

# STATISTICS

## Dual-Titles

### Dual-title Ph.D. in Statistics and Climate Science

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

Climate Science (<https://bulletins.psu.edu/graduate/programs/majors/climate-science/>) is a field devoted to the study of Earth's climate in the past, present, and future. A particular focus is understanding the effects of human activities (anthropogenic impacts) and natural forcing on climate. The Climate Science dual-title degree program is administered by the Department of Meteorology and Atmospheric Science for the participating graduate programs. The dual-title degree program is offered through participating programs in the College of Earth and Mineral Sciences and, where appropriate, other graduate programs in the University. The program enables students from several graduate programs to gain the perspectives, techniques, and methodologies of Climate Science, while maintaining a close association with major program areas of application.

#### Admission Requirements

Students must apply and be admitted to the graduate program in Statistics and The Graduate School before they can apply for admission to the dual-title degree program. After admission to their primary program, students must apply for admission to and meet the admissions requirements of the Climate Science dual-title program. Refer to the Admission Requirements section of the Climate Science Bulletin page (<https://bulletins.psu.edu/graduate/programs/majors/climate-science/>). Doctoral students must be admitted into the dual-title degree program in Climate Science no later than the end of the fourth semester (not counting summer semesters) of entry into the graduate major program.

#### Degree Requirements

To qualify for the dual-title degree, students must satisfy the degree requirements for the Ph.D. in Statistics. In addition, students must complete the degree requirements for the dual-title in Climate Science, listed on the Climate Science Bulletin page (<https://bulletins.psu.edu/graduate/programs/majors/climate-science/>). The qualifying examination in the Statistics satisfies the qualifying exam requirement for the dual-title degree program in Climate Science.

#### Ph.D. Committee Composition

In addition to the general Graduate Council requirements for Ph.D. committees (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/>), the Ph.D. committee of a Climate Science dual-title doctoral degree student must include at least one member of the Climate Science Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in Climate Science, the member of the committee representing Climate Science must be appointed as co-chair. The Climate Science representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

#### Dissertation and Dissertation Defense

Students in the dual-title program are required to write and orally defend a dissertation on a topic that is approved in advance by their

Ph.D. committee and reflects their original research and education in both Statistics and Climate Science. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the Statistics graduate program, and the Graduate School.

### Dual-Title M.S. and Ph.D. in Statistics and Operations Research

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

The Operations Research dual-title degree program is administered by an Operations Research committee, which is responsible for management of the program. The program enables students from diverse graduate programs to attain and be identified with the tools, techniques, and methodology of operations research, while maintaining a close association with areas of application. Operations research is the analysis—usually involving mathematical treatment—of a process, problem, or operation to determine its purpose and effectiveness and to gain maximum efficiency.

#### Admission Requirements

Students must apply and be admitted to the graduate program in Statistics and the Graduate School before they can apply for admission to the dual-title degree program. Students are encouraged to submit their application forms as early as possible. Doctoral students must be admitted into the dual-title degree program in Operations Research no later than the end of the fourth semester (not counting summer semesters) of entry into the graduate major program. The "Request for Dual-Title Degree in Operations Research" form must be filled out in consultation with the Graduate Coordinator in the Statistics Department and submitted to the Chair of the Operations Research Program.

For the M.S. dual-title degree in Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>), in addition to those prescribed by the graduate major program, prerequisites for acceptance to the program without deficiency include the following or their equivalent:

Code	Title	Credits
MATH 140	Calculus With Analytic Geometry I	4
MATH 141	Calculus with Analytic Geometry II	4
MATH 220	Matrices	2-3
CMPSC 101	Introduction to Programming	3
3 credits of probability and statistics		3

The "Request for Masters Dual-Title Degree in Operations Research" form must be filled out.

For the Ph.D. dual-title degree in Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>), in addition to those prescribed by the graduate major program, prerequisites for acceptance to the program without deficiency include the following or their equivalent:

Code	Title	Credits
MATH 401	Introduction to Analysis I	3
MATH 436	Linear Algebra	3

CMPSC 101	Introduction to Programming	3
3 credits of probability and statistics		3

The "Request for Ph.D. Dual-Title Degree in Operations Research" form must be filled out.

### Degree Requirements

To qualify for the dual-title degree, students must satisfy the requirements for the degree they are enrolled in Statistics. In addition, they must satisfy the requirements described below, as established by the Operations Research committee.

For the M.S. dual-title degree in Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>), the minimum requirements are:

- 6 credits in stochastic/statistical methods, including a minimum of 3 credits in each of the areas of statistical methods and stochastic processes;
- 6 credits in optimization, including a minimum of 3 credits in linear programming;
- 3 credits in computational methods; and
- 3 credits in applications/specialization.

