

Geological Sciences

In the College of Sciences

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Faculty

Emeritus: Abbott, Bertine, Day, Dorman, Girty, Jiracek,
Kern, Krummenacher, Marshall, Miller, Peterson, Ptacek,
Thorbjarnarson, Wallace

Chair: Gontz

The Rollin and Caroline Eckis Chair in Seismology: Olsen

Professors: Frost, Gontz, Kimbrough, Olsen, Rockwell, Schellenberg

Associate Professor: Ma

Assistant Professor: Maloney

Lecturers: Camp, Robinson, Sacramentogrilo

Offered by the Department

Doctor of Philosophy degree in geophysics.

Master of Science degree in geological sciences.

Major in geological sciences with the B.S. degree in applied arts and sciences.

Emphasis in general geology.

Emphasis in engineering geology.

Emphasis in environmental geosciences.

Emphasis in geophysics.

Emphasis in hydrogeology.

Emphasis in paleontology.

Major in geological sciences with the B.A. degree in applied arts and sciences.

Minor in geological sciences.

Minor in oceanography.

The Rollin and Caroline Eckis Chair in Seismology

A gift from Rollin and Caroline Eckis, combined with matching funds from the Atlantic Richfield Company and contributions from SDSU faculty and staff, established The Rollin and Caroline Eckis Chair in Seismology at SDSU. The late Rollin Eckis was former president of Richfield Oil Company and vice chairman of the board of Atlantic Richfield Company.

The first appointee to the chair, Dr. Steven M. Day, conducts research on the mechanics of earthquakes and earthquake hazards. The current appointee, Dr. Kim Bak Olsen, conducts research on seismic wave propagation as well as earthquake source description and hazards.

The Major

Geological sciences is the study of the earth, its past, present, and future. Geoscientists apply basic physical, chemical, and biological principles to understand how the earth was formed, how it evolved, and how it may change in the future. In addition to understanding the origin and evolution of our planet, geologists seek to discover, use, and manage earth's resources in clean and environmentally responsible ways, and manage our water resources in a renewable way. The challenges will grow as geoscientists address major societal issues including dwindling energy resources, climate change, environmental pollution, and natural disasters from earthquakes, volcanic eruptions, and coastal subsidence.

Students who are curious about the planet on which we live, challenged by environmental problems facing humankind, and intrigued by a subject which combines both the arts and applied science, should consider the geological sciences as a major. Job prospects are good. Employment of geoscientists is projected to grow by 16 percent from 2012 to 2022, faster than the average for all occupations according to the U.S. Bureau of Labor Statistics. Many openings are expected in consulting firms and the oil and

gas industry. Job opportunities should be excellent for geoscientists who graduate with a master's degree. Most new jobs will be in management, scientific, and geotechnical consulting services. Many government agencies, including the U.S. Geological Survey, the U.S. Bureau of Reclamation, the California Department of Conservation, and regional planning offices hire geoscientists.

The department offers two undergraduate degree options:

- The Bachelor of Science degree is designed for students who intend to become professional geologists and/or those who plan to attend graduate school in geosciences. The program includes courses normally expected of graduate school applicants and prepares students for the examination for professional geologic registration licensing.
- The Bachelor of Arts degree is designed for students who seek a degree in the geological sciences as a foundation for careers in a variety of areas. This option leverages the strongly interdisciplinary socially relevant aspects of the science. The B.A. program includes a broad spectrum of courses, and focuses both on information about the earth and on how society makes decisions that affect the earth system. The Bachelor of Arts degree in Applied Arts and Sciences meets the requirements of the California Community College Associate in Science (AS-T) in Geology for Transfer degree students completing the Transfer Model Curriculum (TMC).

Impacted Program

The geological sciences major and emphases are impacted programs. To be admitted to the geological sciences major or an emphasis, students must meet the following criteria:

- a. Complete preparation for the major;
- b. Complete a minimum of 60 transferable semester units;
- c. Have a minimum cumulative GPA of 2.0.

To complete the major, students must fulfill the degree requirements for the major described in the catalog in effect at the time they are accepted into the premajor at SDSU (assuming continuous enrollment).

Major Academic Plans (MAPs)

Visit <http://www.sdsu.edu/mymap> for the recommended courses needed to fulfill your major requirements. The MAPs website was created to help students navigate the course requirements for their majors and to identify which General Education course will also fulfill a major preparation course requirement.

Geological Sciences Major

**With the B.S. Degree in Applied Arts and Sciences
(Major Code: 19141)**

All candidates for a degree in applied arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements." All required upper division courses must be taken for letter grades only, not credit/no credit.

