DEPARTMENT OF GEOLOGICAL SCIENCES

The Department of Geological Sciences offers a Master of Science Degree in Geology, a Master of Science Degree in Geoinformatics, and a Certificate of Professional Development in Geographic Information Science. Department faculty also participate in the Ph.D. program in Environmental Science and Engineering administered by the Department of Civil and Environmental Engineering.

Master of Science Degree in Geology

The Master of Science degree program in Geology offers opportunities for advanced study and research designed to prepare students for roles in industry, government, research institutes, or educational institutions.

Program Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, applicants are expected to have completed an undergraduate degree in geology (equivalent to UTSA's) or a bachelor's degree in chemistry, physics, mathematics, computer science, life sciences, or engineering from an accredited institution of higher education with sufficient coursework in the geosciences. Students whose undergraduate preparation is deficient but who meet the minimum University standards for admission may be conditionally admitted and required to complete specific courses as conditions of admission. If such courses are listed as deficiencies, they will not count toward the graduate degree. Applicant's evaluations will be considered on a case-by-case basis.

Applicants must submit two letters of recommendation from persons familiar with the applicant's academic record, a personal statement of research interest, and undergraduate transcripts. All supporting documents must be sent to the Graduate School. Incomplete applications will not be considered until all required items are in an applicant's file.

Applicants whose native language is not English must submit scores from the Test of English as Foreign language (TOEFL) or the International English Language Testing Systems (IELTS) and must meet the minimum University-wide requirements.

The graduate faculty and Graduate Advisor of Record (GAR) will be responsible for recommending acceptance into the program. The GAR will take the lead in advising students until an academic advisor is identified. A limited number of teaching assistantships are available, and the application form can be found on the departmental webpage. Individual faculty members may have opportunities for research assistantships and should be contacted directly.

Graduate Committee

As specified by University regulations, candidates for the Master of Science degree must have a Graduate Committee. The Committee will be chaired by the student's academic advisor and will consist of a minimum of two other members. Each student must decide if they are going to complete the thesis or non-thesis option in the first year if not done so in the first semester because that will determine the type of committee appointed. The Committee should be appointed once an academic advisor and topic have been determined. University rules for the supervising committee must be followed. Only tenured or tenure-track faculty members can chair these committees, and no more than one member can be a nontenure-track faculty member or be from another institution.

Comprehensive Examination

Candidates for the Master of Science degree must pass a comprehensive examination administered by their Graduate Committee. The student should normally schedule this examination the semester before the degree requirements are to be completed. The student's Graduate Committee will determine the content of the examination. Normally, the examination will consist of academic material that the student is expected to have mastered during his or her course of study. For a thesis option student, the thesis defense is treated as the comprehensive examination. The examination may only be taken twice. If it is not passed the first time, it may be scheduled again in the following semester.

Thesis Option in Geology

Degree Requirements

The Master of Science degree in Geology requires the successful completion of a minimum of 30 semester credit hours (exclusive of coursework or other study required to remove academic or admission deficiencies).

Thesis Option Requirements

All candidates for the Master of Science in Geology with thesis option must complete a minimum of 30 semester credit hours of the following:

A. 8 semester credit hours of required courses:		8
GEO 5103	Current Topics in the Geosciences	
GEO 5113	Research Design in the Geosciences	
GEO 5991	Graduate Seminar in Geology (repeat for a total of 2 hours)	
B. A minimum of 16 semester credit hours of electives in consultation with Graduate Advisor of Record:		16
A minimum of 16 hours of graduate credit in organized classes with the approval of the Graduate Advisor of Record is required. This may include no more than 6 hours total of any combination of GEO 6953 Independent Study and GEO 5973 Directed Research. Under special circumstances, students may take up to 6 semester credit hours of upper-division undergraduate coursework in the College of Sciences or College of Engineering with approval of the Graduate Advisor of Record. If approved to enroll in undergraduate coursework students must complete the Permission for Enrolling in Undergraduate Courses While a Graduate form and receive all approvals.		
C. Master's Thesis:		6
GEO 6983	Master's Thesis (repeated for a total of 6 hours)	
Candidates must submit a research proposal to the student's Academic Advisor and Committee no later than the beginning of the third semester of graduate work.		
D. Comprehensive Examination:		

Candidates for the Master of Science degree electing the thesis option must also pass a final oral comprehensive examination in which they successfully defend their thesis before their Graduate Committee. The thesis defense will take two to three hours to complete. The thesis defense is normally scheduled in the last semester before the degree requirements are to be completed. Part of the thesis defense will be a public presentation in an open, advertised forum.

