

# Earth and Environmental Sciences (EAES)

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## Courses

### EAES 400. Field Experience in Earth Sciences. 1-6 hours.

Training in and application of field methods (geological, geochemical, and geophysical) to solution of problems in earth and environmental sciences. Course Information: May be repeated to a maximum of 6 hours. Field trips required at a nominal fee. Field work required. Students who wish to use EAES 400 to satisfy the summer course selective must register for at least 4 credit hours. Prerequisite(s): Consent of the instructor.

### EAES 415. Environmental Geochemistry. 4 hours.

Origin and distribution of elements in the earth. Thermodynamics and kinetics of mineral-solution reactions. Behavior of stable and radioisotopes in geochemical processes. Elemental Cycles. Course Information: Prerequisite(s): EAES 330 and EAES 385; and CHEM 122 and CHEM 123; or consent of the instructor.

### EAES 416. Organic Geochemistry. 3 hours.

Global carbon cycle, chemical composition of biogenic matter, sedimentology and diagenesis of organic matter, molecular fossils, geopolymers, fossil fuels, anthropogenic organic compounds, carbon isotope geochemistry. Course Information: Prerequisite(s): EAES 330; and CHEM 122 and CHEM 123; or consent of the instructor.

### EAES 418. Introduction to Biogeochemistry. 3 hours.

Explores the interaction of the biosphere, geosphere, and atmosphere on Earth, with focus on biogeochemical cycles and the methods used to study them. Examination of conditions on Early Earth and the changes brought by the introduction of life. Course Information: Prerequisite(s): CHEM 122 and CHEM 123; and EAES 330 or EAES 385 or EAES 111; or consent of the instructor. Recommended background: BIOS 110.

### EAES 430. Petrology. 3 hours.

Introduction to the formation and classification of igneous and metamorphic rocks, as well as discussion of their implications for global-scale processes on Earth including formation of mineral deposits and earthquakes. Course Information: Prerequisite(s): EAES 111 and EAES 330; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

### EAES 440. Structural Geology and Tectonics. 3 hours.

Introduction to deformation structures recorded in the lithosphere as well as discussion of deformation mechanisms and their relationship with plate tectonics. The course also explores key processes occurring in different tectonic settings. Course Information: Field trip required at a nominal fee. Prerequisite(s): EAES 111 and EAES 330; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

### EAES 444. Geophysics. 4 hours.

Introduction to basic principles of geophysics applicable for environmental problems and the solid earth including magnetics, electric, seismic, gravity, geophysical well logging, radioactivity and heat flow. Course Information: Prerequisite(s): EAES 111 or consent of the instructor. Recommended background: EAES 385 and completion of introductory courses in physics and calculus.

### EAES 460. Earth System History. 4 hours.

Earth history in the context of the interactions of the components of the Earth system; methods used to establish the ages of geologic events and to reconstruct ancient geographies and environments; implications for current issues of global change. Course Information: Field trip required at a nominal fee. Field trip cost assessed prior to trip, depending on destination and vehicle expenses. Prerequisite(s): EAES 330 and EAES 385. Recommended background: EAES 360 and EAES 440.

### EAES 470. Environmental Geomorphology. 4 hours.

Quantitative analysis of the mechanics, rates, and distribution of physical processes that modify Earth's and other planets' surfaces. Introduction to field, theoretical, and modelling approaches. Course Information: Prerequisite(s): EAES 330 or EAES 385; and MATH 181; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

### EAES 472. Remote Sensing and GIS for Earth and Environmental Sciences. 3 hours.

Analysis and visualization of spatial datasets in Earth and environmental science obtained by remote sensing techniques. Passive and active remote sensing methods to identify geohazards and monitor environmental changes. Course Information: Extensive computer use required. Prerequisite(s): Grade of C or better in EAES 380; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory-Discussion.

### EAES 473. Soils and the Environment. 4 hours.

Soil science, emphasizing local soils and parent materials, soil classification and mapping, soil physics, soil gases and greenhouse gas emissions, soil chemistry and biogeochemistry, soil-plant interactions, and soil invertebrates. Course Information: Same as BIOS 473. Field work required. Recommended background: Introductory courses in Chemistry and Biology. Coursework in EAES (such as EAES 101 and/or EAES 111) is preferred.

