

# GEOLOGY & GEOPHYSICS (GEOS)

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## College of Natural Science & Mathematics

Department of Geosciences

907-474-7565

### GEOS F101L GEOS F101X Laboratory

0 Credit

Offered Fall

**Co-requisites:** GEOS F101X.

**Attributes:** UAF GER Natural Science Req

**Lecture + Lab + Other:** 0 + 0 + 0

**Grading System:** Non-Graded

### GEOS F101X The Dynamic Earth (n)

4 Credits

Offered Fall

An introduction to how the Earth works and the geophysical and geochemical basis for our understanding of the Earth, emphasizing Alaskan examples. A course theme is that the Earth is changing around us, at a variety of scales. Students collect, analyze and interpret data in all laboratory exercises.

**Prerequisites:** Placement in WRTG F111X; placement in MATH F105.

**Co-requisites:** GEOS F101L.

**Attributes:** UAF GER Natural Science Req

**Lecture + Lab + Other:** 3 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### GEOS F102X Wicked Maps for Wicked Problems: Geographic

Information Systems Across Disciplines

4 Credits

Offered Spring

Today's digital maps give instant information about pretty much anything in the world. They help find where people want to go, and also make change possible. Students will learn how to create digital maps that convey all types of information about any place around the globe.

**Attributes:** UAF GER Natural Science Req

**Lecture + Lab + Other:** 3 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### GEOS F106X Life in the Age of Dinosaurs (n)

4 Credits

Offered Spring Even-numbered Years

Promote a broader understanding of deep time through an examination of life and environments during the Mesozoic, or "Age of Dinosaurs." Discussions and exercises will focus on major events and processes that shaped the physical environments of the Mesozoic, such as the formation and break up of continents, global climate, and changing sea levels. Building on this foundation, the course will examine the fossil record to learn what it reveals about the major patterns in the diversity of terrestrial and marine life. Special emphasis will be placed on the origin, extinction, and paleobiology of dinosaurs. Important groups of contemporary vertebrates and invertebrates, including marine reptiles, mammals, flying reptiles, and ammonites will also be examined. The rise of flowering plants and the importance of fossil floras in understanding Mesozoic climates will be explored. Labs will provide opportunities to examine and identify fossils and use them to reconstruct ancient environments.

**Prerequisites:** Placement in WRTG F111X; placement in MATH F105.

**Attributes:** UAF GER Natural Science Req

**Lecture + Lab + Other:** 3 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### GEOS F111X Earth and Environment: Elements of Physical

Geography (n)

4 Credits

Offered Fall

This asynchronous online course focuses on the processes that shape the physical environment, especially in relation to Alaska. Climate change will serve as the capstone topic, which integrates course concepts with current challenges facing society. Labs will build research and skillsets through field and computer-based activities. Special fees will apply.

**Prerequisites:** Placement in WRTG F111X; placement in MATH F105.

**Attributes:** UAF GER Natural Science Req

**Lecture + Lab + Other:** 3 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### GEOS F112L GEOS F112X Laboratory (n)

0 Credit

Offered Spring

**Co-requisites:** GEOS F112X.

**Attributes:** UAF GER Natural Science Req

**Lecture + Lab + Other:** 0 + 0 + 0

**Grading System:** Non-Graded

### GEOS F112X The History of Earth and Life (n)

4 Credits

Offered Spring

Historical geologic interpretation, geologic time scale, stratigraphic record and interpretation. Sedimentation and plate tectonics, fossil record and utilization, biostratigraphy, and geologic evolution of the North American continent. Lab examination of fossils, interpretation of geologic maps and stratigraphic columns.

**Prerequisites:** GEOS F101X; placement in WRTG F111X; placement in MATH F105.

**Co-requisites:** GEOS F112L.

**Attributes:** UAF GER Natural Science Req

**Lecture + Lab + Other:** 3 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F119 Glaciers, Earthquakes and Volcanoes: Past, Present and Future**

3 Credits

Offered Spring

This course provides a basic overview of the science and societal relevance of earthquakes, glaciers and volcanoes, with an emphasis on Alaska.

**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F120L GEOS F120X Laboratory**

0 Credit

Offered Spring

**Co-requisites:** GEOS F120X.**Attributes:** UAF GER Natural Science Req**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Non-Graded**GEOS F120X Glaciers, Earthquakes and Volcanoes: Past, Present and Future (n)**

4 Credits

Offered Spring

This course provides a basic overview of the science and societal relevance of earthquakes, glaciers and volcanoes, with an emphasis on Alaska.

**Co-requisites:** GEOS F120L.**Attributes:** UAF GER Natural Science Req**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F190 The Geology of Wine**

2 Credits

Offered Spring Even-numbered Years

This course explores the relationship between geology, climate, and viticulture. Aspects of geology that influence landscape, soil development and climate are evaluated in reference to their effects on wine-growing regions. The geology, tectonic setting, soil and climate of individual wine-growing areas will be explored through lectures, discussions, class projects/presentations, and lab wine tastings.

**Prerequisites:** Student must be 21 years of age to enroll.**Lecture + Lab + Other:** 1.5 + 0.5 + 0**Grading System:** Pass/Fail Grades**GEOS F192 Seminar**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken unlimited times for up to 99 credits**GEOS F213 Mineralogy (n)**

4 Credits

Offered Fall

Mineral chemistry, atomic structure, elementary crystallography, optical crystallography and descriptive and determinative mineralogy. Instrumental determinative techniques (x-ray diffraction, petrographic microscope).

**Prerequisites:** MATH F151X, MATH F230X, MATH F251X, MATH F252X or MATH F253X (may be taken concurrently); CHEM F105X; GE F261 or GEOS F101X.**Lecture + Lab + Other:** 2 + 6 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F214 Petrology and Petrography (n)**

4 Credits

Offered Spring

Origin, occurrence and classification of igneous and metamorphic rocks. Laboratory work involves hand lens identification and thin section examination of representative rocks.