Total Credit Hours	30

Non-Thesis Option in Geology

Degree Requirements

The Master of Science degree in Geology requires the successful completion of a minimum of 36 semester credit hours (exclusive of coursework or other study required to remove academic or admission deficiencies).

Non-Thesis Option Requirements

A non-thesis option is available for those who want the opportunity to earn the Master of Science degree in Geology primarily through organized coursework. Non-thesis students should consult the Graduate Advisor of Record on their program of study during the first semester of residence. Candidates are required to complete a minimum of 36 semester credit hours of the following:

A. 11 semester credit hours of required courses:		11
GEO 5103	Current Topics in the Geosciences	
GEO 5113	Research Design in the Geosciences	
GEO 5973	Directed Research	
GEO 5991	Graduate Seminar in Geology (Repeated for a total of 2 semester credit hours)	
B. A minimum of 25 semester credit hours of electives in consultation with the Graduate Advisor of Record		25
An additional 25 hours of graduate credit as approved by the Graduate Advisor of Record is required. Under special circumstances, students may take up to 6 semester credit hours of approved upper-division undergraduate coursework within the College of Sciences or College of Engineering with approval of the Graduate Advisor of Record. If approved to enroll in undergraduate coursework students must complete the Permission for Enrolling in Undergraduate Courses While a Graduate form and receive all approvals.		
C. Comprehensive Examination:		
GEO 6961	Comprehensive Examination	
Enrollment in GEO 6961, Comprehensive Examination, will be required in the semester the comprehensive examination is taken, if registered for no other courses that semester.		
Candidates are required to pass a written comprehensive examination that covers several major areas of geology. This examination is taken after the student has completed at least 30 semester credit hours of coursework. If GEO 6961 Comprehensive Examination is taken, it does not contribute toward the 36-semester-credit-hour minimum.		
Total Credit Hours		36

Master of Science Degree in Geoinformatics

The Master of Science degree program in Geoinformatics offers opportunities for advanced study and research designed to prepare students for roles in industry, government, research and/or academic institutions. The educational objective of this program is to produce graduates who are capable of applying geospatial technology for conducting original research in industry or academia as well as assuming a leadership role in their chosen employment field. This is a multidisciplinary program administered by the Department of Geological Sciences. It encompasses faculty and facilities from the College of Sciences, College of Liberal and Fine Arts, College of Engineering, College of Public Policy, College of Architecture, Construction and Planning, as well as individual faculty from other UTSA departments.

Program Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, applicants are expected to have completed either a bachelor of science degree, with emphases in geological, biological, physical, environmental, or computational sciences, or a bachelor of arts degree, with emphases in geography, social sciences, humanities, or business. Five required background classes or equivalents are: algebra (MAT 1073), computer programming (CS 1063), physics (PHY 1603 or PHY 1943), statistics (STA 1053), and world geography (GES 1023). Students whose undergraduate preparation is deficient but who meet the minimum University standards for admission may be conditionally admitted and required to complete specific courses as conditions of admission. If such courses are listed as deficiencies, they will not count toward the graduate degree. Background with GIS and/or remote sensing courses is a plus, but not required. Applicants' evaluations will be considered on a case-by-case basis.

Applicant must submit two letters of recommendation from persons familiar with the applicant's academic record, a personal statement of research or career interest and undergraduate transcripts. All supporting documents should be submitted through the Graduate School website. Incomplete applications will not be considered until all required items are in an applicant's file.

Applicants whose native language is not English must submit scores from the Test of English as Foreign language (TOEFL) or the International English Language Testing Systems (IELTS) and must meet the minimum University-wide requirements.