### EAES 475. Hydrology/Hydrogeology. 3 hours.

The occurrence, storage, movement, and quality of water above, on and below the Earth's surface. Topics progress through atmospheric water vapor processes, Earth surface hydrology, and groundwater hydrology. Course Information: Field trip required at nominal fee. Prerequisite(s): EAES 111; or consent of the instructor. Recommended Background: EAES 385 and EAES 330 and MATH 181. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

### EAES 478. Elements of Machining Scientific Equipment. 1 hour.

Elements of machining scientific equipment, including the use of machine shop tools and technical drawing of scientific apparatus. Course Information: Same as CHEM 480 and PHYS 480. Satisfactory/Unsatisfactory grading only. Prerequisite(s): Graduate standing; and approval of the department.

### EAES 480. Modern Statistics in Earth and Environmental Sciences. 4 hours.

Scientific programming in R for modern statistical applications in Earth and environmental science. Study design, linear regression, hypothesis testing with bootstrapping, and inference for proportions, means, and regression models. Course Information: Extensive computer use required. WIFI-enabled laptop computer required. Prerequisite(s): EAES 380 or equivalent experience in a scientific programming language with consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Discussion.

**EAES 484. Planetary Science. 3 hours.**

Introduction to the study of the solar system, exploring the expressions of geologic processes on planetary bodies other than Earth. Course Information: Prerequisite(s): EAES 330 and EAES 385; or consent of the instructor.

**EAES 487. Introduction to Geobiology and Astrobiology. 3 hours.**

Emphasis on the emergence of microbiological life on Earth; evolution of the biosphere and life on early Earth; adaptations of life to extreme conditions, habitability, biosignatures; and the possibility of life elsewhere. Course Information: Prerequisite(s): EAES 418 and CHEM 122; or consent of the instructor. Recommended background: Introductory Biology; Introductory Earth Science.

**EAES 490. Climate Change and Extreme Weather. 4 hours.**

Exploration of fundamental knowledge of climate change and extreme weather, their causes, and driving mechanisms. Course Information: Prerequisite(s): Junior standing or above; or consent of the instructor. Recommended background: Introductory Physics, Calculus, Meteorology, Earth Science and/or Environmental Science.

**EAES 492. Internship in the Earth and Environmental Sciences. 1 hour.**

Off-campus participation in governmental or private-sector training program. Credit is contingent on submission of a final report. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated with approval. A combined maximum of 6 hours of credit in EAES 492 and EAES 396 may be applied toward the degree. Prerequisite(s): Approval of the Department.

**EAES 494. Current Topics in Earth and Environmental Sciences. 1-4 hours.**

Discussion of current research topics in earth and environmental sciences. Course Information: May be repeated to a maximum of 8 hours if topics vary. Students may register in more than one section per term. Prerequisite(s): Junior or Senior standing and 12 hours of advanced courses in earth and environmental sciences are recommended.

**EAES 510. Advanced Geochemistry. 3-4 hours.**

Advanced topics in one of the following categories: isotope geochemistry and geochronology, distribution of elements in the earth's crust, mineral systems with and without volatile components, low-temperature mineral systems. Lectures and seminars. Course Information: May be repeated if topics vary. Prerequisite(s): Consent of the instructor. Recommended background: Credit in EAES 410.

**EAES 511. Principles of Aqueous Geochemistry. 4 hours.**

Theory and application of thermodynamics and kinetics to processes controlling the compositions of natural waters, including solid and gas solubility, dissolution and precipitation, sorption, oxidation-reduction, acid-base equilibria. Course Information: Prerequisite(s): Consent of the instructor.

**EAES 512. Solid-Water Interface Chemistry. 4 hours.**

Description, theory, and characterization of molecular-scale chemical processes at the solid-water interface. Major emphasis on oxide minerals with minor emphasis on metals, salts, and organics. Course Information: Prerequisite(s): Consent of the instructor.

**EAES 513. Stable Isotope Geochemistry and Biogeochemistry. 4 hours.**

Lectures and readings will cover nucleosynthesis, physical basis of isotopic fractionation, isotopic distributions in nature, and applications of stable isotope ratio measurements in studies of geologic, hydrologic, and biogeochemical cycles. Course Information: Prerequisite(s): Consent of the instructor.

**EAES 514. Environmental Radioactivity. 4 hours.**

Covers the origins and distribution of radioactivity in the natural environment, along with applications of radioactivity measurements to studies of geologic, hydrologic, atmospheric, and biological processes. Course Information: Prerequisite(s): Consent of the instructor.

**EAES 516. Advanced Organic Geochemistry/Biochemistry. 4 hours.**

Carbon biogeochemical cycle, carbon fixation and carbon isotope fractionation, compound specific isotope analysis, biomarker geochemistry, paleoenvironment. Course Information: Prerequisite(s): EAES 416 or consent of the instructor.

