insurance, interest rate risk. Offered fall semesters. Prerequisites: ACTS:4180. Requirements: grade of C+ or higher in ACTS:4180.

ACTS:4380 Mathematics of Finance II
Derivatives markets, options on stocks and interest rates, financial applications. Offered spring semesters. Prerequisites: ACTS:4130 and (ACTS:3080 or ACTS:3085) and (STAT:4100 or STAT:5100). Requirements: grade of C+ or higher in ACTS:4130, and grade of C+ or higher in ACTS:3080 or ACTS:3085.

Statistics

STAT:3100 Introduction to Mathematical Statistics I
Descriptive statistics, probability, discrete and continuous distributions, sampling, sampling distributions. Prerequisites: MATH:1560 or MATH:1860.

STAT:3101 Introduction to Mathematical Statistics II
Estimation, testing statistical hypotheses, linear models, multivariate distributions, nonparametric methods. Prerequisites: STAT:3100.

STAT:3120 Probability and Statistics
Models, discrete and continuous random variables and their distributions, estimation of parameters, testing statistical hypotheses. Prerequisites: MATH:1560 or MATH:1860.

STAT:3200 Applied Linear Regression
Regression analysis with focus on applications; model formulation, checking, selection; interpretation and presentation of analysis results; simple and multiple linear regression; logistic regression; ANOVA; hands-on data analysis with computer software. Prerequisites: STAT:2010 or STAT:2020. Same as IE:3760.

STAT:3210 Experimental Design and Analysis
3 s.h.
Single- and multifactor experiments; analysis of variance; multiple comparisons; contrasts; diagnostics; fixed, random, and mixed effects models; designs with blocking and/or nesting; two-level factorials and fractions thereof; use of statistical computing packages. Prerequisites: STAT:3200.

**STAT:3510 Biostatistics** 3 s.h.
Statistical concepts and methods for the biological sciences; descriptive statistics, elementary probability, sampling distributions, confidence intervals, parametric and nonparametric methods, one-way ANOVA, correlation and regression, categorical data. Prerequisites: MATH:0100.

**STAT:3620 Quality Control** 3 s.h.
Basic techniques of statistical quality control; application of control charts for process control variables; design of inspection plans and industrial experimentation; modern management aspects of quality assurance systems. Offered fall semesters. Prerequisites: STAT:2020. Same as IE:3600, CEE:3142.

**STAT:4100 Mathematical Statistics I** 3 s.h.
Probability, conditional probability, random variables, distribution and density functions, joint and conditional distributions, various families of discrete and continuous distributions, mgf technique for sums, convergence in distribution, convergence in probability, central limit theorem. Prerequisites: MATH:2700 and MATH:2850.

**STAT:4101 Mathematical Statistics II** 3 s.h.
Transformations, order statistics, point estimation, sufficient statistics, Rao-Blackwell Theorem, delta method, confidence intervals, likelihood ratio tests, applications. Prerequisites: STAT:4100.

**STAT:4143 Introduction to Statistical Methods** 3 s.h.
Analysis, interpretation of research data; descriptive statistics; introduction to probability, sampling theory, statistical inference (binomial, normal distribution, t-distribution models); linear correlation, regression. Same as PSQF:4143.

**STAT:4200 Statistical Methods and Computing** 3 s.h.
Methods of data description and analysis using SAS; descriptive statistics, graphical presentation, estimation, hypothesis testing, sample size, power; emphasis on learning statistical methods and concepts through hands-on experience with real data. Prerequisites: MATH:1005. Recommendations: graduate standing in non-statistics or less quantitative major.

**STAT:4510 Regression, Time Series, and Forecasting** 3 s.h.
Regression analysis, forecasting, time series methods; use of statistical computing packages. Prerequisites: STAT:4101 or STAT:5101. Requirements: grade of C+ or higher in STAT:4101 or STAT:5101.

**STAT:4520 Bayesian Statistics** 3 s.h.
Bayesian statistical analysis, with focus on applications; Bayesian and frequentist methods compared; Bayesian model specification, choice of priors, computational methods; hands-on Bayesian data analysis using appropriate software; interpretation and presentation of analysis results. Prerequisites: STAT:3200 and (STAT:3100 and STAT:3101) or STAT:3120 or (STAT:4100 and STAT:4101). Same as PSQF:4520.

**STAT:4740 Large Data Analysis** 3 s.h.
Current areas that deal with problem of Big Data; techniques from computer science, mathematics, statistics; high performance and parallel computing, matrix techniques, cluster analysis, visualization; variety of applications including Google PageRank, seismology, Netflix-type problems, weather forecasting; fusion of data with simulation; projects. Prerequisites: CS:1210 and MATH:2700 and (STAT:2010 or STAT:2020). Same as CS:4740, MATH:4740.

**Graduate**

**Actuarial Science**

**ACTS:6160 Topics in Actuarial Science** arr.
Prerequisites: ACTS:4180 and ACTS:4380. Requirements: grades of C+ or higher in ACTS:4180 and ACTS:4380.