Geoinformatics Graduate Studies Committee comprised of five graduate faculty members elected from the involved departments and colleges, and Graduate Advisor of Record (GAR) will be responsible for recommending acceptance into the program. A limited number of teaching assistantships are available and application should be submitted to the Department Chair. Individual faculty members may have opportunities for research assistantships or research fellowships and should be contacted directly.

Graduate Committee

As specified by University regulations, candidates for the Master of Science degree must have a Graduate Committee. The Committee will be chaired by the student's graduate advisor and will consist of a minimum of two other members. Each student must decide if they are going to complete the thesis or non-thesis option in the first year if not done so in the first semester because that will determine the type of committee appointed. The Committee should be appointed once an

academic advisor and topic have been determined. University rules for the supervising committee must be followed. Only tenured or tenure-track faculty members can chair these committees, and no more than one member can be a nontenure-track faculty member or be from another institution.

Comprehensive Examination

Candidates for the Master of Science Degree must pass a comprehensive examination administered by their Graduate Committee. The student should schedule this examination the semester before the degree requirements are to be completed. The student's Graduate Committee will determine the content of the examination. The examination will consist of academic material that the student is expected to have mastered during his or her course of study. For a thesis option student, the thesis defense is treated as the comprehensive examination. The examination may only be taken twice. If it is not passed the first time, it may be scheduled again in the following semester.

Thesis Option in Geoinformatics

Degree Requirements

The Master of Science degree in Geoinformatics requires the successful completion of a minimum of 32 semester credit hours (exclusive of coursework or other study required to remove academic or admission deficiencies).

Thesis Option Requirements

All candidates for the Master of Science in Geoinformatics with thesis option must complete a minimum of 32 semester hours of the following:

A. 17 semester credit hours of required courses:		17
One of the following:		
GEO 5033	Geographical Information Systems	
CE 5093	Geographic Information Systems (GIS)	
All of the following:		
GEO 5063	Applied Statistics for Geoinformatics	
GEO 6011	Seminar in Geospatial Science and Applications (Repeated for a total of 2 semester credit hours)	
GEO 6053	Remote Sensing	
GEO 6513	Advanced GIS	
GEO 6533	Programming for Geospatial Application	
B. A minimum of 9 semester credit hours of electives in consultation with Graduate Advisor of Record:		9
An additional 9 semester credit hours of graduate credit as approved by the Graduate Advisor of Record is required, which includes a minimum of two prescribed courses in a candidate's substantive area of interest from the following:		
ANT 6653	Spatial Techniques in Anthropology	
CE 5303	Hydrometeorology	
CS 5443	Database Management Systems	
CS 5573	Cloud Computing	
CS 5633	Analysis of Algorithms	
CS 6243	Machine Learning	
DEM 7093	GIS for Population Science	
DEM 7263	Spatial Demography	
ES 5023	Environmental Statistics	
GEO 6063	Ocean Remote Sensing	
GEO 6083	Remote Sensing Image Processing and Analysis	
GEO 6093	Remote Sensing in Hydrology	
GRG 5913	Design and Management of Geographic Information Systems	
IS 5003	Introduction to Information Systems	
IS 5143	Information Technology	
IS 6703	Introduction to Data Mining	
IS 6733	Big Data Technology	
STA 5093	Introduction to Statistical Inference	
STA 5103	Applied Statistics	
STA 6863	Spatial Statistics	
URP 5233	GIS for Urban Studies	
Or other courses if course descriptions are appropriate.		
C. Master's Thesis:		6
GEO 6983	Master's Thesis	
D. Comprehensive Examination		
Candidates for the Master of Science degree electing the thesis option must also pass a final oral comprehensive examination in which they successfully defend their thesis before their Graduate Committee. The thesis defense will take one to two hours to complete. The thesis defense is normally scheduled in the last semester before the degree requirements are to be completed. Part of the thesis defense will be a public presentation in an open, advertised forum.		
Total Credit Hours		32

Non-Thesis Option in Geoinformatics

Degree Requirements

The Master of Science degree in Geoinformatics requires the successful completion of a minimum of 32 semester credit hours (exclusive of coursework or other study required to remove academic or admission deficiencies).

