Statistics, Ph.D.

Learning Outcomes
Graduates will be able to:
• have a solid understanding of the mathematical and statistical theory that underlies statistical methods;
• conduct literature reviews to summarize the state of the art for specific theoretical and applied topics;
• formulate, implement, and assess appropriate statistical models for analyzing data;
• identify limitations of existing methods and independently develop and assess novel methods (e.g., for analyzing new types of data);
• appreciate the issues of uncertainty, reproducibility, and computability in data analysis;
• collaborate with non-statisticians to help collect and analyze data; and
• acquire effective communication skills for disseminating statistical findings.

Requirements
The Doctor of Philosophy program in statistics requires a minimum of 76 s.h. of graduate credit, including work completed for the M.S. degree.

The Graduate College requires a minimum q.p.a. of 3.00 to graduate with a Ph.D. degree; however, the Department of Statistics and Actuarial Science requires a higher q.p.a. of at least 3.40 to earn the Ph.D. in statistics. This includes all courses used to meet degree requirements plus additional courses that are relevant to a student’s program.

Ph.D. students complete required coursework, including four courses in one of four concentration areas: actuarial science/financial mathematics, biostatistics, data science, or probability/mathematical statistics (see “Concentration Areas” below for area descriptions and course lists). They may take coursework or seminars in other departments to relate an area of specialization to other fields of knowledge, to acquire the ability to use electronic digital computing equipment, or to learn non-English language skills necessary for reading scientific journals and communicating with scholars in other languages.

Ph.D. Qualifying Procedure
Students enter the Ph.D. program in one of two tracks.

Statistics
After successfully passing both the M.S. final examination in statistics and the creative component (in exceptional cases, a student may petition to go through the Ph.D. qualifying procedure early), a student who will choose actuarial science/financial mathematics as the selected concentration area, can request, by notifying the director of graduate studies, to go through the Ph.D. qualifying procedure. Upon this request, the faculty evaluate the student’s body of work and assess the student’s potential for research. The body of work will include the M.S. final examination in actuarial science, professional examinations passed, and course work. This evaluation and assessment results in one of two decisions—the student is officially admitted into the Ph.D. program in the actuarial science/financial mathematics 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 plan of study that does not conform to the requirements described below but is of high quality may be approved by the director of graduate studies.

The Ph.D. with a major in statistics requires the following coursework.

Required Coursework
Actuarial Science/Financial Mathematics Concentration Area
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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
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<tbody>
<tr>
<td>STAT:4100-STAT:4101</td>
<td>Mathematical Statistics I-II (same as IGPI:4100-IGPI:4101)</td>
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<tr>
<td>STAT:5100-STAT:5101</td>
<td>Statistical Inference I-II (for well-prepared students)</td>
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<td>Quantitative Methods for Actuaries</td>
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<tr>
<td>ACTS:4180</td>
<td>Life Contingencies I</td>
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</tr>
<tr>
<td>ACTS:4280</td>
<td>Life Contingencies II</td>
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<td>Probability and Stochastic Processes I</td>
<td>3</td>
</tr>
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<td>High-Dimensional Probability for Data Science</td>
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<tr>
<td>STAT:7100</td>
<td>Advanced Inference I</td>
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<tr>
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<tr>
<td>STAT:7200</td>
<td>Linear Models</td>
<td>4</td>
</tr>
<tr>
<td>STAT:7300</td>
<td>Foundations of Probability I</td>
<td>3</td>
</tr>
</tbody>
</table>
Biostatistics Concentration Area

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.

<table>
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<tr>
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<th>Hours</th>
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<tbody>
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</tr>
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</tr>
<tr>
<td>STAT:5200/IGPI:5199</td>
<td>Applied Statistics I</td>
<td>4</td>
</tr>
<tr>
<td>STAT:5201</td>
<td>Applied Statistics II</td>
<td>3</td>
</tr>
<tr>
<td>STAT:5400/IGPI:5400</td>
<td>Computing in Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT:6220</td>
<td>Statistical Consulting</td>
<td>3</td>
</tr>
<tr>
<td>STAT:6300</td>
<td>Probability and Stochastic Processes I</td>
<td>3</td>
</tr>
<tr>
<td>STAT:6990</td>
<td>Readings in Statistics (two consecutive enrollments)</td>
<td>2</td>
</tr>
<tr>
<td>STAT:5120</td>
<td>Mathematical Methods for Statistics</td>
<td>3</td>
</tr>
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<td>3</td>
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<td>STAT:7200</td>
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<td>3</td>
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</tr>
<tr>
<td>STAT:7990</td>
<td>Reading Research</td>
<td>18</td>
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Seminars chosen from STAT:7190, STAT:7290, and STAT:7390

At least four of these, with at least one numbered 7000 or above:

<table>
<thead>
<tr>
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<th>Hours</th>
</tr>
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<td>High-Dimensional Probability for Data Science</td>
<td>3</td>
</tr>
<tr>
<td>STAT:6530/IGPI:6530</td>
<td>Environmental and Spatial Statistics</td>
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</table>

Data Science Concentration Area

The data science track emphasizes the theory, methodology, and application of techniques for working with and learning from data. This concentration area prepares students to develop new methods for visualizing and modeling data, managing reproducible data analysis workflows, and collaborating with scientists and other data stakeholders. It is excellent preparation for students interested in academic, industrial, or government positions that involve data visualization, modeling, and analysis.