**Prerequisites:** GEOS F213.**Lecture + Lab + Other:** 2 + 6 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F221 Introduction to Field Geology**

2 Credits

Offered Spring Even-numbered Years

This course gives students the opportunity to apply 100-level geologic concepts at field sites with excellent exposures and straightforward stratigraphy. Participants use tools and technology, including a jacob staff, geologic compass, GPS receivers and mapping apps, to measure stratigraphic sections and create a geologic map on a topographic base map.

**Prerequisites:** GEOS F101X; GEOS F112X.**Lecture + Lab + Other:** 8 + 33 + 24**Grading System:** Letter Grades with option of Plus/Minus**GEOS F225 Field and Computer Methods in Geology (n)**

2 Credits

Offered Spring

We discuss and practice basic geologic field methods, including taking notes, topographic maps, measurement of structural elements, field mapping, and field safety, both with traditional analogue and modern digital tools. Computers are used for collecting data in the field, processing field and analytical data and producing maps and reports.

**Prerequisites:** GEOS F214 (may be taken concurrently).**Lecture + Lab + Other:** 1 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F258 Unmanned Aircraft Systems (UAS) Operations**

3 Credits

Offered As Demand Warrants

Covers the use of unmanned aircraft systems (UAS), sensors, and support infrastructure required to conduct a selected mission set. Emphasis is on mission analysis, planning, and conduct, including definition of requirements/constraints, identification of appropriate assets, flight planning considerations, and data analysis requirements. Teams coordinate resources for mission and report results.

**Cross-listed with** AERO F258; CS F258; and ME F258.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F262 Rocks and Minerals**

3 Credits

Offered Fall Even-numbered Years

Physical properties of minerals and rocks, classification, mode of occurrence and economic applications. Labs on recognition and measurement of physical properties. Course may not be used to satisfy degree requirements in geology or geological engineering.

**Prerequisites:** GE F261, GEOS F101X.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F292 Seminar**

1-6 Credits

**Lecture + Lab + Other:** 1-6 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken unlimited times for up to 99 credits

**GEOS F292P Seminar**

1-6 Credits

**Lecture + Lab + Other:** 1-6 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken unlimited times for up to 99 credits**GEOS F304 Geomorphology (n)**

3 Credits

Offered Spring Odd-numbered Years

Surface features of the Earth and the processes which create or modify them. Application to Quaternary history, environmental science and related fields. Laboratory examination of topographic maps and aerial photographs, introduction to geomorphic measurements.

**Prerequisites:** GEOS F101X or GEOS F111X.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F309 Tectonics**

3 Credits

Offered Fall Odd-numbered Years

In-depth exploration of Plate Tectonics theory including plate boundary interactions- which trigger volcanoes and earthquakes, form mountain belts and oceans- via geochemistry, sedimentology, geophysics and structure. Understanding creation and evolution of lithosphere and mantle, how we detect tectonic processes and how present tectonic environments help reconstruct ancient crustal events.

**Prerequisites:** WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X; GEOS F112X; GEOS F214 or GEOS F262 (either may be taken concurrently).**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F314 Structural Geology (n)**

4 Credits

Offered Spring

Introductory overview of how rocks are deformed, types of geological structures including folds, faults and penetrative fabrics, and the associations of structures characteristic of different tectonic settings. Provides background in structural geology. Emphasis in the laboratory on examples and techniques that are broadly applicable in geology, especially interpreting geologic maps.

**Prerequisites:** GEOS F320, GEOS F322 or GEOS F214 (GEOS F214 may be taken concurrently); MATH F152X; PHYS F123X or PHYS F211X.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F315 Paleobiology and Paleontology (n)**

4 Credits

Offered Fall Even-numbered Years

Survey of the history of life on Earth as represented in the fossil record. Contribution of paleontology to the study of evolution, past environments and paleogeography; biostratigraphically important invertebrate fossil groups and their temporal ranges; evolution of terrestrial flora and fauna; current issues in paleontology. Emphasis on recognition of major.

**Prerequisites:** BIOL F103X or BIOL F115X or GEOS F112X; WRTG F111X; WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F317 Paleontological Research and Laboratory Methods**

2 Credits

Offered As Demand Warrants

This introductory course covers the fundamentals of paleontological research and laboratory methods including fossil preparation, curation and digital imaging techniques such as microphotography and photogrammetry. Emphasis is placed on oral presentation of research results for both scientific and public audiences.

**Prerequisites:** GEOS F101X and GEOS F112X.**Lecture + Lab + Other:** 1 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F320 Sedimentology for Geological Engineers**

3 Credits

Offered Fall

Origin, classification, composition, transportation, deposition and diagenesis of sediments. Emphasis on sedimentary processes, sedimentary petrology and interpretation of ancient sedimentary rocks. Not intended for Geoscience majors and does not substitute for GEOS F322.

**Corequisites:** GEOS F213.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F322 Stratigraphy and Sedimentation (n)**

4 Credits

Offered Fall

Analysis and interpretation of sedimentary rocks in stratigraphic successions based on comparison with features found in modern depositional environments. Application of the principles of facies analysis and litho-, bio-, sequence, and chronostratigraphy in surface and subsurface examples. Emphasis in the laboratory on interpretation of depositional environments based on lithofacies, biofacies and sedimentary structures and correlation of stratigraphic sequences using surface and subsurface data.

**Prerequisites:** GEOS F101X or GE F261; GEOS F112X.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F332 Ore Deposits and Structure**

3 Credits

Offered Spring Even-numbered Years

Distribution and characteristics (especially mineralogy, morphology, and structure) of major mineral deposit types with background on structural techniques. Emphasis on application to mineral exploration and development. Laboratory exercises stress recognition of major mineral deposit types, zoning and grade patterns; and use of structural techniques in mineral deposit exploration/development.

