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GEOSPATIAL SCIENCE & ENGINEERING DOCTORAL PROGRAM

The Ph.D. in Geospatial Science & Engineering (GS&E) program provides a multidisciplinary doctoral education that focuses on geographic information science (GISc). GISc is an emerging multidisciplinary field that incorporates research in geography/geographic sciences, environmental science and engineering, electrical and computer science and engineering, and the social sciences. There are three degree plan options. The student may declare either one of two specializations: (1) **Remote Sensing Geography** or (2) **Remote Sensing Engineering**. Alternatively, the student may elect to pursue a degree without a declared specialization. This latter approach can provide a significant range of flexibility to customize an interdisciplinary course of study.

COURSE LISTING FOR GEOSPATIAL SCIENCE & ENGINEERING

I. REQUIRED COURSES (6 credits required).

Two interdisciplinary courses are required of all students in the GSE program: (1) GSE 740 *Introduction to Geospatial Science and Engineering* and (2) GSE 790 *Seminar in GSE*. GSE 740 provides an introduction to research in GSE, a survey of current faculty research, and lectures and exercise on professional skills development. All students should take GSE 740 at the first opportunity. Three credits of the one-credit seminar course GSE 790 are required, but weekly attendance at this program-wide speaker series is strongly encouraged throughout the degree program. Six credits of required core coursework (GSE 740, GSE 790) must be completed by the end of the second year.

Basic GSE Courses

GSE 740 *Intro to GSE* (3 cr)

GSE 790 *GSE Seminar* (1 cr) to be taken three times

NOTE: A minimum grade of "B" is required in these courses to complete the Ph.D. program.

II. SPECIALIZATION COURSES (at least 6 credits required).

A minimum of six credits of coursework in geography or engineering must be selected from an approved list of Specialization and Supporting Courses, which focus on the specialization area of the student's dissertation topic.

The ***Specialization in Remote Sensing Geography*** requires the following two courses:
GSE/GEOG 741 *Quantitative Remote Sensing for Terrestrial Monitoring*
GSE/GEOG/WL 743 *Geospatial Analysis*

If the student's Advisory Committee decides that the student has had sufficient preparation in the material covered in 741 and/or 743, substitute courses shall be determined by the Advisory Committee and approved by the Graduate School.

The ***Specialization in Remote Sensing Engineering*** requires two of the following four courses to meet the Specialization requirement:

GSE/EE 751 *Remote Sensing Engineering*
 GSE/GEOG 752 *Image Geometry and Photogrammetry*
 GSE/EE 753 *Advanced Image Processing*
 GSE/EE 754 *Active Sensor Systems*

For those students not pursuing either Specialization, the 6 credit requirement will be substituted with courses approved by the student's Advisory Committee.

NOTE: A minimum grade of "B" is required in these courses to complete the Ph.D. program.

III. SUPPORTING COURSES (12 or 15 credits required).

A minimum of 12 credits for the 60-credit Plan or 15 credits for the 90-credit Plan of multidisciplinary coursework must be selected from an approved list of supporting courses. This is intended to add multidisciplinary support of the chosen specialization and dissertation topic. Supporting courses should be selected primarily from the course offerings of GSE Graduate Program. *Courses may be selected from offerings of other graduate programs with the approval of the Advisory Committee. Possible supporting courses include, but are not limited to, those listed below.*

Two GSE courses (760: *Advanced Methods in Geospatial Modeling* and 766: *Advanced Remote Sensing Applications*) are topical courses with different thematic content and instructors each semester. These courses may be repeated for credit for up to 12 credits. For current offerings and instructors, check the GIScCE webpage or contact the GIScCE office.

NOTE: Before attempting to register for these courses, be sure to check on their current availability.

Tools & Techniques

GSE/EE 751 *Remote Sensing Engineering*
 GSE/GEOG 752 *Image Geometry and Photogrammetry*
 GSE/EE 753 *Advanced Image Processing*
 GSE/EE 754 *Active Sensor Systems*
 GSE/GEOG 768 *Land Cover & Land Use Characterization*
 GSE/GEOG 771 *Field Methods in Spectroscopy*
 GSE 760 (Topical) *Advanced Methods in Geospatial Modeling*
 GEOG 588 *GIS II*
 GEOG 589 *GIS III*
 GEOG 770 (Topical) *Advanced Geographic Techniques*
 GEOG 786 *Advanced Geographic Information Systems*
 EE 670 *Information and Signal Processing*
 EE 685 *Microwave Theory*