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</tr>
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</tr>
<tr>
<td>STAT:5101</td>
<td>Statistical Inference II</td>
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</tr>
<tr>
<td>STAT:5200/IGPI:5199</td>
<td>Applied Statistics I</td>
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<td>Applied Statistics II</td>
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</tr>
<tr>
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<td>Computing in Statistics</td>
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<td>STAT:6220</td>
<td>Statistical Consulting</td>
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<td>STAT:6300</td>
<td>Probability and Stochastic Processes I</td>
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</tr>
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<td>Readings in Statistics (two consecutive enrollments)</td>
<td>2</td>
</tr>
<tr>
<td>STAT:5120</td>
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</tr>
<tr>
<td>STAT:7100</td>
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<td>STAT:7101</td>
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</tr>
<tr>
<td>STAT:7200</td>
<td>Linear Models</td>
<td>4</td>
</tr>
<tr>
<td>STAT:7400/IGPI:7400</td>
<td>Computer Intensive Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT:7500/BAIS:7500</td>
<td>Statistical Machine Learning</td>
<td>3</td>
</tr>
<tr>
<td>STAT:7990</td>
<td>Reading Research</td>
<td>18</td>
</tr>
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</table>

Seminars chosen from STAT:7190, STAT:7290, and STAT:7390

At least two of these, with at least one numbered 7000 or above:
Probability/Mathematical Statistics Concentration Area

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.

<table>
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<td>STAT:6300</td>
<td>Probability and Stochastic Processes I</td>
<td>3</td>
</tr>
<tr>
<td>STAT:6990</td>
<td>Readings in Statistics (two consecutive enrollments)</td>
<td>2</td>
</tr>
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</table>

And all of these:

- STAT:5120 Mathematical Methods for Statistics 3
- STAT:7100 Advanced Inference I 3
- STAT:7101 Advanced Inference II 3
- STAT:7200 Linear Models 4
- STAT:7300 Foundations of Probability I 3
- STAT:7400 IGPI:7400 Computer Intensive Statistics 3
- STAT:7990 Reading Research 18

Seminar chosen from STAT:7190, STAT:7290, and STAT:7390 2

At least four of these, with at least one numbered 7000 or above:

- DATA:7350 High-Dimensional Probability for Data Science 3
- STAT:6301 Probability and Stochastic Processes II 3
- STAT:7301 Foundations of Probability II 3
- STAT:7500 BAIS:7500 Statistical Machine Learning 3
- STAT:7520 Bayesian Analysis 3

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. Ordinarily, this second opportunity to pass the exam will occur one year later, during the week before fall classes begin. However, a student who performs well on one area of the exam but not the other may, in consultation with their advisor and the director of graduate studies, petition the department to move up their second opportunity to the week before the next spring semester's classes begin. The department’s decision on whether to grant this petition will take into account any extenuating circumstances.

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);
- probability (topics in STAT:6300 Probability and Stochastic Processes I and STAT:7300 Foundations of Probability I); and

Students in the actuarial science/financial mathematics concentration area have the option of taking only one of the four examinations listed above and an actuarial science/financial mathematics examination designed by their advisor and approved by the director of graduate studies.

Committee

Upon passing the Ph.D. final examination, the candidate chooses a committee of at least four members, which is approved by the advisor. At least three of the faculty members must be University of Iowa tenure-track faculty members. At least two of the faculty members must be from the major department (defined as faculty members who hold any appointment in the major department), and University of Iowa tenure-track faculty members.

The department may request the Graduate College dean’s permission to replace one of the four committee members with a recognized scholar of professorial rank from another academic institution.

Prospectus

Within 18 months of passing the Ph.D. final exam, the candidate should present a written and oral prospectus to the committee. The prospectus describes the problems the student is considering for the thesis, relevant background material, ideas for solving the problems, and any preliminary results. Failure to successfully complete the prospectus within 24 months of passing the Ph.D. final exam will jeopardize the continuation of a student’s financial support.
Admission

Applicants must meet the admission requirements of the Graduate College; see the Manual of Rules and Regulations on the Graduate College website.