**Prerequisites:** GEOS F262 or GEOS F213 and GEOS F214.**Lecture + Lab + Other:** 1 + 6 + 0**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F370 Sedimentology and Structural Geology for Petroleum Engineers (n)**

4 Credits

Offered Fall

Origin and distribution of sedimentary rocks including depositional environments, stratigraphic relationships and structures. Emphasis on the relationship to petroleum occurrences and petroleum exploration. Laboratory exercises on mapping, structural problems and facies relationships in petroleum exploration.

**Prerequisites:** GEOS F101X or GE F261.**Cross-listed with** PETE F370.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F375 Oral Communication Skills for Geoscientists**

1 Credit

Offered As Demand Warrants

This course will give you skills and practice in oral communication, especially as applied to professional geology. The course will provide a comfortable environment for students to develop and improve their skills both in creating and delivering oral presentations. The specific focus will vary with the instructor.

**Prerequisites:** COM F131X or COM F141X; GEOS F225; junior standing.**Lecture + Lab + Other:** 0.5 + 0 + 1.5**Grading System:** Letter Grades with option of Plus/Minus**GEOS F380 Geological Hazards**

3 Credits

Offered Spring

Surveys natural hazards and the disasters they cause, with emphasis on geological hazards in Alaska. Investigates hazardous phenomena, prediction and mitigation. Topics include: earthquakes, volcanoes, tsunamis, weather/climate and asteroid impacts. Provides foundation in basic geological hazards related to science, suitable for use in teaching, communications, policy and emergency management careers.

**Prerequisites:** GEOS F101X or GEOS F120X or GEOS F106X.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F392 Seminar**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken unlimited times for up to 99 credits**GEOS F392P Seminar**

1-6 Credits

**Lecture + Lab + Other:** 1-6 + 6 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken 98 times for up to 99 credits**GEOS F398 Research**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken unlimited times for up to 99 credits**GEOS F406 Volcanology**

3 Credits

Offered Spring Odd-numbered Years

Physical processes of volcanism. Topics include physical properties of magmas, eruption mechanisms, deposition mechanism and volcanic hazards. Emphasis on explosive volcanism and its products, pyroclastic rocks. Geochemistry and petrology will not be emphasized in this course.

**Prerequisites:** GEOS F101X or GEOS F120X; MATH F251X; PHYS F123X or PHYS F211X.**Stacked with** GEOS F606.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F413 Geology of Alaska**

2 Credits

Offered Fall Odd-numbered Years

An overview of the geological provinces of Alaska, followed by in-depth exploration of the geologic history and tectonic evolution of those regions.

**Prerequisites:** GEOS F309 and GEOS F314.**Stacked with** GEOS F612.**Lecture + Lab + Other:** 2 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken 2 times for up to 4 credits**GEOS F416 Applied Geophysics (n)**

3 Credits

Offered Spring Even-numbered Years

Introduction to the theory and practice of geophysical techniques and the interpretation and modeling of geophysical data. Topics include: gravity, GPS, magnetic seismic, and electrical methods and their application to regional and local geophysical exploration in Alaska.

**Prerequisites:** GEOS F419.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F417 Introduction to Geochemistry (n)**

3 Credits

Offered Fall

Application of chemical principles and elemental/isotopic behavior to the study of the Earth. Topics include: aqueous geochemistry, high-temperature mineral-elemental chemistry, isotopic chemistry, kinetics and thermochemistry.

**Prerequisites:** CHEM F106X; GEOS F322 or CHEM F202.**Stacked with** GEOS F618.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F419 Solid Earth Geophysics**

3 Credits

Offered As Demand Warrants

Concepts and techniques of geophysics including origin of the Earth, its structure and large scale dynamic processes responsible for its surface features. Geophysical techniques including seismology, gravity and magnetic methods are discussed along with measurements of the Earth's thermal structure, rotation rates and tidal effects.

**Prerequisites:** MATH F251X; PHYS F124X.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F422 Geoscience Applications of Remote Sensing (n)**

3 Credits

Offered Spring Odd-numbered Years

Remote sensing and its applications to geologic, environmental and physical sciences. Includes physical principles, digital image processing and hands-on project experience using satellite images for mapping and change detection.

**Prerequisites:** PHYS F124X or PHYS F212X.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F424 International Volcanological Field School**

3 Credits

Offered Summer

A field-based course that takes students to designated volcanoes and provides an opportunity to learn about volcanic processes through direct examination of volcanic products. Specific location to be announced at registration. Course may be repeated for credit when location varies. Students registering for the class must complete the course application and provide a reference letter.

**Prerequisites:** application required, permission of instructor, appropriate background in Geology, Chemistry and Physics.**Stacked with** GEOS F624.**Special Notes:** Students must be in good health, capable of hiking for at least 20 km per day carrying heavy backpacks, and be willing to camp under primitive, remote and possibly uncomfortable conditions.**Lecture + Lab + Other:** 2 + 1 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken 2 times for up to 6 credits**GEOS F426 Applied Seismology**

4 Credits

Offered As Demand Warrants

Presentation of modeling techniques for analyzing earthquakes and Earth structure using wave propagation algorithms and real seismic data. Topics include the seismic wavefield (body waves and surface waves), earthquake moment tensors, earthquake location and seismic tomography.

**Prerequisites:** MATH F253X; MATH F314.**Stacked with** GEOS F626.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F427 Inverse Problems and Parameter Estimation**

3 Credits

Offered As Demand Warrants

An inverse problem uses observations to infer properties of an unknown physical model. This course covers methods for solving inverse problems, including numerous examples arising in the natural sciences. Topics include linear regression, method of least squares, estimation of uncertainties, iterative optimization, and probabilistic (Bayesian) and sampling approaches.