Environmental Sensing & Applications

GEOG 765 *Historical Geography of US Land Use and Land Cover*
 GSE/GEOG 766 (Topical) *Advanced Remote Sensing Applications*
 GSE/GEOG/WL/BIOL 767 *Fire and Ecosystems*

Special Electives

GEOG 620 *Advanced Regional Studies*

GEOG 790 *Seminar in Geography*

GEOG 791 *Special Problems*

GEOG 792 *Independent Research*

NOTE: A minimum grade of “B” is required in these courses to complete the Ph.D. program

IV. DISSERTATION (36 credits required).

Requirements — The dissertation should represent at least one academic year of full-time research. Of no specific length, it should advance or modify knowledge in the major discipline and demonstrate the candidate’s mastery of the subject. The dissertation should be prepared in the style of one of the journals in the major discipline as required by the major department and in the format required by the Graduate School as specified in “Instructions for Dissertation.” When submitted, it will include an abstract of no more than 350 words.

The dissertation should be an integrated document reporting philosophic inquiry. The students are encouraged to develop one or more journal articles from their dissertations. Some departments may require that the journal articles be a part of the dissertation. However, the dissertation should be a single document rather than a compilation of individual manuscripts.

Review — It is the responsibility of the student to schedule the oral examination and distribute a copy to each member of the graduate committee, including the graduate representative, ten working days in advance of the oral examination.

Binding— When the final approved copy of the dissertation is completed, four copies are submitted to the Library for binding. The cost for binding these copies is the responsibility of the student. Two copies, one on at least 50 percent rag content paper (cotton bond), and an additional abstract, printed on at least 50 percent rag content paper (cotton bond) must be returned to the Graduate School with a receipt from the Library showing the binding costs paid at least five working days prior to Commencement.

Electronic Dissertation Submission — All doctoral candidates are required to submit their dissertations in the appropriate format for electronic publication. Students should contact the Graduate School for appropriate guidelines.

Continuing Dissertation Enrollment

See in the Graduate Catalog the section entitled “Continual Registration for Dissertation/Thesis/Research-Design Paper.” Failure to maintain registration or enrollment will automatically terminate the doctoral program. Reinstatement requires retaking the Comprehensive Written Examination with performance approved by the Advisory Committee.

ADVISORY COMMITTEE

During the student's first semester in residence, the major advisor shall recommend to the Dean of the Graduate School members of the Ph.D. advisory committee who are members of the Graduate Faculty, as follows:

- a. The major advisor, who acts as chair;
- b. The head of the department of Geography or Electrical Engineering or the Director of the GIScCE or a department in the area of the major (depending on the student's intended specialization) or her or his representative;
- c. An additional member from an appropriate major department or institution, which may be a qualified scientist from outside SDSU;
- d. A member of the Graduate Faculty from the major area or a related area appointed so that the total minimum membership of the committee is uniform.
- e. A representative of the Graduate Faculty appointed by the Dean of the Graduate School. The major advisor may request additional members of the Committee beyond those required.

PLAN OF STUDY INFORMATION

Within six weeks after the Advisory Committee is formed, it will schedule a meeting with the student to approve a Plan of Study and to consider a research area for the dissertation. The Plan of Study must be prepared using the form provided by the Graduate School and approved by the Advisory Committee and the Dean of the Graduate School. Delay in submitting a Plan of Study may result in disapproval of courses taken prior to approval. The student cannot take the comprehensive written examination prior to approval of the Plan of Study. Changes in the approved Plan of Study must be requested using the form provided by Graduate School, and must be approved by the Advisory Committee and the Dean of the Graduate School. While devising your plan of study, refer to the "Academic Information" section in the Graduate School catalog, in addition to the following information.

PLAN OF STUDY CREDIT REQUIREMENTS

Total Credits Required— A minimum of three academic years of full-time work beyond the Bachelor's degree (minimum of 90 semester credits, 90-Credit Plan) or a minimum of two academic years of full time work beyond the Master's degree (minimum of 60 semester credits, 60-Credit Plan) are required for the Doctor of Philosophy degree. Where consideration is given to a master's degree the degree must be in the area of the major, minor or a related area; be an academic program from a regionally accredited institution; and be declared at the time the Plan of Study is submitted. The Advisory Committee may require more credits than the minimum listed above if it believes the extra requirements are in the best interest of the student.

Graduate Credit Requirement — At least 50 percent of the credits on a Plan of Study must be in courses open only to graduate students (600-series or above).

GEOSPATIAL SCIENCE AND ENGINEERING EXAMINATIONS

Four evaluations are administered as the student progresses through the program. These are the (1) Interim Evaluation, (2) Comprehensive Examination, (3) Dissertation Prospectus Meeting, and (4) Dissertation Defense. These evaluations play a dual role in assessment and professional training.