Courses to satisfy the requirement of 36 or more upper division units in the major may be selected from upper division geological sciences courses not explicitly excluded. Students may petition the department to include courses from other disciplines to complete the upper division major requirement.

A minor is not required with this major.

Emphasis in General Geology

(SIMS Code: 775324)

Preparation for the Major. Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 101 and 104; Geological Sciences 200, 205, 221; Biology 100, 100L; Chemistry 200, 201; Mathematics 150, 151; Physics 195, 195L, 196, 196L. (44 units)

Recommended: Physics 197, 197L; Mathematics 252.

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 37-39 upper division units in approved courses to include Geological Sciences 300, 306, 307, 324, 336, 508, 530; and 12 additional upper division units from geological sciences (upper division courses from outside department by approval).

Emphasis in Engineering Geology

(SIMS Code: 775313)

Preparation for the Major. Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 101 and 104; Geological Sciences 205, 221; Chemistry 200; Aerospace Engineering 200 [or Mechanical Engineering 200]; Mathematics 150, 151, 252; Physics 195, 196, 197. (40 units)

Recommended: Civil Engineering 218; Physics 195L, 196L, 197L.

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 38 upper division units in approved courses to include Geological Sciences 300, 306, 307, 324, 336, 508 (4 units); Civil Engineering 301 or Mechanical Engineering 304, Civil Engineering 462, 463; nine upper division units selected from Geological Sciences 498A, 498B, 514, 530, 550, 551, 560 or Civil Engineering 465; or other upper division courses approved by the department.

Emphasis in Environmental Geosciences

(SIMS Code: 775318)

Preparation for the Major. Oceanography 100, or Geological Sciences 100 and 101; or Geological Sciences 101 and either Geological Sciences 104 or Environmental Science 100 [or Sustainability 100]; Geological Sciences 200, 221; Biology 100, 100L; Chemistry 200, 201, Chemistry 232 and 232L, or 251; Mathematics 124 or 150; Physics 180A, 180B, 182A, 182B. (40-41 units)

Recommended: Geological Sciences 205, Statistics 250.

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 39 upper division units in approved courses to include Geological Sciences 306, 307, 324, 336, 505, 514, 530, 551; and 12 upper division units selected from Geological Sciences 300, 303, 305, 498A, 498B, 499, 508 (4 units), 520, 521, Environmental Science 301, Geography 370, Philosophy 332 [or Sustainability 332], Political Science 334 [or Sustainability 334].

Emphasis in Geophysics

(SIMS Code: 775346)

Preparation for the Major. Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 101 and 104; Geological Sciences 200, 221; Chemistry 200; Mathematics 150, 151, 252; Physics 195, 195L, 196, 196L, 197, 197L. Aerospace Engineering 280 must be taken if student selects Aerospace Engineering 515 and/or Electrical Engineering 340 in the major. (39 units)

Recommended: Geological Sciences 205, Statistics 250.

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 36-39 upper division units in approved courses to include Geological Sciences 300, 306, 307, 324, and 560; Mathematics 342A and 342B, or Aerospace Engineering 515; two courses selected from Geological Sciences 336, Physics 350*, Physics 400A* (or Electrical Engineering 340*); and nine upper division units of approved courses in geological sciences at the 500-level.

* Additional prerequisites required.

Emphasis in Hydrogeology

(SIMS Code: 775357)

Preparation for the Major. Oceanography 100, or Geological Sciences 100 and 101, or Geological Sciences 101 and 104; Geological Sciences 205, 221; Biology 100; Chemistry 200, 201; Mathematics 150, 151, 252; Physics 195, 196, 197. (45 units)

Recommended: Geological Sciences 200, Physics 195L, 196L, 197L.

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 36 upper division units in approved courses to include Geological Sciences 300, 306, 307, 324, 336, 508 (4 units), 514 or 530, 551; and eight upper division units of departmentally approved courses.

Emphasis in Paleontology

(SIMS Code: 775390)

Preparation for the Major. Oceanography 100, or Geological Sciences 100 and 101; or Geological Sciences 101 and either Geological Sciences 104 or Environmental Science 100 [or Sustainability 100]. Geological Sciences 200, 205, 221; Biology 203, 203L, 204, 204L, 215; Chemistry 200, 201; Mathematics 124 or 150; Physics 180A, 182A. (43 units)

Recommended: Physics 180B and 182B.