**Prerequisites:** MATH F253X; MATH F314.**Stacked with** GEOS F627; PHYS F625.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F428 Elementary Scanning Electron Microscopy**

1 Credit

Offered Spring Even-numbered Years

Basic theory and operating procedures for scanning electron microscopy. Includes sample preparation, imaging and qualitative elemental analysis. Biological and nonbiological applications are covered.

**Prerequisites:** Junior standing.**Stacked with** GEOS F628.**Lecture + Lab + Other:** 0.5 + 1.5 + 0**Grading System:** Pass/Fail Grades**GEOS F430 Statistics and Data Analysis in Geology (n)**

3 Credits

Offered Spring

Computer-supported geologic applications of elementary statistics, Markov chains, time-series analysis, trend-surface analysis, factor analysis, cluster analysis, discriminant analysis, and multiple regression.

**Prerequisites:** GEOS F225; STAT F200X.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F431 Foundations of Geophysics**

4 Credits

Offered Fall Even-numbered Years

Applications of continuum mechanics, heat flow, and potential theory to geophysical problems. Topics such as postglacial rebound, non-Newtonian fluid flow, thermal convection, stress-relaxation, rheology of Earth materials, gravity and magnetics will be discussed. Emphasis is on methods to solve problems in global and regional geophysics and the interpretation of solutions.

**Prerequisites:** GEOS F419; MATH F302; MATH F314.**Stacked with** GEOS F631.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F436 Programming and Automation for Geoscientists**

2 Credits

Offered Fall

Basic concepts of computer programming and effective task automation for computers, with an emphasis on tools and problems common to the geosciences and other physical sciences. Use of Python, Jupyter Notebooks, shell scripting and command line tools, making scientific figures, maps and visualizations. Provided asynchronously remotely.

**Prerequisites:** Senior standing.**Stacked with** GEOS F636.**Lecture + Lab + Other:** 1 + 3 + 0**Grading System:** Pass/Fail Grades**GEOS F438 Basin Analysis**

3 Credits

Offered As Demand Warrants

Examines sedimentary basins as a record of subsidence. Review and discuss techniques used to image basin stratigraphy as well as the quantitative techniques which can be used to recover basin history.

**Prerequisites:** GEOS F322 or GEOS F370.**Recommended:** GEOS F314; GEOS F419.**Stacked with** GEOS F638.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F452 Quaternary Seminar**

3 Credits

Offered As Demand Warrants

Discussion of the Quaternary Period (relatively recent past – spanning the past two million years) in order to gain a better understanding of the landscape, biota and climate of the present day. Quaternary studies are concerned with the historical dimension of the natural sciences.

**Prerequisites:** GEOS F304; GEOS F315; GEOS F322.

**Cross-listed with** ANTH F451.

**Stacked with** GEOS F651; ANTH F651.

**Special Notes:** Topics range widely over diverse interdisciplinary subjects of quaternary interest, such as paleoclimatology, paleobiogeography, vertebrate paleontology and sedimentology.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F453 Palynology and Paleopalynology (n)**

4 Credits

Offered Fall Even-numbered Years

Survey of the evolutionary record of palynomorphs and their uses in biostratigraphy and paleoclimatology. Focus on evolution of palynomorphs from Precambrian to the present and concurrent evolutionary developments of producing plants. Use of Quaternary palynofloras in reconstructing global climates. Labs involve collection of herbarium specimens, processing of fossil palynomorphs, study of type slides and a survey of palynofloras from each geologic period.

**Prerequisites:** BIOL F115X or GEOS F315; senior standing.

**Stacked with** GEOS F653.

**Lecture + Lab + Other:** 3 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F454 Field Geology (n)**

6 Credits

Offered Summer Odd-numbered Years

Mapping sedimentary and crystalline rocks in different tectonic settings in central Alaska using analog and digital tools. Collecting structural and lithological data, compiling geologic maps, and drafting written reports. Mapping challenges increase from intensive guidance by "geo buddies" during the initial project to independent mapping during the final capstone project.

**Prerequisites:** WRTG F111X; WRTG F211X, WRTG F212X, WRTG F213X, WRTG F214X; GEOS F214; GEOS F225; GEOS F309; GEOS F314; GEOS F315; GEOS F322; junior standing.

**Lecture + Lab + Other:** 6 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F456 Paleopedology**

3 Credits

Offered As Demand Warrants

Origin, classification, composition, transportation, deposition and diagenesis of sediments. Emphasis on sedimentary processes, sedimentary petrology and interpretation of ancient sedimentary rocks. Not intended for Geoscience majors and does not substitute for Geos 322.

**Prerequisites:** GEOS F322 or NRM F380.

**Stacked with** GEOS F656.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F458 Big Geospatial Data (n)**

3 Credits

Offered Fall Odd-numbered Years

Analysis of large geospatial data sets and data-driven modeling for solving geoscientific problems. The class intertwines i) cloud-based processing of big vector and raster data sets from GPS surveys, models and remote sensing, and ii) predictive modeling using data science techniques such as Random Forests.

**Prerequisites:** GEOS F422, NRM F338 or senior standing in science or engineering.

**Stacked with** GEOS F658.

**Lecture + Lab + Other:** 2 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F459 Visible and Infrared Remote Sensing**

3 Credits

Offered Spring Even-numbered Years

The course covers the principles and practice of remote sensing in the visible and infrared region, including spectral signatures, radiative transfer, image analysis, and information extraction. The laboratory part provides hands-on experience with multispectral, thermal, hyperspectral, and LiDAR data sets. Practical examples are drawn from geology, hydrology, and forestry.

**Prerequisites:** GEOS F422.

**Stacked with** GEOS F659.

**Lecture + Lab + Other:** 2 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F460 The Dynamic Alaska Coastline**

3 Credits

Offered Spring Even-numbered Years

This course will provide the knowledge base for understanding Alaska's dynamic coastlines with an emphasis on climate and tectonic, driven changes. The class includes a multiday field trip to Homer offering field-based learning activities. Special fees apply.