Non-Thesis Option Requirements

The non-thesis option is available for those who want the opportunity to earn the Master of Science degree in Geoinformatics primarily through organized coursework. Non-thesis students should consult the Graduate Advisor of Record on their program of study during the first semester of residence. For the independent study course, the candidate must work on a project that applies geospatial technology to the candidate's area of specialty and must write a final project report and present to the candidate's Graduate Committee as the final oral comprehensive examination. This is scheduled in the last semester before the degree requirements are to be completed.

Candidates are required to complete a minimum of 32 semester credit hours of the following:

A. 20 semester credit hours of required courses:		20
One of the following:		
CE 5093	Geographic Information Systems (GIS)	
GEO 5033	Geographical Information Systems	
All of the following:		
GEO 5063	Applied Statistics for Geoinformatics	
GEO 6011	Seminar in Geospatial Science and Applications (Repeated for a total of 2 semester credit hours)	
GEO 6053	Remote Sensing	
GEO 6513	Advanced GIS	
GEO 6533	Programming for Geospatial Application	
GEO 6953	Independent Study	

B. A minimum of 12 semester credit hours of electives in consultation with Graduate Advisor of Record:		12
An additional 12 hours of graduate credit as approved by the Graduate Advisor of Record is required, which includes a minimum of two prescribed courses in a candidate's substantive area of interest from the following:		
ANT 6653	Spatial Techniques in Anthropology	
CE 5303	Hydrometeorology	
CS 5443	Database Management Systems	
CS 5573	Cloud Computing	
CS 5633	Analysis of Algorithms	
CS 6243	Machine Learning	
DEM 7093	GIS for Population Science	
DEM 7263	Spatial Demography	
ES 5023	Environmental Statistics	
GEO 6063	Ocean Remote Sensing	
GEO 6083	Remote Sensing Image Processing and Analysis	
GEO 6093	Remote Sensing in Hydrology	
GRG 5913	Design and Management of Geographic Information Systems	
IS 5003	Introduction to Information Systems	
IS 5143	Information Technology	
IS 6703	Introduction to Data Mining	
IS 6733	Big Data Technology	
STA 5103	Applied Statistics	
STA 6863	Spatial Statistics	
STA 6973	Special Problems	
URP 5233	GIS for Urban Studies	
Or other courses if course descriptions are appropriate.		
Total Credit Hours		32

Certificate of Professional Development in Geographic Information Science

The purpose of the Professional Certificate in Geographic Information Science is to train individuals from a broad range of academic disciplines to be competent users of Geographic Information Science and the related tools of Remote Sensing and GIS programming. Although the program is generally oriented toward geological sciences professionals, individuals with business, social science, medical, engineering, computer science, criminal science, or education backgrounds will benefit from this professional certificate. Individuals completing this certificate will gain a practical and hands-on knowledge of Geospatial Science. All courses taken in the Professional Certificate in Geographic Information Science program may be applied toward a Master's degree in Geology or Environmental Science, a Doctoral degree in Environmental Science and Engineering, or other graduate degree with approval of the Graduate Advisor of Record of the degree program.

Description of Certificate Program

The Certificate in Geographic Information Science is a 15-hour program. Degree-seeking or special graduate students from any discipline at UTSA are allowed to complete the Certificate in Geographic Information Science program. Candidates for the certificate should ideally complete the program within one year, but not more than two years. Students will receive program guidance from the GIS Certificate Advisor.

Certificate Curriculum

To complete the certificate program, students are to take the following four graduate courses addressing Geographic Information Science, and a fifth course, chosen in consultation with and approved by the student's GIS Certificate Advisor, which will serve as a "capstone" course in which the student will apply at an advanced level what has been learned in the other four required courses. The fifth course may be any course with a strong component of GIS application, including independent study, in the student's area of specialty.