**EAES 518. Geobiology. 4 hours.**

Interactions between microorganisms and minerals, preservation of organisms and biofilms, influence of microorganisms in biogeochemical cycles, microorganisms on early Earth, life in extreme environments, the dark biosphere, and astrobiology. Course Information: Same as BIOS 518. Recommended background: Basic knowledge of biology, chemistry, and earth sciences at the level of introductory college courses in each subject.

**EAES 520. Advanced Mineralogy. 4 hours.**

Various types in one of the following categories: structural determination, advanced diffraction techniques, crystal chemistry and structural mineralogy. Lectures, seminars, and laboratory. Course Information: May be repeated if topics vary. Prerequisite(s): Consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

**EAES 524. X-Ray Crystallography. 4 hours.**

Introduction to the use of diffraction techniques and crystallography for the identification and characterization of materials. Course Information: Previously listed as EAES 424. Prerequisite(s): Consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

**EAES 525. Quaternary Change. 4 hours.**

Interactions between climate, sea level, ice sheets, and the landscape during the Quaternary, with special focus on the period since the Last Glacial Maximum. Course Information: Field trip required at a nominal fee. Prerequisite(s): Consent of the instructor. Recommended background: Geomorphology, Hydrogeology/Hydrology, Introductory Earth science, Introductory Physics, Introductory Chemistry.

**EAES 530. Advanced Petrology. 3-4 hours.**

Selected topics: generation and properties of magmas, formation of metamorphic rocks, reaction rates in metamorphic rocks. Course Information: May be repeated if topics vary. Prerequisite(s): Consent of the instructor. Recommended background: Credit in EAES 430.

**EAES 541. Seismology. 4 hours.**

Elastic wave propagation theory, instrumentation, seismic source mechanisms, body and surface waves, free oscillations, earth's interior, focal mechanisms, earthquakes and plate tectonics. Course Information: Prerequisite(s): EAES 444 or consent of the instructor.

**EAES 543. Advanced Geophysics and Plate Tectonics. 4 hours.**

Advanced topics in geophysics and plate tectonics including subjects such as mantle convection, driving forces of plate tectonics and evolution of rifted continental margins. Course Information: May be repeated if topics vary. Students may register in more than one section per term. Prerequisite(s): EAES 444 or EAES 448.

**EAES 545. Spatial and Temporal Analysis and Modeling. 4 hours.**

Methods for the analysis and modeling of spatial and temporal patterns in the earth and environmental sciences. Data acquisition. Course Information: Prerequisite(s): Graduate standing; and consent of the instructor.

**EAES 546. Research Methods for Landscape Ecological and Anthropogenic Processes. 4 hours.**

Students will develop the skills to choose and utilize relevant methods and tools used in the study and management of altered natural landscapes to achieve research and management objectives through hands-on interdisciplinary laboratory modules. Course Information: Same as BIOS 546 and CME 546. Prerequisite(s): Consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Laboratory/Discussion.

**EAES 547. Field Experiences in Landscape Ecological and Anthropogenic Processes. 4 hours.**

Evaluation of the issues and needs of various landscape restorations and related urban-impacted sites in the Chicago metropolitan area based upon selected readings, site visits and presentations and discussions with the site manager/coordinators. Course Information: Same as BIOS 547 and CME 547. Prerequisite(s): Consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Lecture/Discussion and one practice.

**EAES 548. Capstone Project in Landscape, Ecological and Anthropogenic Processes. 4 hours.**

Interdisciplinary capstone project course that explores a "real-world" environmental issue selected by the students and approved by the faculty. Students will conduct research and analysis collaboratively and develop solutions and recommendations. Course Information: Same as BIOS 548 and CME 548. Prerequisite(s): Grade of B or better in BIOS 540 or Grade of B or better in CME 540 or Grade of B or better in EAES 540 or Grade of B or better in UPP 555; and Grade of B or better in BIOS 546 or Grade of B or better in CME 546 or Grade of B or better in EAES 546 or Grade of B or better in UPP 555; and Grade of B or better in BIOS 547 or Grade of B or better in CME 547 or Grade of B or better in EAES 547 or Grade of B or better in UPP 555. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Studio.

**EAES 555. Advanced Sedimentary Geology. 3 hours.**

Advanced topics in modern sedimentology and stratigraphy. Course Information: May be repeated if topics vary. Field trips required at nominal fee. Prerequisite(s): EAES 455 or consent of the instructor.