1. INTERIM EVALUATION

Upon completion of approximately half of the coursework on the Plan of Study, the Advisory Committee will meet to evaluate the progress of the student, provide advice and counsel, and recommend continuance or termination of the program. Because the Doctor of Philosophy is a terminal academic degree, student performance includes an evaluation of progress in the program and academic performance. The Advisory Committee may recommend to the Dean of the Graduate School termination of the student in the program.

2. COMPREHENSIVE EXAMINATION

The intent of the Comprehensive Examination is to assess the breadth of knowledge in geospatial science and engineering. The student becomes a candidate for the Ph.D. degree only upon successful completion of all portions of the examination. Students are encouraged to take the Comprehensive Examination during the first semester of their second year, but they must take it no later than the first semester of their third year in the program. Students taking the Comprehensive Examination must have successfully completed the required courses. All parts of the Comprehensive Examination will normally be completed in one semester.

The Comprehensive Examination is administered by the student's Advisory Committee. The written portion of the exam can be delivered in one of two formats (A or B). The Advisory Committee determines which format is appropriate for the student.

Format A is composed of a written synthesis paper. The process is designed to provide professional training in literature research, synthetic thinking, and effective communication of ideas and knowledge. The written synthesis paper is to provide an inclusive treatment of the published literature on a topic assigned by the Advisory Committee. The length, content, and format of the synthesis paper should be suitable for publication in the *Annual Review* series (e.g., *AR of Environment and Resources* or *Earth and Planetary Sciences* or *Ecology, Evolution, and Systematics*). This synthesis paper should clearly indicate the relevance of the topic to the appropriate broader field(s) of study and also indicate potential directions for future research on the topic.

Format B is composed of a written examination consisting of a series of examination questions submitted by the Advisory Committee that are answered in accordance with the directions of the Advisory Committee. The oral portion of the Comprehensive Examination is administered after the Committee has evaluated the written portion of the Comprehensive Examination, whether in format A or B. The oral examination is administered to doctoral students individually and will assess breadth of knowledge in the fields of geospatial science and engineering related to the student's intended field of

specialization. Students are expected to possess the breadth and depth of knowledge equivalent to that presented in a standard textbook on introductory remote sensing and spatial analysis, as well as the knowledge obtained in advanced undergraduate courses in a relevant set of related fields.

The written examination (either format) must be satisfactorily completed before the student is allowed to sit for the oral examination. If any part of the written portion of the examination is deemed unsatisfactory, the student will be notified in writing of the need to repeat that part of the Comprehensive Examination the following semester, and the oral examination will be postponed. The student will be given one opportunity to repeat any single part of the written portion of the examination that was deemed unsatisfactory.

In the event that a student does not pass the oral examination, she or he will be advised in writing of the area(s) of perceived deficiency and recommendations will be included concerning the coursework and/or individual study needed to rectify the deficiency. The oral examination may be repeated once and should be administered the semester following the first attempt. Failure to pass any part of the Comprehensive Examination on the second attempt will result in a recommendation by the Advisory Committee to the Dean of the Graduate School that the student should be dismissed from the program. A written explanation of the failure will be provided to the student by the Advisory Committee and the Dean of the Graduate School.

3. DISSERTATION PROSPECTUS MEETING

The intent of the Dissertation Prospectus Meeting is to assess the depth of knowledge in the intended field of research specialization and to provide professional training in the preparation and presentation of a research proposal. The Dissertation Prospectus Meeting is scheduled individually for each student and consists of three parts, namely, a written research proposal, a research seminar, and an oral examination. The research proposal serves as a dissertation prospectus and must be written in the format of a NASA Earth Systems Science Fellowship or an NSF Doctoral Dissertation Improvement Grant (or a similar format approved by the Advisory Committee). The Dissertation Prospectus Meeting must be arranged no later than the end of the third year in the program, and all three parts of the Dissertation Prospectus Meeting are coordinated around the research seminar. The research proposal must be submitted at least two weeks prior to the scheduled date for the research seminar and oral examination. The research seminar must be publicized as open to the public and must be scheduled during early morning or early afternoon and is followed immediately by an oral examination that is closed to the public. The three parts of the Dissertation Prospectus Meeting will be used to assess the student's ability to conceive, design, execute, and communicate the purpose of a suitable research project.

In the event that the research proposal, the seminar, or performance on the oral examination is deemed unsatisfactory, the Dissertation Prospectus Meeting must be repeated. After successful completion of the Dissertation Prospectus Meeting, the Program Coordinator will be notified of the result in writing by the Advisory Committee and the student will continue research until he or she is ready to defend the Dissertation

of the research. During this period, the Advisory Committee should meet with the student at least once every six months. The meeting dates will be recorded and kept on file by the Program Coordinator.