**Prerequisites:** Junior standing; GEOS F111X or GEOS F101X; CHEM F105X or PHYS F123X; NRM F338 or equivalent GIS coursework.

**Stacked with** GEOS F660.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F465 Geoarchaeology**

3 Credits

Offered As Demand Warrants

Geological context of archaeological sites and the geologic factors that affect their preservation, with emphasis on Alaska. Includes a one or two-day weekend field trip in late April or early May.

**Prerequisites:** GEOS F101X, an introductory course in archaeology.

**Cross-listed with** ANTH F465.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F469 Geodetic Methods and Modeling**

3 Credits

Offered As Demand Warrants

Theory and application of modern geodetic tools to measure Earth's surface deformation with emphasis on GPS and InSAR. Basics of data processing. Evaluation of signals and modeling of their sources. Applications include magma systems, earthquake cycle, and hydro- and cryosphere. Labs in Python require programming experience (GEOS F436/F636).

**Prerequisites:** MATH F314; MATH F410; MATH F432.**Stacked with** GEOS F669.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F477 Ice in the Climate System (n)**

3 Credits

Offered As Demand Warrants

Earth's cryosphere includes seasonal snow, permafrost, sea ice, mountain glaciers and ice sheets. This course will cover the formation of each of these forms of snow and ice and their response to changing environmental conditions. Interdisciplinary perspectives allow study of the role snow and ice plays within the Arctic system.

**Prerequisites:** PHYS F123X or PHYS F211X; MATH F251X.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F480 Climate Change Processes: Past, Present, Future**

4 Credits

Offered Fall Odd-numbered Years

This 'synthesis' course for Geography, NRM, or Natural Sciences undergraduates provides literacy in the rapidly developing field of climate-change science. Students will gain an understanding of climate dynamics and Earth's climate history and will be trained to critically evaluate the validity of paleoclimatic reconstructions and climate-model predictions.

**Prerequisites:** Junior or senior standing.**Cross-listed with** ATM F480.**Stacked with** ATM F680 and GEOS F680.**Lecture + Lab + Other:** 4 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F481 Snow in the Environment**

3 Credits

Offered As Demand Warrants

Snow is a critical buffer between cold air temperatures and warming permafrost, between harsh winds and vegetation, and between herbivores and their food source. This course focuses on snow properties, metamorphism and redistribution by wind. We will examine the snows interactions with permafrost, glaciers, sea ice, vegetation, wildlife and humans.

**Stacked with** GEOS F681.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F482 Geoscience Seminar**

1 Credit

Offered Fall and Spring

A weekly seminar, given by guest speakers, on a topic in geosciences. Students are expected to prepare for the seminars and to participate in discussion following the seminars.

**Stacked with** GEOS F682.**Lecture + Lab + Other:** 1 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken 99 times for up to 99 credits**GEOS F483 Research Design, Writing and Presentation Methods (n)**

3 Credits

Offered Fall

This is a capstone professional development class where students write a research proposal, participate in engagement activities, and produce professional documents that prepare students for graduate and professional careers. It is writing and oral intensive and will focus on the oral and written presentation of your work.

**Prerequisites:** COM F131X or COM F141X; WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X; junior standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F485 Mass Extinctions, Neocatastrophism and the History of Life**

3 Credits

Offered Spring Odd-numbered Years

In-depth analysis of mass extinction, focusing on evidence for catastrophes and impact on the uniformitarian paradigm. Effects of mass extinctions on the evolution of extant fossil biota is explored through classic and current papers. The course emphasizes critical reading and application of scientific methods to reconstruct catastrophic deep-time events.

**Prerequisites:** GEOS F322 and GEOS F315.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F486 Vertebrate Paleontology (n)**

3 Credits

Offered Spring Odd-numbered Years

The study of vertebrate evolution through geologic time. Covers the temporal range, diversity and systematics of major vertebrate groups as documented in the fossil record, with an emphasis on current problems in vertebrate evolutionary pattern and process. Labs emphasize comparative morphology and identification of major vertebrate groups.

**Prerequisites:** BIOL F310 or GEOS F315.**Cross-listed with** BIOL F486.**Stacked with** GEOS F686; BIOL F686.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F488 Undergraduate Research**

1-3 Credits

Offered As Demand Warrants

Advanced research topics from outside the usual undergraduate requirements.

**Prerequisites:** Permission of instructor.**Recommended:** A substantial level of technical/scientific background.**Lecture + Lab + Other:** 1-3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken 8 times for up to 24 credits**GEOS F488P Undergraduate Research**

1-3 Credits

Offered As Demand Warrants

Advanced research topics from outside the usual undergraduate requirements.

**Prerequisites:** Permission of instructor.**Recommended:** A substantial level of technical/scientific background.**Lecture + Lab + Other:** 1-3 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken 8 times for up to 24 credits

**GEOS F492 Seminar**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken unlimited times for up to 99 credits**GEOS F492P Seminar**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken 98 times for up to unlimited credits**GEOS F499 Geology and Geophysics Senior Thesis**

3 Credits

This course is intended for talented students to explore geology or geophysics more deeply through research under the mentorship of a faculty member in the department.

**Prerequisites:** Geology and Geophysics major with senior standing and a GPA of 3.2 or higher, completion of a minimum of 2 credits of GEOS F488 on a project approved by faculty mentor and department chair, and submission of a proposal approved by faculty mentor and department chair.

**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F602 Geophysical Fields**

3 Credits

Offered Spring Odd-numbered Years

Introduction to the application of potential theory and its associated mathematical tools to fields of geophysical interest, namely gravity, magnetics, and heat flow. Emphasis will be placed on methods and tools for solving a variety of problems in global and regional geophysics, and the geophysical interpretation of solutions.

**Prerequisites:** MATH F410 and MATH F432; or graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F604 Seismology**

3 Credits

Offered As Demand Warrants

Sources of ground motion including focal mechanisms, magnitude and propagation of waves within the earth. Measurement of seismic data by analog and digital techniques and subsequent treatment of seismic data by various techniques including inversion.