**EAES 560. Topics in Paleontology. 3-4 hours.**

In-depth analysis of current problems and issues in paleontology, involving reading primary literature, student presentations, and critical discussions. Course Information: Same as BIOS 560. May be repeated if topics vary. Prerequisite(s): Consent of the instructor.

**EAES 570. Advanced Surficial Processes. 4 hours.**

Advanced topics in theoretical, empirical, and applied aspects of hillslope processes, sediment transport mechanics, river mechanics, weathering and soil development, or drainage basin development. Course Information: May be repeated if topics vary. Prerequisite(s): EAES 470.

**EAES 572. Quaternary Environmental Systems. 3 hours.**

Interrelations between eolian, lacustrine, marine, eolian and glacial environments for the past 1.8 million years; geochronologic and isotopic methods; stratigraphic and geomorphic approaches. Course Information: Prerequisite(s): EAES 470.

**EAES 575. Advanced Hydrology. 3 hours.**

Selective topics; mechanics of near-surface groundwater, flow in fractured rocks, groundwater contamination, unsaturated-saturated flow, surface-groundwater interactions. Course Information: May be repeated if topics vary. Prerequisite(s): EAES 475.

**EAES 576. Paleoclimatology. 3 hours.**

Principles of climatology and paleoclimatology; mechanisms and causes of climate change for the past 63 million years; geologic records of climate and modelling. Course Information: Prerequisite(s): EAES 470.

**EAES 577. Climate and Land Interactions. 4 hours.**

Data and model driven analysis of how land surface properties influence Earth's climate system including energy balance, radiative transfer, ecohydrology, boundary layer processes, and global carbon and water cycles. Course Information: Extensive computer use required. Prerequisite(s): Consent of the instructor. Recommended background: Integral and differential calculus; Introductory Physics, Introductory Earth Science; Spreadsheet data analysis.

**EAES 578. Ecohydrology. 4 hours.**

Analysis of interactions between water and ecosystems across the aquatic continuum, from uplands to the coastal ocean. Feedbacks between ecological/biogeochemical processes and the hydrologic cycles. Course Information: Extensive computer use required. Basic experience with Matlab, R, or Python recommended. Prerequisite(s): Consent of the instructor. Recommended Background: Differential Equations, Introductory Earth Science.

**EAES 579. Climate Change and Ecosystem Science. 4 hours.**

Exploration of global climate change using conceptual, quantitative, field, and laboratory methods of ecosystem science, including soil biogeochemistry, ecosystem ecology, and Earth system modeling. Course Information: Field trip required at a nominal fee. Prerequisite(s): Graduate or professional standing; and consent of the instructor. Recommended background: Introductory Chemistry; Introductory Biology; Introductory Earth Science; Spreadsheet data analysis.

**EAES 580. Aquatic Science. 3 hours.**

Addresses environmental issues related to lakes, rivers, estuaries, and coastal zones. Topics will cover sampling techniques, impact of humans, and global change. Course Information: Field trip required at nominal fee. Prerequisite(s): EAES 475; or consent of the instructor.

**EAES 582. Climate Modeling, Data Analysis, and Applications. 4 hours.**

Introduction to climate modeling fundamentals, data analysis, and applications. Students will gain skills in programming, data handling, and quantitative methods to solve climate-related problems. Course Information: Extensive computer use required. Prerequisite(s): Consent of the instructor. Recommended background: Differential Equations; Introductory Physics, Mathematics, Meteorology, Earth and Environmental Science.

**EAES 590. Teaching and Presentation of Earth and Environmental Science. 2 hours.**

Development of students' skills in the pedagogy of teaching in the Earth and Environmental Sciences, and in the presentation in various forms of scientific information relevant to the discipline.

**EAES 595. Departmental Seminar. 0 hours.**

Special one-hour seminar, every Thursday, by invited speakers from other earth and environmental sciences departments, governmental agencies, and industry. Course Information: Satisfactory/Unsatisfactory grading only.

**EAES 596. Advanced Studies in Earth and Environmental Sciences.**

**1-6 hours.**

Independent study or research with faculty supervision, leading to a written report. Course Information: May be repeated. A maximum of 4 hours of credit may be applied toward the requirements for the M.S. degree. Prerequisite(s): Consent of the head of the department and the faculty member who will supervise the study.

**EAES 598. Master's Thesis Research. 0-16 hours.**

Individual work under the supervision of faculty members in their respective fields. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Consent of the thesis supervisor.

**EAES 599. Ph.D. Thesis Research. 0-16 hours.**

Individual work under the supervision of faculty members in their respective fields. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Consent of the thesis supervisor.