4. FINAL ORAL EXAMINATION (DISSERTATION DEFENSE)

The final examination is oral and public. Due notice thereof will be posted on the Graduate office bulletin board at least ten days in advance. It is scheduled by the advisory committee with the approval of the Dean of the Graduate School. The final examination cannot be taken earlier than two months after the comprehensive examinations have been passed. The advisory committee conducts it at the time and place announced, after the candidate's studies have been completed and the form of the dissertation accepted by the Graduate Office.

While the advisory committee determines the character and length of the examination, sufficient time should be devoted to a consideration of matters relating to the dissertation to test thoroughly the ability of the candidate to defend her or his work. In addition, questions to test his or her general knowledge, judgment, critical thinking, and coursework may be asked.

Passing the final examination requires the approval of the representative of the Graduate Faculty and all but one of the other members of the advisory committee. If the student fails, another examination may be scheduled only with the approval of the advisory committee and the Dean of the Graduate School.

The completed dissertation must be submitted to all members the Advisory Committee at least 10 days prior to the scheduled Final Examination. The Dean of the Graduate School, Program Coordinator, and Department Chair must be invited to attend, and the event must be open to the public, unless a prior confidentiality agreement precludes an open meeting.

The public defense of the dissertation is immediately followed by an oral examination by the Advisory Committee. In the event that the student fails to successfully defend the dissertation, one additional dissertation defense may be attempted only with the approval of the Advisory Committee and the Dean of the Graduate School. Reasons for the failure will be provided by the Advisory Committee to the student in writing. Failure on the second attempt will result in a recommendation by the Advisory Committee to the Dean of the Graduate School that the student be dismissed from the program. A written explanation of the second failure will be provided to the student by the Dean of the Graduate School and the Advisory Committee.

After successful completion of the Final Examination the appropriate form must be signed by the Advisory Committee, Program Coordinator, and the Dean of the Graduate School and the celebration may commence. The student should consult with the Office of the Graduate Dean well in advance of his or her anticipated completion date regarding submission deadlines for the Graduation Application, submission requirements for the dissertation, payment of archiving and/or binding fees, etc.

Obsolete Program— If the Doctor of Philosophy degree is not completed within eight years from the time of admission to work toward the degree, a reconsideration of the student's program will be required. In such cases, the rules of the Graduate School in effect at the beginning of the ninth year will become effective for the student.

Obsolete Coursework — Courses completed more than eight years before completion of the doctorate and not part of a previous degree are regarded as obsolete coursework. Such courses may be used in the doctoral degree program if validated. Validation is allowed at the discretion of the Advisory Committee, the Dean of the Graduate School, and department involved and can be accomplished by passing a validation examination in the subject matter area. Validated obsolete coursework cannot exceed fifty percent of the total coursework listed on the Plan of Study and must be certified by the Advisory Committee on a form provided by the Graduate School. However, credits earned as a part of a Master's degree, which are applied toward the doctoral program, remain valid. There is a \$30 per course fee for validation of courses.

Checklist for GSE Doctoral Program

Step	Requirements	When Due
0	Application for Admission to Graduate School.	One month prior to initial registration.
1	Designation of Major Advisor.	Upon admission to program.
2	Designation of Advisory Committee.	Within first semester of graduate work or prior to 12 semester hr of graduate work.
3	Approval of Plan of Study by Advisory Committee and submission to Graduate School.	Within the first semester of graduate work.
4	Interim Evaluation by the Advisory Committee.	By the end of fourth semester (or 2nd yr).
5	Comprehensive Examinations.	By the end of the fifth semester (or 1st semester of 3rd yr). Graduate School notified 10 days in advance
6	Dissertation Prospectus Meeting.	By the end of the sixth semester (or 3rd yr).
7	Advancement to Candidacy Status.	At least 2 months prior to final oral examination.
8	Filing of Graduation Application.	Date set by the Graduate School
9	Memo submitted from Major Advisor to Graduate School requesting Final Oral Examination.	At least 10 working days prior to final oral examination.
10	Dissertation due to Graduate School and Advisory Committee.	At least 10 working days prior to final oral examination.
11	Final Oral Examination (Dissertation Defense).	Deadline set by the Graduate School.
12	Corrected copies of Dissertation due to Graduate School.	Deadline set by the Graduate School.
13	Arrangements for microfilming and binding of Dissertation.	At least 5 days prior to commencement.