**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F605 Geochronology**

3 Credits

Offered Fall Odd-numbered Years

Application of the most commonly used radiometric dating methods to geologic problems. Fundamentals of the K-Ar, Rb-Sr, fission-track, U-Th-Pb and C methods. Laboratory training in K-Ar and fission-track dating techniques.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F606 Volcanology**

3 Credits

Offered Spring Odd-numbered Years

Physical processes of volcanism. Topics include physical properties of magmas, eruption mechanisms, deposition mechanism and volcanic hazards. Emphasis on explosive volcanism and its products, pyroclastic rocks. Geochemistry and petrology will not be emphasized in this course.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F406.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F611 Advanced Structural Geology and Tectonics**

3 Credits

Offered As Demand Warrants

This advanced course in structural geology and tectonics offers in-depth treatment of topics that may vary with each offering. Examples are tectonics and sedimentation, mountain belts of the world, structural analysis, structural geology of specific tectonic settings, active tectonics and topography, structural interpretation of seismic reflection data, and other topics.

**Prerequisites:** GEOS F314; graduate standing.**Special Notes:** Course may be repeated for different topics up to three times for credit.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F612 Geology of Alaska**

2 Credits

Offered Fall Odd-numbered Years

An overview of the geological provinces of Alaska, followed by in-depth exploration of the geologic history and tectonic evolution of those regions.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F413.**Lecture + Lab + Other:** 2 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken 2 times for up to 4 credits**GEOS F614 Ice Physics**

3 Credits

Offered Spring Even-numbered Years

A survey of the physics of ice. Topics will include the crystal structure and properties of ice, high pressure phases, hydrogen bonding, mechanical, thermal, electrical and acoustic properties, nucleation and growth, and optical and surface properties (adhesion, friction).

**Prerequisites:** Graduate standing.**Cross-listed with** PHYS F614.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F615 Sea Ice**

3 Credits

Offered As Demand Warrants

A study of sea ice in the natural environment including sea ice properties and processes on the micro-scale and the macro-scale, freezing processes and sea ice growth, ice decay and ice dynamics.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus



**GEOS F616 Permafrost**

3 Credits

Offered As Demand Warrants

Study of the occurrence, thickness, environmental problems, and mass and energy transport of permafrost, including soil and ice interaction, freezing and thawing processes, and mechanical and electrical properties and processes.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F617 Glaciers**

3 Credits

Offered As Demand Warrants

The mechanisms responsible for the existence, motion and variations of present-day glaciers and ice sheets, the paleoclimate information they contain and their role in engineering hydrology.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F618 Introduction to Geochemistry**

3 Credits

Offered Fall

Application of chemical principles and elemental/isotopic behavior to study of the Earth. Topics include: aqueous geochemistry, high-temperature mineral-elemental chemistry, isotopic chemistry, kinetics and thermochemistry.

**Prerequisites:** CHEM F106X; GEOS F322 OR CHEM F331 and CHEM F332; graduate standing.**Stacked with** GEOS F417.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F621 Advanced Petrology**

4 Credits

Offered As Demand Warrants

A detailed treatment of various aspects of petrology. Specific topics to be considered in different semesters include metamorphic petrology, igneous petrology, and igneous and metamorphic petrography. Each time the course is offered, only one topic will be presented.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F621B Adv Petrology: Igneous Petrology**

3-4 Credits

Offered As Demand Warrants

**Lecture + Lab + Other:** 2-3 + 3-6 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F621C Advanced Petrology**

3-4 Credits

Offered As Demand Warrants

An advanced course providing a detailed treatment of various aspects of petrology. Specific topics to be considered in different semesters include: (A) metamorphic petrology, (B) igneous petrology, and (C) igneous and metamorphic petrography. Each time the course is offered, only one topic will be presented.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 2-3 + 3-6 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F622 Digital Image Processing in the Geosciences**

3 Credits

Offered Fall Even-numbered Years

Image processing and analysis techniques to monitor and understand the Earth system. Geoscience applications to be addressed include thin-section analysis, remote sensing of geohazards and geomorphometry. Apart from lectures and demonstrations, the advantages and drawbacks of image processing techniques will be evaluated through exercises and a course project.

**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F624 International Volcanological Field School**

3 Credits

Offered Summer

A field-based course that takes students to designated volcanoes and provides an opportunity to learn about volcanic processes through direct examination of volcanic products. Specific location to be announced at registration. Course may be repeated for credit when location varies. Students registering for the class must complete the course application and provide a reference letter.

**Prerequisites:** graduate standing in volcanology.**Stacked with** GEOS F424.

**Special Notes:** Students must be in good health, capable of hiking for at least 20 km per day carrying heavy backpacks, and be willing to camp under primitive, remote and possibly uncomfortable conditions.

**Lecture + Lab + Other:** 2 + 1 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken 2 times for up to 6 credits**GEOS F626 Applied Seismology**

4 Credits

Offered As Demand Warrants

Presentation of modeling techniques for analyzing earthquakes and Earth structure using wave propagation algorithms and real seismic data. Topics include the seismic wavefield (body waves and surface waves), earthquake moment tensors, earthquake location and seismic tomography.

**Prerequisites:** MATH F253X; MATH F314.**Stacked with** GEOS F426.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F627 Inverse Problems and Parameter Estimation**

3 Credits

Offered As Demand Warrants

An inverse problem uses observations to infer properties of an unknown physical model. This course covers methods for solving inverse problems, including numerous examples arising in the natural sciences. Topics include linear regression, method of least squares, estimation of uncertainties, iterative optimization, and probabilistic (Bayesian) and sampling approaches.