**ACTS:6480 Loss Distributions** 3 s.h.
Severity, frequency, and aggregate models and their modifications; risk measures; construction of empirical models. Offered spring semesters. Prerequisites: STAT:4101 or STAT:5101. Corequisites: ACTS:6580. Requirements: grade of C+ or higher in STAT:4101 or STAT:5101.

**ACTS:6580 Credibility and Survival Analysis** 3 s.h.
Construction and selection of parametric models; credibility; simulation. Offered spring semesters. Prerequisites: STAT:4101 or STAT:5101. Corequisites: ACTS:6480. Requirements: grade of C+ or higher in STAT:4101 or STAT:5101.

**ACTS:7730 Advanced Topics in Actuarial Science/Financial Mathematics** arr.

**Statistics**

**STAT:5090 ALPHA Seminar** 1 s.h.
Resources available to students, program requirements, tips for academic success, professional statistical organizations, library and career center resources, statistical computing, scientific document preparation, history of statistics. Requirements: graduate standing in statistics.

**STAT:5100 Statistical Inference I** 3 s.h.
Review of probability, distribution theory (multiple random variables, moment-generating functions, transformations, conditional distributions), sampling distributions, order statistics, convergence concepts, generating random samples. Prerequisites: MATH:2850 and STAT:3101.
STAT:5101 Statistical Inference II 3 s.h.
Continuation of STAT:5100; principles of data reduction, point estimation theory (MLE, Bayes, UMVU), hypothesis testing, interval estimation, decision theory, asymptotic evaluations. Prerequisites: STAT:5100.

STAT:5120 Mathematical Methods for Statistics 3 s.h.
Real numbers, point set theory, limit points, limits, metric spaces, continuity, sequences and series, Taylor series (multivariate), uniform convergence, Riemann-Stieltjes integrals. Requirements: statistics graduate standing.

STAT:5200 Applied Statistics I 4 s.h.
Introduction to computing environments and statistical packages, descriptive statistics, basic inferential methods (confidence intervals, chi-square tests); linear models (regression and ANOVA models—specification and assumptions, fitting, diagnostics, selection, testing, interpretation). Prerequisites: STAT:3101. Corequisites: STAT:4100 or STAT:5100. Requirements: facility with matrix algebra.

STAT:5201 Applied Statistics II 3 s.h.
Design of experiments and analysis of designed experiments; models for fixed and random effects; mixed models; design and analysis of complex plans; sample-size methods. Prerequisites: STAT:5200.

STAT:5400 Computing in Statistics 3 s.h.
R; database management; graphical techniques; importing graphics into word-processing documents (e.g., LaTeX); creating reports in LaTeX; SAS; simulation methods (Monte Carlo studies, bootstrap, etc.). Prerequisites: STAT:3200, and STAT:3120 or STAT:3101 or STAT:4101. Corequisites: STAT:5100 and STAT:5200, if not taken as prerequisites.

STAT:5610 Design and Analysis of Biomedical Studies 3 s.h.
Simple and multiple linear regression and correlation; one- and two-way layout considerations in planning experiments; factorial experiments; multiple comparison techniques; orthogonal contrasts. Offered spring semesters. Prerequisites: BIOS:5110. Same as BIOS:5120.

STAT:5810 Research Data Management 3 s.h.
Overview of problems encountered in gathering and processing data from biomedical investigations; introduction to data management techniques useful in biomedical studies; introduction to Microsoft Access. Offered fall semesters. Requirements: Python or Java or C programming capability. Same as BIOS:5310.

STAT:6220 Statistical Consulting 3 s.h.
Realistic supervised data analysis experiences, including statistical packages, statistical graphics, writing statistical reports, dealing with complex or messy data. Offered spring semesters. Prerequisites: (STAT:3200 and STAT:3210) or (STAT:5200 and STAT:5201). Requirements: for undergraduate majors — major g.p.a. of 3.00 or above, and grades of B or higher in STAT:3200 and STAT:3210.

STAT:6300 Probability and Stochastic Processes I 3 s.h.
Conditional expectations; Markov chains, including random walks and gambler’s ruin; classification of states; stationary distributions; branching processes; Poisson processes; Brownian motion. Prerequisites: STAT:4100.

STAT:6301 Probability and Stochastic Processes II 3 s.h.
Markov chains with continuous state space, Martingales, random walks, Brownian motion and other continuous-time Markov chains, simulation methods. Prerequisites: STAT:6300.

STAT:6510 Applied Generalized Regression 3 s.h.
Applications of semiparametric models, generalized linear models, nonlinear normal errors models, correlated response models; use of statistical packages, especially SAS. Requirements: introductory statistics and applied linear models.

STAT:6513 Intermediate Statistical Methods 4 s.h.

STAT:6514 Correlation and Regression 4 s.h.

STAT:6516 Design of Experiments 4 s.h.