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 36 upper division units in approved courses to include Geological Sciences 306, 324, 336, 508 (4 units); Biology 352, 354; and 15 upper division units of departmentally approved courses.

Geological Sciences Major

With the B.A. Degree in Applied Arts and Sciences

(Major Code: 19141) (SIMS Code: 775311)

All candidates for a degree in applied arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements."

A minor is not required with this major.

Preparation for the Major. Oceanography 100, or Geological Sciences 100 or 104, and 101; Geological Sciences 200, 205, Mathematics 150 and 151, or any two of the following: Astronomy 101, Computer Science 100, Mathematics 141, 150, Physics 180A, 195, 196, Statistics 250. One of the following pairs: Chemistry 200 and 201, or Chemistry 100 and Biology 100 or 101, or Chemistry 200 and Biology 100 or 101. (24-29 units)

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 24 upper division units in approved courses to include Geological Sciences 303, 336, 505 or 520 or 537, Oceanography 320, and 12 additional units selected from Geological Sciences 301, 305, 306, 324, 412, 496, 499, 505, 508, 514, 520, 521, 530, 537, 550, 551, 560, 580; Anthropology 302, 360, 471; Biology 315, 324, 327; Chemistry 300; Economics 455, 456; Environmental Engineering 320, 355; Environmental Science 301; Geography 370; History 441; Journalism and Media Studies 300, 440, 494; Political Science 334 [or Sustainability 334], 564; Philosophy 332 [or Sustainability 332]; Public Administration 320, 485; Public Health 304, 331; Recreation and Tourism Management 305, 483. Students should consult with the undergraduate adviser in developing a program of study in support of career goals.

Geological Sciences Minor

(SIMS Code: 775301)

The minor in geological sciences consists of a minimum of 17 units in geological sciences, nine of which must be in upper division courses. Courses include Oceanography 100 or Geological Sciences 100 or 104; and 101, 205; and nine units selected from Geological Sciences 301, 303, 305; Oceanography 320.

Courses in the minor may not be counted toward the major, but may be used to satisfy preparation for the major and general education requirements, if applicable. A minimum of six upper division units must be completed in residence at San Diego State University.

Oceanography Minor

For a listing of requirements refer to the section of this catalog on Oceanography.

Courses (GEOL)

Refer to *Courses and Curricula and University Policies* sections of this catalog for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

LOWER DIVISION COURSES

GEOL 100. Planet Earth (3) [GE]

Earth's global systems. Plate tectonics, earthquakes, and volcanoes; evolution of our planet and life through geologic time; economic resources including fossil fuels and precious minerals; agents of erosion that shape the land.

GEOL 101. Dynamics of the Earth Laboratory (1) [GE]

Three hours of laboratory.
Prerequisite: Credit or concurrent registration in Geological Sciences 100, 104, or Environmental Science 100 [or Sustainability 100].

Hands-on experience with land forms, rocks, minerals, topographic maps, and aerial photographs. Includes demonstrations and field trips. Designed to accompany and augment Geological Sciences 100 or 104.

GEOL 104. Earth Science (3) [GE]

Earth's four principal reservoirs and their interconnectedness: solid earth, ocean, atmosphere, and biosphere. How humanity affects and is affected by these reservoirs. Most appropriate for liberal studies majors.

GEOL 200. Geologic Inquiry and Problem Solving (3)

Two lectures and three hours of laboratory.
Prerequisites: Oceanography 100; or Geological Sciences 100 and 101; or Geological Sciences 101 and either Geological Sciences 104 or Environmental Science 100 [or Sustainability 100].

Guided inquiry field and laboratory approach to solution of geologic problems. Written reports and oral presentations. Required weekend field trips.

GEOL 205. Historical Geology (4)

Three lectures and three hours of laboratory. Arrangement for field study during the semester.
Prerequisites: Oceanography 100 or Geological Sciences 100 and 101 or Geological Sciences 101 and 104.

Evolutionary history of earth as traced through rock and fossil records. Stratigraphic and depositional concepts.

GEOL 221. Mineralogy (3)

Two lectures and three hours of laboratory.
Prerequisites: Oceanography 100; or Geological Sciences 100 and 101; or Geological Sciences 101 and either Geological Sciences 104 or Environmental Science 100 [or Sustainability 100]. Credit or concurrent registration in Chemistry 200. Recommended: Geological Sciences 200.

Practice in determination of common minerals; their geologic environment, utilization, and economic significance. Introduction to optical techniques in mineral identification.