A minimum of 9 credits must be in the 500 series. Particular courses may satisfy both the graduate major program requirements and those in the Operations Research program. The supervisor of the master's thesis must be a member of the Graduate Faculty recommended by the chair of the program granting the degree and approved by the Operations Research committee as qualified to supervise thesis work in operations research.

The minimum requirements for the Ph.D. dual-title degree in Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>) are:

- 9 credits in stochastic/statistical methods, including a minimum of 3 credits in each of the areas of statistical methods and stochastic processes;
- 9 credits in optimization, including a minimum of 3 credits in linear programming;
- 6 credits in computational methods, including a minimum of 3 credits in simulation; and
- 12 credits in applications/specialization.

A minimum of 18 credits must be in the 500 series, and particular courses may satisfy both the graduate major program requirements and those in the Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>) program.

### Qualifying Exam

The qualifying examination committee for the dual-title Ph.D. degree will be composed of Graduate Faculty from Statistics and must include at least one Graduate Faculty member from the Operations Research program. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. There will be a single qualifying examination, containing elements of both Statistics and Operations Research. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the qualifying examination may be delayed one semester beyond the normal period allowable.

### Ph.D. Committee Composition

The Ph.D. committee must conform to all requirements of the primary program and the Graduate Council. In accordance with Graduate Council policy (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-602-phd-committee-formation/>), the Ph.D. committee of a Statistics and Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>) dual-title doctoral degree student must include at least one member of the Operations Research Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role.

If the chair of the committee representing Statistics is not also a member of the Graduate Faculty in Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>), the member of the committee representing Operations Research must be appointed as co-chair.

### Comprehensive Exam

After completing all course work, doctoral students in the dual-title doctoral degree program in Statistics and Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>) must pass a comprehensive examination that includes written and oral components.

There are two ways for students to complete their comprehensive examination.

Typically, both written and oral components of the comprehensive examination involve the defense of a dissertation proposal, which must contain core Statistics content and substantial Operations Research content, and is evaluated by the Ph.D. committee. The Operations Research representative(s) on the student's Ph.D. committee will participate in the evaluation of the comprehensive examination.

Alternatively, the student may have a written and oral comprehensive exam focusing on at least two key areas in Statistics with content from Operations Research (acting as a first minor field). The examination focuses on the dissertation prospects and the student's preparation to undertake dissertation research, and is evaluated by the Ph.D. committee. The Operations Research representative(s) on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination. A written and oral defense of a dissertation proposal would then occur at a later stage as per committee's recommendation.

### Dissertation and Dissertation Defense

Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that is approved in advance by their Ph.D. committee and reflects their original research and education in Statistics and Operations Research (<https://bulletins.psu.edu/graduate/programs/majors/operations-research/>). The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

### Dual-Title Ph.D. in Statistics and Social Data Analytics

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

Statistics doctoral students seeking to attain and be identified with an interdisciplinary array of tools, techniques, and methodologies

for social data analytics, while maintaining a close association with statistics, may apply to pursue a dual-title Ph.D. in Statistics and Social Data Analytics (<https://bulletins.psu.edu/graduate/programs/majors/social-data-analytics/>). Social data analytics is the integration of social scientific, computational, informational, statistical, and visual analytic approaches to the analysis of large or complex data that arise from human interaction. The dual-title Ph.D. aims to enable scientists who expand the capability of social data analytics, and use those capabilities creatively to answer important social scientific questions and to address grand social challenges, in both academic and nonacademic settings.

### Admission Requirements

Students must apply and be admitted to the graduate program in Statistics and the Graduate School before they can apply for admission to the dual-title degree program. Applicants interested in the dual-title degree program may make their interest in the program known clearly on their applications to Statistics and include remarks in their statement of purpose that address the ways in which their research and professional goals in statistics reflect an expanded interest in Social Data Analytics-related research.

To be enrolled in the dual-title doctoral degree program in Social Data Analytics, a student must submit a letter of application and transcript, which will be reviewed by the Social Data Analytics Admissions Committee. An applicant must have a minimum grade point average of 3.0 (on a 4-point scale) to be considered for enrollment in the dual-title degree program. Students must be admitted into the dual-title degree program in Social Data Analytics no later than the end of the fourth semester (not counting summer semesters) of entry into the primary Ph.D. program and before taking the comprehensive exam.

### Degree Requirements

To qualify for the dual-title degree, students must satisfy the requirements of the Ph.D. in Statistics. In addition, they must satisfy the requirements described below, as established by the Social Data Analytics Committee. Within this framework, final course selection is determined by the student in consultation with academic advisers from their home department and Social Data Analytics.