STAT:6530 Environmental and Spatial Statistics 3 s.h.
Methods for sampling environmental populations, sampling design, trend detection and estimation, geostatistics, kriging, variogram estimation, lattice data analysis, analysis of spatial point patterns. Prerequisites: STAT:3200 and STAT:4101.

STAT:6540 Applied Multivariate Analysis 3 s.h.

STAT:6547 Nonparametric Statistical Methods 3 s.h.
Selected nonparametric methods; one- and two-sample location tests and estimation methods, measures of association, analyses of variance; emphasis on relationships to classical parametric procedures. Prerequisites: PSQF:6243 or STAT:3120. Same as PSQF:6247.

**STAT:6550 Introductory Longitudinal Data Analysis** 3 s.h.
Statistical models and estimation methods used to analyze correlated data (e.g., same subject measured repeatedly); emphasis on use of statistical software. Offered fall semesters of odd years. Prerequisites: STAT:3200 or STAT:6510 or BIOS:5730 or BIOS:6110. Same as BIOS:6310.

**STAT:6560 Applied Time Series Analysis** 3 s.h.
General stationary, nonstationary models, autocovariance autocorrelation functions; stationary, nonstationary autoregressive integrated moving average models; identification, estimation, forecasting in linear models; use of statistical computer packages. Offered spring semesters. Prerequisites: STAT:3101 and (STAT:3200 or STAT:5200).

**STAT:6970 Topics in Statistics** 3 s.h.

**STAT:6990 Readings in Statistics** arr.

**STAT:7100 Advanced Inference I** 3 s.h.
Concepts of convergence, asymptotic methods including the delta method, sufficiency, asymptotic efficiency, Fisher information and information bounds for estimation, maximum likelihood estimation, the EM-algorithm, Bayes estimation, decision theory. Prerequisites: STAT:5101 and STAT:5120.

**STAT:7101 Advanced Inference II** 3 s.h.
Hypothesis testing, asymptotics of the likelihood ratio test, asymptotic efficiency, statistical functionals, robustness, bootstrap and jackknife, estimation with dependent data. Prerequisites: STAT:7100.

**STAT:7190 Seminar: Mathematical Statistics** arr.

**STAT:7200 Linear Models** 4 s.h.
Linear spaces and selected topics in matrix algebra, multivariate normal distribution and distributions of quadratic forms, full-rank and non-full-rank linear models, estimability, least squares and best linear unbiased estimator, interval estimation, hypothesis testing, random and mixed models, best linear unbiased prediction, variance component estimation. Prerequisites: STAT:5101 and STAT:5200 and STAT:5201.


**STAT:7300 Foundations of Probability I** 3 s.h.
Probability theory, with emphasis on constructing rigorous proofs; measure spaces, measurable functions, random variables and induced measures, distribution functions, Lebesque integral, product measure and independence, Borel Cantelli lemma, modes of convergence. Prerequisites: STAT:5120.

**STAT:7301 Foundations of Probability II** 3 s.h.
Laws of large numbers, characteristic functions and properties, central limit theorem, Radon-Nikodym derivatives, conditional expected value and martingales. Prerequisites: STAT:7300.

**STAT:7390 Seminar: Probability** arr.

**STAT:7400 Computer Intensive Statistics** 3 s.h.
Computer arithmetic; random variate generation; numerical optimization; numerical linear algebra; smoothing techniques; bootstrap methods; cross-validation; MCMC; EM and related algorithms; other topics per student/instructor interests. Prerequisites: STAT:3101 and (STAT:5200 or BIOS:5710). Requirements: proficiency in Fortran or C or C++ or Java.

**STAT:7510 Analysis of Categorical Data** 3 s.h.
Models for discrete data, distribution theory, maximum likelihood and weighted least squares estimation for categorical data, tests of fit, models selection. Offered spring semesters. Prerequisites: (STAT:4101 or STAT:5101) and (STAT:5200 or BIOS:5720). Same as BIOS:7410.

**STAT:7520 Bayesian Analysis** 3 s.h.
Decision theory, conjugate families, structure of Bayesian inference, hierarchical models, asymptotic approximations for posterior distributions, Markov chain Monte Carlo methods and convergence assessment, model adequacy and model choice. Prerequisites: STAT:5101 and STAT:5200 and STAT:5400.

**STAT:7560 Time Series Analysis** 3 s.h.
Stationary time series, ARIMA models, spectral representation, linear prediction inference for the spectrum, multivariate time series, state space models and processes, nonlinear time series. Prerequisites: STAT:4101 and STAT:6560.

**STAT:7570 Survival Data Analysis** 3 s.h.
Types of censoring and truncation; survival function estimation; life tables; parametric inference using exponential, Weibull, and accelerated failure time models; nonparametric tests; sample size calculation; Cox regression with stratification and time-dependent covariates; regression diagnostics; competing risks; analysis of correlated survival data. Offered fall semesters. Prerequisites: BIOS:5720 and (STAT:4101 or STAT:5101). Same as BIOS:7210.

**STAT:7990 Reading Research** arr.