GEOL 296. Experimental Topics (1-4)

Selected topics. May be repeated with new content. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree.

UPPER DIVISION COURSES (Intended for Undergraduates)

GEOL 300. Geological Data Analysis (3)

Two lectures and three hours of laboratory.
Prerequisite: Credit or concurrent registration in Mathematics 150. Theory and techniques of geological data analysis. Elementary programming to model statistical processes. Statistical inference, error propagation, plotting, and curve fitting using geological examples.

GEOL 301. Geology of National Parks and Monuments (3) [GE]

Prerequisite: Completion of the General Education requirement in Foundations of Learning II.A., Natural Sciences and Quantitative Reasoning. Recommended: Geological Sciences 100.

Geology of a group of national parks and monuments, selected for their geological significance, scenic beauty, and visitor popularity. Not acceptable to the B.S. degree in geological sciences.

GEOL 303. Natural Disasters (3) [GE]

Prerequisite: Completion of the General Education requirement in Foundations of Learning II.A., Natural Sciences and Quantitative Reasoning. Recommended: Geological Sciences 100.

Geologic processes that have dramatically affected the human race: earthquakes, volcanoes, landslides, and floods. Not acceptable to the B.S. degree in geological sciences, except for the emphasis in environmental geosciences.

GEOL 305. Water and the Environment (3) [GE]

Prerequisites: Completion of the General Education requirement in Foundations of Learning II.A., Natural Sciences and Quantitative Reasoning. Recommended: Geological Sciences 100 or Geography 101.

Movement of fresh water on earth. Hydrologic cycling of water from precipitation, runoff, infiltration, stream and groundwater flow to the ocean. Problems caused by over-use of water resources, urbanization, and water pollution examined with case studies. Not acceptable to the B.S. degree in geological sciences, except for the emphasis in environmental geosciences.

GEOL 306. Structural Geology and Field Methods (5)

Two lectures and three hours of laboratory and six weekends in the field.

Prerequisites: Geological Sciences 324; algebra, trigonometry, and at least high school physics. Highly recommended: First semester college physics.

Integrates structural and introductory field geology. Principles, causes, and mechanisms of rock deformation combined with field study. Graphical, computer, and analytical techniques for working with folds and faults are applied in the field. Field observations are presented in geologic maps, cross sections, and reports.

GEOL 307. Geophysics and Field Methods (4)

Two lectures and three hours of laboratory and a minimum of three weekends in field during semester.

Prerequisites: Geological Sciences 306; Mathematics 124 or 150; Physics 180A or 195.

Principles and field studies of gravity, magnetic, and seismic techniques applied to structure, dynamics, and shallow environment of the earth. Computer-aided data reduction and interpretation.

GEOL 324. Petrology (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 221.
Composition, classification, occurrence, and origin of igneous, sedimentary, and metamorphic rocks. Identification of rocks in hand specimen; petrographic analysis of rocks in thin section; modeling and interpretation of petrologic data.

GEOL 336. Sedimentology and Lithostratigraphy (3)

Two lectures and three hours of laboratory.
Prerequisites: Geological Sciences 200 (not required but recommended for emphases in engineering geology and hydrogeology) and Geological Sciences 205 (not required but recommended for emphases in environmental geosciences and geophysics).

Sedimentologic description and interpretation of the textures and structures of sediments and sedimentary rocks. Stratigraphic analysis of stratal succession, age relationships, and correlation on local and global scales.

GEOL 412. Processes and Inquiry in the Earth Sciences (4)

Three lectures and two hours of activity.

Prerequisite: Completion of the General Education requirement in Foundations of Learning II.A., Natural Sciences and Quantitative Reasoning.

Investigation of processes of inquiry and rational thinking skills characteristic of the earth sciences.

GEOL 496. Selected Topics in Geology (1-4)

Prerequisite: Consent of instructor.

Selected topics in geology and related earth sciences. May be repeated with new content. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit six units.

GEOL 498A. Research Methods and Communication (1) Cr/NC

Prerequisites: Nine upper division units in geological sciences. Cumulative 3.0 GPA and consent of instructor. **Proof of completion of prerequisites required:** Copy of transcript.

Development and testing of scientific hypotheses and their effective communication through oral, written, and visual modes. To be taken prior to registration in Geological Sciences 498B.

GEOL 498B. Senior Thesis (2)

Prerequisite: Consent of instructor.

Individual research project, written thesis, and oral presentation done under supervision of professor chosen by student.

GEOL 499. Special Study (1-4)

Prerequisites: Acceptable grade average in at least 12 upper division units within the major and consent of staff.