Financial Support

Funds are available to help support outstanding Ph.D. applicants. Fellowships, teaching assistantships, and research assistantships provide an attractive stipend plus tuition at the resident rate and tuition scholarships for students who are appointed at least one-quarter time. In most cases, full tuition waivers are granted.

Students who wish to be considered for financial assistance for their third year in the program should request to go through the Ph.D. qualifying process no later than the spring semester of their second year.

Career Advancement

Statistics and probability are vital to many fields, so the demand for well-trained statisticians is strong. Statisticians work in medicine, engineering, law, public policy making, marketing, manufacturing, engineering, agriculture, varied social and natural sciences, and numerous other areas.

The program prepares students for careers in research, applications, and teaching. To learn more about job opportunities, see ASA JobWeb on the American Statistical Association website.

The Pomerantz Career Center offers multiple resources to help students find internships and jobs.

Academic Plans

Sample Plan of Study

Sample plans represent one way to complete a program of study. Actual course selection and sequence will vary and should be discussed with an academic advisor. For additional sample plans, see MyUI.

Statistics, Ph.D.

Data Science Concentration

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Career</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Semester</td>
<td></td>
<td>76 s.h. must be graduate level coursework; graduate transfer credits allowed upon approval. More information is included in the General Catalog and on department website.</td>
</tr>
</tbody>
</table>

| First Year | | |
| Fall | | 11 |
| STAT:5090 | ALPHA Seminar | 1 |
| STAT:5100 | Statistical Inference I | 3 |
| STAT:5200 | Applied Statistics I | 4 |
| STAT:5400 | Computing in Statistics | 3 |
| Hours | | 11 |

| Spring | | |
| STAT:5101 | Statistical Inference II | 3 |

| Second Year | | |
| Fall | | 9 |
| Written Exam b | | |
| Creative Component c, d | | |
| STAT:6300 | Probability and Stochastic Processes I | 3 |
| STAT:6990 | Readings in Statistics e | 1 |
| STAT:7100 | Advanced Inference I | 3 |
| STAT:7200 | Linear Models | 4 |
| Hours | | 11 |

| Spring | | 10 |
| Present Creative Component f | | |
| STAT:4580 | Data Visualization and Data Technologies | 3 |
| STAT:6220 | Statistical Consulting | 3 |
| STAT:6990 | Readings in Statistics e | 1 |
| STAT:7400 | Computer Intensive Statistics | 3 |

| Third Year | | |
| Any Semester | | 10 |
| Identify dissertation advisor, dissertation topic, and dissertation committee | | |

| Fall | | 10 |
| Comprehensive Exam g | | |
| STAT:4540 | Statistical Learning | 3 |
| STAT:7990 | Reading Research h | 3 |
| Concentration Area course i | | 3 |
| Hours | | 10 |

| Spring | | 10 |
| DATA:7350 | High-Dimensional Probability for Data Science | 3 |
| STAT:7290 or STAT:7390 or STAT:7190 | Seminar: Applied Statistics or Seminar: Probability or Seminar: Mathematical Statistics | 2 |
| STAT:7500 | Statistical Machine Learning | 3 |
| STAT:7990 | Reading Research h | 2 |
| Hours | | 10 |

| Fourth Year | | 6 |
| Fall | | 3 |
| STAT:7990 | Reading Research h | 3 |
| Concentration Area course i | | 3 |
| Hours | | 6 |

| Spring | | 3 |
| Prospectus Defense j | | |
| STAT:7990 | Reading Research h | 3 |
| Hours | | 3 |

| Fifth Year | | 3 |
| Fall | | 3 |
| STAT:7990 | Reading Research h | 3 |
| Hours | | 3 |
a Students must complete specific requirements in the University of Iowa Graduate College after program admission. Refer to the Graduate College website and the Manual of Rules and Regulations for more information.

b Written two-part exam to fulfill the master's final exam requirement; taken prior to start of second year fall semester classes.

c Students must complete a creative component that is related to their application and career interests. It 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, normally during the fall and spring semesters of the second year.

d Satisfactorily complete the creative component requirement draft by the end of the semester.

e Two consecutive enrollments are required.

f The creative component requirement must be completed and presented by mid-spring; the paper is then presented orally in a public seminar.

g Typically completed at the beginning of the third year, the comprehensive examination consists of both written and oral components in two of the following four areas: statistical inference, linear models, probability, and statistical computing. See the General Catalog and the department website for specifics.

h Students must complete at least 18 s.h. of Reading Research credit.

i Students must complete a minimum of two courses (6 s.h.) with at least one numbered 7000 or above; see the General Catalog for list of approved courses. Work with faculty advisor to determine appropriate coursework and sequence.

j Within 18 months of passing the comprehensive exam, students typically present a written and oral prospectus to their PhD committee. See the General Catalog and department website for specifics.

k Dissertation defense.