A. 3 hours selected from the following:		3
ANT 6653	Spatial Techniques in Anthropology	
CE 5093	Geographic Information Systems (GIS)	
DEM 7093	GIS for Population Science	
GEO 5033	Geographical Information Systems	
GRG 5913	Design and Management of Geographic Information Systems	
B. 9 hours of requied courses:		9
GEO 5063	Applied Statistics for Geoinformatics	
GEO 6513	Advanced GIS	
GEO 6533	Programming for Geospatial Application	
C. Capstone course chosen in consultation with and approved by the student's GIS Certificate Advisor		3
Total Credit Hours		15

Geology (GEO) Courses

GEO 5033. Geographical Information Systems. (2-2) 3 Credit Hours. Application of the computer to environmental planning and management problems through a Geographical Information System (GIS). Using the computer as a mapping device for query, analysis, creation and display of spatially related data. Additional topics include using the Global Positioning System (GPS) for data acquisition. (Same as CE 5293. Credit cannot be earned for both CE 5293 and GEO 5033.) Course Fees: GS01 $90; IUE1 $15; LRS1 $15; STSI $15.

GEO 5063. Applied Statistics for Geoinformatics. (3-0) 3 Credit Hours. Prerequisites: CS 1063, MAT 1073, and STA 1053, or consent of instructor. This course will cover both the basic statistics and in depth coverage of analytical methods used in the analysis of geospatial data. Descriptive clustering methods for spatial data and in depth coverage of linear models used in the analysis of geospatial data will also be covered. Variogram models and kriging techniques will also be covered. All course materials will be taught using the programming language R. Course Fees: GS01 $90; IUE1 $15; LRS1 $15; STSI $15.

GEO 5103. Current Topics in the Geosciences. (3-0) 3 Credit Hours. Prerequisite: Graduate standing in geology or consent of instructor. Evaluation of current research trends and methodology in the geosciences. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5113. Research Design in the Geosciences. (3-0) 3 Credit Hours. Prerequisite: GEO 5103 or consent of instructor. Development of research projects, including literature review, methodology, and data analysis. Elements of project management will also be covered. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5223. Advanced Environmental Geology. (3-0) 3 Credit Hours. Prerequisites: GEO 4063 and ES 5213, or consent of instructor. Study of the geology of the environment, with emphasis on the physical and social effects of catastrophic geologic processes. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5303. Petroleum Geology. (3-0) 3 Credit Hours.
Prerequisites: GEO 3103 and GEO 3123, or consent of instructor. Integrated study of the generation, migration, and entrapment of petroleum. Survey of surface and subsurface geological and geophysical techniques for exploration and production. Case studies of petroleum systems including economic aspects of the petroleum industry. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5413. River Science. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in biology, environmental science, geology, or civil engineering, or consent of instructor. An in-depth examination of river sediment transport principles. Topics include water and sediment supply, sediment dynamics, river morphology, and channel instability. Field trips may be required. (Formerly GEO 5414. Same as CE 5323. Credit can be earned for only one of the following: CE 5323, CE 5653, GEO 5414, or GEO 5413.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5434. Fluvial Processes and Deposits. (3-3) 4 Credit Hours.
Prerequisite: GEO 4113 or GRG 3723, or consent of instructor. An in-depth examination of the interface between fluvial geomorphology and sedimentology. Key topics include sediment transport principles, bedform development, facies models, and architectural analysis. Field trips may be required. Course Fees: GS01 $120; LRS1 $20; STSI $20.

GEO 5454. Advanced Paleontology. (3-3) 4 Credit Hours.
Prerequisite: GEO 3063 or consent of instructor. In-depth paleontological analyses. Current literature and scientific deliberations will be emphasized. Topic 1: Focused Paleontology. Detailed study of one to three taxonomic groups. Topic 2: Vertebrate Paleontology. The evolutionary history of the Vertebrata. Topic 3: Earth Systems Paleontology. Survey of past interactions between the biosphere, lithosphere, and atmosphere. May be repeated for credit when topics vary. Field trips may be required. Course Fees: GS01 $120; LRS1 $20; STSI $20.