Individual study in field, library, laboratory, or museum work. Maximum credit four units.

**UPPER DIVISION COURSES
(Also Acceptable for Advanced Degrees)**

GEOL 505. Imaging and GIS in Disaster Response (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 200 or enrollment in homeland security program.

Imaging and Geographic Information Systems applications in disaster management.

GEOL 508. Advanced Field Geology (4 or 6)

One lecture and three hours of laboratory plus 28 days in the field. For the option with six units: two additional weeks of field or laboratory work.

Prerequisite: Geological Sciences 306.

Investigation of individually assigned areas, preparation of geologic maps, geologic sections, and gathering other types of data, e.g., petrologic, geophysical, or paleontologic, as appropriate. Students are responsible for cost of food and transportation. Students must demonstrate the physical ability to adequately and safely perform fieldwork under varying weather conditions; in steep, uneven or rocky terrain; for long periods of time.

GEOL 514. Process Geomorphology (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 306.

Processes shaping and affecting the earth's surface, and application of resultant land forms in interpretation of geologic structure, stratigraphy, and neotectonics.

GEOL 520. Economic Geology (3)

Prerequisite: Geological Sciences 200.

Origin and distribution of mineral deposits, economic considerations involved in their recovery, and assessment of available reserves.

GEOL 521. Petroleum Geology (3)

Prerequisite: Geological Sciences 336.

History of petroleum exploration; statistics of energy use; principles of well logging; theories of petroleum generation, migration, and accumulation; exploration and production techniques; case studies of important oil fields.

GEOL 530. Geochemistry (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 324; Credit or concurrent registration in Chemistry 201; Mathematics 124 or 150.

Fundamental principles of low- and high-temperature geochemistry. Origin of the elements; formation of the solar system; differentiation of the earth; weathering at the earth's surface; chemistry of natural waters. Laboratory methods applied to geological problems.

GEOL 537. Geobiology (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 205 and either Biology 100-100L, 101-101L or 203-203L, and Geological Sciences 336.

Principles of paleontology, including ecology and evolution. Tools of paleontology, including biomechanics, shape analysis, phylogeny, population analysis, study of biogeographic, temporal, and environmental distribution. Focus on using biology to solve geologic problems and vice versa.

GEOL 538. Notable Historic Earthquakes (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 300.

Earthquake magnitude, fault source physics and rupture mechanisms, earthquake location and ground motion estimation, geotechnical aspects, earthquake triggering and geodesy.

GEOL 550. Engineering Geology (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 306.

Relationships between geologic processes and works of humans. Topics include rock and soil mechanics, ground water flow, slope stability, seismicity, land subsidence, and evaluation of geologic materials with respect to dam sites, tunnel alignments, and building foundations.

GEOL 551. Hydrogeology (3)

Two lectures and three hours of laboratory.

Prerequisites: Geological Sciences 306 and Mathematics 124 or 150.

Theory of ground water flow. Exploration for and development of the ground water resource. Aquifer tests, water quality, and water resource management. Occurrence of water in alluvial, sedimentary, volcanic, plutonic, and metamorphic terrains.

GEOL 560. Earthquake Seismology (3)

Two lectures and three hours of laboratory.

Prerequisites: Mathematics 252, Physics 197. Recommended: Mathematics 342A.

Theory of seismic wave excitation, propagation, and recording. Methods of seismogram interpretation and analysis. Applications to tectonics and earthquake hazard analysis.

GEOL 580. Seismic Interpretation and 3D Visualization (3)

Two lectures and three hours of laboratory.

Prerequisite: Geological Sciences 306.

Computer-based seismic interpretation, mapping, and modeling in both 2D and 3D. Overview of basic seismic processing. Emphasis on industrial applications, both petroleum and shallow geotechnical.

GEOL 587. Volcanology (3)

Prerequisite: Geological Sciences 324.

Magma and magma chamber properties. Eruptive mechanisms, volcano types, and a variety of volcanic phenomena associated with Hawaiian, Strombolian, Plinian, Vulcanian, and hydrovolcanic eruptions. Volcanic phenomena applied to classic and historic eruptions. (Formerly numbered Geological Sciences 687.)

GEOL 596. Advanced Topics in Geology (1-4)

Prerequisite: Consent of instructor.

Advanced special topics in the geological sciences. May be repeated with new content. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit of six units of 596 applicable to a bachelor's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

**GRADUATE COURSES
Refer to the *Graduate Bulletin*.**