**Prerequisites:** MATH F253X; MATH F314.**Cross-listed with** PHYS F625.**Stacked with** GEOS F427.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F628 Elementary Scanning Electron Microscopy**

1 Credit

Offered Spring Even-numbered Years

Basic theory and operating procedures for scanning electron microscopy. Includes sample preparation, imaging and qualitative elemental analysis. Biological and nonbiological applications are covered.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F428.**Lecture + Lab + Other:** 0.5 + 1.5 + 0**Grading System:** Pass/Fail Grades**GEOS F629 Geologic Hazards and Natural Disasters**

3 Credits

Offered Spring Odd-numbered Years

Examination of hazardous geologic processes which produce natural disasters, including volcanism, tectonism, flooding, etc. Includes scientific approaches to evaluating the magnitude and probability of risk from future hazardous events.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F631 Foundations of Geophysics**

4 Credits

Offered Fall Even-numbered Years

Applications of continuum mechanics, heat flow, and potential theory to geophysical problems. Topics such as postglacial rebound, non-Newtonian fluid flow, thermal convection, stress-relaxation, rheology of Earth materials, gravity and magnetism will be discussed. Emphasis is on methods to solve problems in global and regional geophysics and the interpretation of solutions.

**Prerequisites:** Graduate standing.**Recommended:** GEOS F419; MATH F302; MATH F314.**Stacked with** GEOS F431.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F633 Aqueous and Environmental Geochemistry**

3 Credits

Offered Spring Odd-numbered Years

Chemistry of aquatic and terrestrial environments, including thermodynamic, kinetic and structural principles applied to aqueous geochemical systems. Emphasis on aqueous speciation and heterogeneous interactions (e.g., dissolution/precipitation and sorption) involved in the partitioning, transformation and transport of chemical species in the environment.

**Prerequisites:** CHEM F331 or Graduate standing.**Cross-listed with** CHEM F609.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F636 Programming and Automation for Geoscientists**

2 Credits

Offered Fall

Basic concepts of computer programming and effective task automation for computers, with an emphasis on tools and problems common to the geosciences and other physical sciences. Use of Python, Jupyter Notebooks, shell scripting and command line tools, making scientific figures, maps and visualizations. Provided asynchronously remotely.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F436.**Lecture + Lab + Other:** 1 + 3 + 0**Grading System:** Pass/Fail Grades**GEOS F638 Basin Analysis**

3 Credits

Offered As Demand Warrants

Examines sedimentary basins as a record of subsidence. Review and discuss techniques used to image basin stratigraphy as well as the quantitative techniques which can be used to recover basin history.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F438.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F639 InSar and Its Applications**

3 Credits

Offered As Demand Warrants

Introduction to the concepts of repeat-pass spaceborne SAR interferometry. Practical use of the technique to derive displacements of the solid earth, glaciers and ice sheets to a precision of a few centimeters and accurate digital elevation models of the Earth's surface.

**Prerequisites:** Basic remote sensing course.**Cross-listed with** PHYS F639.**Lecture + Lab + Other:** 2 + 2 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F640 Petrology of Carbonate Rocks**

4 Credits

Offered As Demand Warrants

Origin, depositional environments, diagenesis and classification of limestones, dolostones and related rocks.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F643 Sandstone Depositional Environments**

3 Credits

Offered As Demand Warrants

Sedimentary depositional environments treating the hydrodynamics, sediment dispersal patterns and preservation potential of modern terrigenous clastic depositional environments and criteria for recognizing their ancient counterparts in the geologic record.

**Prerequisites:** GEOS F320 and GEOS F322; or graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F647 Advanced Sedimentology and Stratigraphy**

3 Credits

Offered Spring Even-numbered Years

Various topics in sedimentology and stratigraphy. Specific offerings to be presented at various times include sequence stratigraphy and sea-level analysis, paleoclimatic and paleoceanographic analyses, sandstone petrology, thermal maturation and geohistory analysis of sediments.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F651 Quaternary Seminar**

3 Credits

Offered As Demand Warrants

Discussion of the Quaternary Period (relatively recent past – spanning the past two million years) in order to gain a better understanding of the landscape, biota and climate of the present day. Quaternary studies are concerned with the historical dimension of the natural sciences.

**Prerequisites:** Graduate standing.**Cross-listed with** ANTH F651.**Stacked with** ANTH F451; GEOS F452.

**Special Notes:** Topics range widely over diverse interdisciplinary subjects of quaternary interest, such as paleoclimatology, paleobiogeography, vertebrate paleontology and sedimentology.

**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F653 Palynology and Paleopalynology**

4 Credits

Offered Fall Even-numbered Years

Survey of the evolutionary record of palynomorphs and their uses in biostratigraphy and paleoclimatology. Focus on evolution of palynomorphs from Precambrian to the present and concurrent evolutionary developments of producing plants. Use of Quaternary palynofloras in reconstructing global climates. Labs involve collection of herbarium specimens, processing of fossil palynomorphs, study of type slides and a survey of palynofloras from each geologic period.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F453.**Lecture + Lab + Other:** 3 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F656 Paleopedology**

3 Credits

Offered As Demand Warrants

Origin, classification, composition, transportation, deposition and diagenesis of sediments. Emphasis on sedimentary processes, sedimentary petrology and interpretation of ancient sedimentary rocks. Not intended for Geoscience majors and does not substitute for Geos 322.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F456.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F657 Microwave Remote Sensing**

3 Credits

Offered Spring Odd-numbered Years

The principles and applications of active and passive microwave remote sensing with emphasis on spaceborne remote sensing of the Earth's atmosphere, land and oceans. The laboratory section will provide hands-on experience on special processing techniques, and the possibility of using these techniques for a student-defined term project in areas of geology, volcanology, glaciology, hydrology, environmental sciences, etc.