GEO 5483. Environmental Hydrogeology. (3-0) 3 Credit Hours.
Focuses on the physical and chemical processes that control natural variation in the chemical and isotopic composition of groundwater, fate and transport of groundwater contaminants, and modeling of groundwater quality using publicly available computer programs. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5504. Advanced Stratigraphy. (3-3) 4 Credit Hours.
Prerequisites: GEO 3123 and GEO 3131, or consent of instructor. Chronologic study of stratigraphic systems, physical properties and facies, depositional and paleogeographic implications, correlation, nomenclature, and biostratigraphy. Sequence stratigraphy and seismic and log analyses are studied. Field trips may be required. Course Fees: GS01 $120; LRS1 $20; STSI $20.

GEO 5603. Physical Hydrogeology. (3-0) 3 Credit Hours.
Prerequisite: GEO 4623 with a grade of "C-" or better, or consent of instructor. Geologic principles governing the flow of subsurface water with an emphasis on physical hydrogeology, interaction of surface and groundwater, hydrogeologic properties and their measurement, flow in the unsaturated zone, mass transport, evolution of aquifer systems, and an introduction to groundwater modeling. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5713. Groundwater Modeling. (3-0) 3 Credit Hours.
Prerequisite: GEO 5603 or consent of instructor. Focus is on using MODFLOW code to model the occurrence and movement of groundwater. Course will discuss hydrogeologic data for modeling, modeling protocol, and MODFLOW packages. Multiple graphics-rich user model interfaces commonly used in groundwater science will be learned. Other computer programs for simulating flow of subsurface fluids may be included. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5894. Advanced Structural Geology. (3-3) 4 Credit Hours.
Prerequisites: GEO 3103 and GEO 3111, or consent of instructor. In-depth study of the various aspects of structural geology: stress and strain, behavior of materials, failure criteria, fault analysis, rheological properties of geologic materials, fold analysis, and subsurface analysis. Field trips may be required. Course Fees: GS01 $120; LRS1 $20; STSI $20.

GEO 5904. Carbonate Petrology. (3-3) 4 Credit Hours.
Prerequisites: GEO 3043, GEO 3051, GEO 3123, and GEO 3131, or consent of instructor. Thin-section analysis and hand-specimen study of carbonate sediment and rocks, carbonate classifications, carbonate facies, models, and carbonate diagenesis. Field trips required. Course Fees: GS01 $120; LRS1 $20; STSI $20.

GEO 5954. Sandstone Petrology. (3-3) 4 Credit Hours.
Prerequisites: GEO 3043, GEO 3051, GEO 3123, and GEO 3131, or consent of instructor. Thin-section analysis and hand-specimen study of clastic rocks, classifications, interpretation of provenance, clastic sedimentary facies, and clastic diagenesis. Field trips may be required. Course Fees: GS01 $120; LRS1 $20; STSI $20.

GEO 5971. Directed Research. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student's Graduate Advisor of Record. The directed research course may involve a laboratory, field-based, or theoretical problem. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Master's degree. Course Fees: GS01 $30; LRS1 $5; STSI $5.

GEO 5972. Directed Research. (0-0) 2 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student's Graduate Advisor of Record. The directed research course may involve a laboratory, field-based, or theoretical problem. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Master's degree. Course Fees: GS01 $60; LRS1 $10; STSI $10.

GEO 5973. Directed Research. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student's Graduate Advisor of Record. The directed research course may involve a laboratory, field-based, or theoretical problem. May be repeated for credit, but not more than 3 hours, regardless of discipline, will apply to the Master's degree. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 5991. Graduate Seminar in Geology. (1-0) 1 Credit Hour.
Prerequisite: Graduate standing in geology or consent of the Graduate Advisor of Record. Topical issues chosen by faculty and current research seminars presented by faculty, visiting lecturers, and Master's degree candidates. May be repeated for credit but only 2 hours may be applied toward the Master's degree. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). Course Fees: GS01 $30; LRS1 $5; STSI $5.

GEO 6011. Seminar in Geospatial Science and Applications. (1-0) 1 Credit Hour.
Seminar will focus on literature review of cutting-edge research in remote sensing, GIS, geoinformatics, and their applications to water resources, surface hydrology and cryosphere. Course Fees: GS01 $30; LRS1 $5; STSI $5.