### Course Work

The minimum course work requirements for the dual-title Ph.D. in Statistics and Social Data Analytics (<https://bulletins.psu.edu/graduate/programs/majors/social-data-analytics/>) are as follows:

- Course work and other requirements for the Ph.D. in Statistics.
- SODA 501 (3 credits)
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- 12 or more elective credits in Social Data Analytics from a list of courses maintained by the Social Data Analytics Committee. Collectively the elective credits must satisfy the following requirements:
  - (A) Core analytics distribution. 3 or more credits in courses focused on statistical learning, machine learning, data mining, or visual analytics. Courses approved as meeting this requirement are designated (A) on the list of approved electives.
  - (Q) Quantification distribution. 6 or more credits in courses focused on statistical inference or quantitative social science methodology. Courses approved as meeting this requirement are designated (Q) on the list of approved electives. (A Statistics Ph.D. student would typically satisfy this distribution requirement as a function of completing the requirements of the Statistics Ph.D.)
  - (C) Computational / informational distribution. 6 or more credits in courses focused on computation, collection, management, processing, or interaction with electronic data, especially at scale. Courses approved as meeting this requirement are designated (C) on the list of approved electives.
  - (S) Social distribution. 6 or more credits in courses with substantial content on the nature of human interaction and/or the analysis of data derived from human interaction and/or the social context or ethics or social consequences of social data analytics. Courses approved as meeting this requirement are designated (S) on the list of approved electives. (A Statistics Ph.D. student would typically satisfy this distribution requirement as a function of completing the requirements of the Statistics Ph.D.)
  - Cross-departmental distribution.
    - 3 or more credits in approved courses with the prefix STAT or that of a primarily social science department. (A Statistics Ph.D. student would typically satisfy this distribution requirement as a function of completing the requirements of the Statistics Ph.D.)
    - 3 or more credits in approved courses with the prefix IST, GEOG, or that of a primarily computer science or engineering department.
    - 6 or more credits in approved courses outside Statistics.
    - 3 or fewer credits in approved courses at the 400-level.

Students are encouraged to take interdisciplinary courses that carry multiple (A), (Q), (C), (S) designations, as well as to select SODA electives that also meet STAT requirements. In particular, the 12 elective SODA credits can be met with as few as 6 credits of appropriately chosen course work. Conversely, 6 credits of SODA course work, including SODA 501 and SODA 502, can be used to meet the STAT elective requirement. Within this framework, final course selection is determined by the student in consultation with academic advisers from Statistics and Social Data Analytics. (There are no formal maxima for the number of double-counted credits. For those meeting the SODA elective requirement with the minimum of 12 credits, the outside-program minimum effectively limits the number of primary degree STAT credits that count toward SODA at 6. For those meeting STAT elective requirements with the minimum of 18 credits, the 12 credit STAT minimum effectively limits the number of SODA credits that count toward STAT at 6.)

### Qualifying Exam

The qualifying examination in Statistics satisfies the qualifying exam requirement for the dual-title degree program in Social Data Analytics.

### Ph.D. Committee Composition

The Ph.D. committee must conform to all requirements of the primary program and the Graduate Council. In accordance with Graduate Council policy (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-602-phd-committee-formation/>), the Ph.D. committee of a Statistics and Social Data Analytics (<https://bulletins.psu.edu/graduate/programs/majors/social-data-analytics/>) dual-title doctoral degree student must include at least one member of the Social Data Analytics Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the committee representing Statistics is not also a member of the Graduate Faculty in Social Data Analytics, the member of the committee representing Social Data Analytics must be appointed as co-chair.

### Comprehensive Exam

After completing all course work, doctoral students in the dual-title doctoral degree program in Statistics and Social Data Analytics must

pass a comprehensive examination that includes written and oral components.

There are two ways for students to complete their comprehensive examination.

Typically, both written and oral components of the comprehensive examination involve the defense of a dissertation proposal, which must contain core Statistics content and substantial Social Data Analytics content, and is evaluated by the Ph.D. committee. The Social Data Analytics representative(s) on the student's Ph.D. committee will participate in the evaluation of the comprehensive examination.

Alternatively, the student may have a written and oral comprehensive exam focusing on at least two key areas in Statistics with content from Social Data Analytics (acting as a first minor field). The examination focuses on the dissertation prospects and the student's preparation to undertake dissertation research, and is evaluated by the Ph.D. committee. The Social Data Analytics representative(s) on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination. A written and oral defense of a dissertation proposal would then occur at a later stage as per committee's recommendation.

#### **Dissertation and Dissertation Defense**

Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that is approved in advance by their Ph.D. committee and reflects their original research and education in Statistics and Social Data Analytics. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.