**Prerequisites:** GEOS F422.**Lecture + Lab + Other:** 2 + 2 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F658 Big Geospatial Data**

3 Credits

Offered Fall Odd-numbered Years

Analysis of large geospatial data sets and data-driven modeling for solving geoscientific problems. The class intertwines i) cloud-based processing of big vector and raster data sets from GPS surveys, models and remote sensing, and ii) predictive modeling using data science techniques such as Random Forests.

**Prerequisites:** Graduate standing in science or engineering.**Stacked with** GEOS F458.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F659 Visible and Infrared Remote Sensing**

3 Credits

Offered Spring Even-numbered Years

The course covers the principles and practice of remote sensing in the visible and infrared region, including spectral signatures, radiative transfer, image analysis, and information extraction. The laboratory part provides hands-on experience with multispectral, thermal, hyperspectral, and LiDAR data sets. Practical examples are drawn from geology, hydrology, and forestry.

**Stacked with** GEOS F459.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F660 The Dynamic Alaska Coastline**

3 Credits

Offered Spring Even-numbered Years

This course will provide the knowledge base for understanding Alaska's dynamic coastlines with an emphasis on climate and tectonic, driven changes. The class includes a multiday field trip to Homer offering field-based learning activities. Special fees apply.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F460.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F666 Scientific Teaching**

2 Credits

Offered Spring Even-numbered Years

This course explores methods for teaching science at the university level. Emphasis is placed on methods of course design, instructional techniques, assessment and course management that have been shown by research to improve student learning. This course is intended for graduate students in the sciences who have an interest in improving their teaching skills. The course format will be a mixture of discussion, workshops and seminars. If the course is over-enrolled, priority will be given to teaching assistants who are assigned to teach large, introductory level (100 or 200 level) courses during the semester they are taking this course.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 2 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus

**GEOS F669 Geodetic Methods and Modeling**

3 Credits

Offered As Demand Warrants

Theory and application of modern geodetic tools to measure Earth's surface deformation with emphasis on GPS and InSAR. Basics of data processing. Evaluation of signals and modeling of their sources. Applications include magma systems, earthquake cycle, and hydro- and cryosphere. Labs in Python require programming experience (GEOS F436/F636).

**Prerequisites:** MATH F314; GEOS F436 or GEOS F636; graduate standing.**Stacked with** GEOS F469.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F670 Selected Topics in Volcanology**

2 Credits

Offered Fall

Survey course in subjects relating to volcanology. Possible subjects include, but are not limited to, eruption dynamics, geophysics of eruptions, volatiles in volcanic systems, modeling volcanic systems. May be repeated for credit.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 2 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken 3 times for up to 6 credits**GEOS F671 Volcano Seismology**

3 Credits

Offered Spring Odd-numbered Years

Survey of seismic behavior of volcanoes. Topics include instrumentation, terminology, swarms and their attributes, high-frequency events, volcanic explosions, volcanic tremor, attenuation and velocity structure, cycles of activity, eruption forecasting, detection of magma chambers, case studies and selected topics. Oral and written student presentations will be required.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F676 Remote Sensing of Volcanic Eruptions**

3 Credits

Offered As Demand Warrants

Focuses on the use of satellite images to detect, monitor and mitigate volcanic hazards, and to understand eruption processes. Thermal anomalies, volcanic clouds and surface morphological features will be discussed in the lecture and test cases analyzed in the laboratory. Satellite data include GOES, AVHRR, MODIS, ASTER, Landsat and SAR.

**Prerequisites:** Recommended: GEOS F422 or equivalent remote sensing class.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken 2 times for up to 6 credits**GEOS F680 Climate Change Processes: Past, Present, Future**

4 Credits

Offered Fall Odd-numbered Years

This 'synthesis' course for Geography, NRM, or Natural Sciences undergraduates provides literacy in the rapidly developing field of climate-change science. Students will gain an understanding of climate dynamics and Earth's climate history and will be trained to critically evaluate the validity of paleoclimatic reconstructions and climate-model predictions.

**Prerequisites:** Junior or senior standing in major; ATM F401, GEOS F315, OCN F419 or OCN F481.**Cross-listed with** ATM F680.**Stacked with** ATM F480, GEOS F480.**Lecture + Lab + Other:** 4 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F681 Snow in the Environment**

3 Credits

Offered As Demand Warrants

Snow is a critical buffer between cold air temperatures and warming permafrost, between harsh winds and vegetation, and between herbivores and their food source. This course focuses on snow properties, metamorphism and redistribution by wind. We will examine the snows interactions with permafrost, glaciers, sea ice, vegetation, wildlife and humans.

**Prerequisites:** Graduate student standing.**Stacked with** GEOS F481.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F682 Geoscience Seminar**

1 Credit

Offered Fall and Spring

A weekly seminar, given by guest speakers, on a topic in geosciences. Students are expected to prepare for the seminars and to participate in discussion following the seminars.

**Prerequisites:** Graduate standing.**Stacked with** GEOS F482.**Lecture + Lab + Other:** 1 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken 99 times for up to 99 credits**GEOS F686 Vertebrate Paleontology**

3 Credits

Offered Spring Odd-numbered Years

The study of vertebrate evolution through geologic time. Covers the temporal range, diversity and systematics of major vertebrate groups as documented in the fossil record, with an emphasis on current problems in vertebrate evolutionary pattern and process. Labs emphasize comparative morphology and identification of major vertebrate groups.

**Prerequisites:** Graduate standing.**Cross-listed with** BIOL F686.**Stacked with** BIOL F486; GEOS F486.**Lecture + Lab + Other:** 2 + 3 + 0**Grading System:** Letter Grades with option of Plus/Minus**GEOS F692 Geol/Geophys Seminar**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken unlimited times for up to 99 credits

**GEOS F692P Seminar**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken 98 times for up to unlimited credits**GEOS F698 Non-thesis Research/Project**

1-9 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken unlimited times for up to 99 credits**GEOS F699 Thesis**

1-12 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Pass/Fail Grades**Repeatable for Credit:** May be taken unlimited times for up to 99 credits