GEO 6043. Global Change. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in the program or consent of instructor. Changes in the global distribution of plants and animals and the causes of the changes will be examined. Factors that are apparently coupled to changes in the atmosphere and environmental temperature will be examined. (Same as CE 6113 and ES 5043. Formerly GEO 5043. Credit can be earned for only one of the following: CE 6113, ES 5043, GEO 5043, or GEO 6043.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6053. Remote Sensing. (2-2) 3 Credit Hours.
Prerequisites: MAT 1073, and PHY 1603 or PHY 1943. Fundamental remote sensing theory and technology will be introduced and emphasized as well as remote sensing applications to land surface, ocean, and atmosphere. Emphasis will be on the interaction of electromagnetic energy with the Earth's surface and different types of remote sensing for data collection. (Formerly GEO 5053. Credit cannot be earned for both GEO 5053 and GEO 6053.) Course Fees: GS01 $90; IUE1 $15; LRS1 $15; STSI $15.

GEO 6063. Ocean Remote Sensing. (3-0) 3 Credit Hours.
Prerequisites: MAT 1073 or equivalent, and PHY 1603 or PHY 1943 or equivalent. This course provides an overview of applications of satellite remote sensing to the study of the physics and biology of the oceans. The physical principles behind each type of ocean observing satellite system is presented as well as the various possible satellite orbits and sampling patterns. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6083. Remote Sensing Image Processing and Analysis. (2-2) 3 Credit Hours.
Prerequisite: GEO 4093 or GEO 6053, or consent of instructor. Fundamentals, algorithms, and techniques of remote sensing image processing, information extraction and analysis, including radiometric and geometric corrections, image enhancement, image sharpening, principal components analysis, image classification, spectral analysis, vectorization, integration with GIS, etc. (Formerly GEO 5083. Credit cannot be earned for both GEO 5083 and GEO 6083.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6093. Remote Sensing in Hydrology. (2-2) 3 Credit Hours.
Prerequisite: GEO 4093 or GEO 6053, or consent of instructor. Apply remote sensing to derive parameters of surface hydrology and hydrometeorology such as precipitation, land surface temperature and emissivity, heat flux, evaporation, evapotranspiration, soil moisture, surface water, water quality, snow and ice, and soil erosion. The contents will also include radar hydrology, microwave techniques and mapping of soil moisture and precipitation, and remote sensing in hydrologic modeling. (Formerly GEO 5093. Credit cannot be earned for GEO 5093 and GEO 6093.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6183. Basin Analysis and Sedimentary Geology. (3-0) 3 Credit Hours.
An interdisciplinary integration of geodynamics, mathematical and physical modeling, and sedimentary geology. Emphasizes basin formation, nature and maturation of the basin fill, and timing of events. Case histories of various basins illustrate approaches. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6243. Paleoecology and Paleoclimatology. (3-0) 3 Credit Hours.
Prerequisite: GEO 3063 or consent of instructor. Study of fossil organisms in relation to their past environments, and their interactions in extinct ecological communities. Use of fossils to interpret past environmental conditions, and the temporal contribution fossil communities provide to research of environmental change. Topic 1: Methods of Paleoecology. Survey of paleoecological theory and methods. Topic 2: Paleoclimatology. Review of the modern climate system and proxies for understanding major climate changes through geologic time. May be repeated for credit when topics vary. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6304. Isotope Geochemistry. (3-2) 4 Credit Hours.
Prerequisite: GEO 3374. The course will cover an introduction to isotope theory, and its utility in geological science and related fields. Focus will be on methods, data acquisition, data corrections, and interpretation. Laboratory methods for isotope sample preparation and hands-on experience with isotope ratio-mass spectrometry (IRMS) and peripherals. Course Fees: GS01 $120; LRS1 $20; STSI $20.

GEO 6344. Micropaleontology. (3-3) 4 Credit Hours.
Prerequisite: GEO 3063 or consent of instructor. A study of microscopic fossil organisms that commonly produced a fossil record. Emphasis on taxonomy, evolution, and processing methods for biostratigraphically and paleoecologically important groups. Field trips may be required. Course Fees: GS01 $120; IUE1 $15; LRS1 $20; STSI $20.

GEO 6403. Advanced Geophysics. (3-0) 3 Credit Hours.
Prerequisite: GEO 3383 or consent of instructor. Application of fundamentals of geophysical properties of the earth, specifically the propagation of seismic energy and electromagnetic (EM) fields in earth materials, toward an advanced analysis of seismic, EM prospection techniques, and well-logging methods. Techniques addressed will be specifically relevant to the petroleum and mineral extraction industries. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6513. Advanced GIS. (2-2) 3 Credit Hours.
Prerequisite: CE 5293 or GEO 5033, or consent of instructor. Geographic Information Systems (GIS) is an excellent tool for modeling, analyzing, and managing environmental systems. This course teaches advanced concepts and applications of industry standard GIS software, including spatial analysis, spatial statistics, geostatistical analysis, 3-D analysis, and geoprocessing. The emphasis of this course is on understanding the underlying principles of those tools and on how to apply them to solve real-world problems. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6523. GIS for Water Resources. (3-0) 3 Credit Hours.
Prerequisites: GEO 4623 and GEO 6513, or consent of instructor. Current approaches for using GIS to acquire, process and analyze spatial data for surface water and groundwater systems. Course will introduce watershed delineation techniques, spatial interpolation methods for analysis of precipitation and groundwater data, and GIS-based modeling of hydrologic mass-balance in watersheds. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6533. Programming for Geospatial Application. (2-2) 3 Credit Hours.
Prerequisite: CE 5293 or GEO 5033, or consent of instructor. This course teaches one or more programming languages with high-level toolkits suitable for GIS (Geographic Information System) application and development in a variety of open source environments. The course introduces key GIS concepts such as location, distance, units, projections, datum, and GIS data formats, examines a number of libraries of programming languages (e.g., Python or others), and explores how to combine these with geo-spatial data to accomplish a variety of tasks. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6813. Water Resources. (3-0) 3 Credit Hours.
Application of management principles to the efficient use of water resources by people and their public and private institutions. Water is examined in terms of its value, use, and changing role in the context of economics, history, politics, and technology. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6951. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student's Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. Course Fees: GS01 $30; LRS1 $5; STSI $5.

GEO 6952. Independent Study. (0-0) 2 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student's Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. Course Fees: GS01 $60; LRS1 $10; STSI $10.

GEO 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing and permission in writing (form available) of the instructor and the student's Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6961. Comprehensive Examination. (0-0) 1 Credit Hour.
Prerequisite: Approval of the appropriate Graduate Program Committee to take the Comprehensive Examination. Independent study course for the purpose of taking the Comprehensive Examination. May be repeated as many times as approved by the Graduate Program Committee. Enrollment is required each term in which the Comprehensive Examination is taken if no other courses are being taken that term. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). Course Fees: GS01 $30; LRS1 $5; STSI $5.

GEO 6973. Special Problems. (3-0) 3 Credit Hours.
Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Problems courses may be repeated for credit when the topics vary, but not more than 6 hours, regardless of discipline, will apply to a Master's degree. Field trips may be required. Course Fees: GS01 $90; LRS1 $15; STSI $15.

GEO 6981. Master's Thesis. (0-0) 1 Credit Hour.
Prerequisites: Permission of the Graduate Advisor of Record and thesis director. Thesis research preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Course Fees: GS01 $30; LRS1 $5; STSI $5.

GEO 6982. Master's Thesis. (0-0) 2 Credit Hours.
Prerequisites: Permission of the Graduate Advisor of Record and thesis director. Thesis research preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Course Fees: GS01 $60; LRS1 $10; STSI $10.

GEO 6983. Master's Thesis. (0-0) 3 Credit Hours.
Prerequisites: Permission of the Graduate Advisor of Record and thesis director. Thesis research preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Course Fees: GS01 $90; LRS1 $15; STSI $15.