

814. Applied Research Methods for Planning and Development
Spring. 3(2-2) Interdepartmental with Urban Planning. Administered by Urban Planning.
P: UP 813. R: Open only to graduate students in Urban and Regional Planning, Public Administration, and Geography.
Techniques in urban and regional planning analysis. Forecasting models. Methods of urban project evaluation.

823. Map Automation
Fall of even-numbered years. 3(2-2)
Use of computers in cartography. Cartographic algorithms, interpolation, and line generalization. Program intelligence. Cartographic data bases.

825. Geoprocessing
Fall of odd-numbered years. 4(4-0)
Integration of digital remote sensing data, geographic information systems, spatial analysis, and expert systems in solving research problems. Class research project.

826. Seminar in Cartography and Geoprocessing
Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
Review of research in cartography, geographic information systems, and remote sensing.

832. Environmental and Natural Resource Law
Fall. 3(3-0) Interdepartmental with Resource Development, Agricultural Economics, Forestry, and Crop and Soil Sciences. Administered by Resource Development.
P: RD 430.
Origin and development of environmental law. Theories of power, jurisdiction, sovereignty, property interests, pollution, and other bases for legal controls of natural resources. Common law and constitutional limitations on governmental power.

836. Microclimate and Its Measurement
Spring. 4(3-3) Interdepartmental with Agricultural Technology and Systems Management. Administered by Agricultural Technology and Systems Management.
The climate near the Earth's surface. Energy balance, thermal radiation exchange, heat fluxes, temperature sensors, wind speed and direction, humidity and evapotranspiration and their measurement.

850. Seminar in Regional Geography
Fall of even-numbered years, Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
Review of research on contemporary geographic issues in different world regions.

854. Economics of Planning and Development
Spring. 3(3-0) Interdepartmental with Urban Planning. Administered by Urban Planning.
P: UP 801.
The physical urban environment and local economic development.

860. Methods and Modeling in Regional Science
Spring. 3(3-0) Interdepartmental with Resource Development. Administered by Resource Development.
P: RD 461.
Regional research techniques. Economic base analysis, input-output analysis, mathematical programming, and econometric and simulation analysis.

865. Advanced Quantitative Methods in Geography
Spring. 4(4-0)
P: GEO 465.
Statistical and mathematical approaches. Multiple regression, principal components and factor analysis, discriminant analysis. Related taxonomic methods.

867. Methods and Modeling in Regional Science
Spring of even-numbered years. 3(3-0) Interdepartmental with Resource Development and Urban Planning.
P: EC 820, GEO 865; GEO 415 or RD 461.
Techniques for regional research: economic base analysis, input-output analysis, mathematical programming, and econometric and simulation analysis.

886. Research Design in Geography
Spring. 3(3-0)
Research and writing in geography. Identification of geographic problems and their relative importance. Structuring and stating hypotheses. Data acquisition and tests for validity.

890. Advanced Readings in Geography
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 12 credits in all enrollments for this course.
R: Approval of department.
Advanced independent readings.

892. Advanced Research in Geography
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course.
Advanced independent research.

899. Master's Thesis Research
Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 30 credits in all enrollments for this course.
R: Open only to graduate students in Geography.

986. Theory and Methods in Geography
Spring. 3(3-0)
R: Open only to Ph.D. students in Geography.
Historical development of the discipline within social and intellectual contexts. Current methodological and philosophical approaches to geographic research.

999. Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course.

GEOLOGICAL SCIENCES GLG

Department of Geological Sciences College of Natural Science

201. The Dynamic Earth
Fall, Spring. 4(3-2)
R: Not open to students with credit in GLG 301.
Physical and chemical processes related to the past, present and future behavior of the earth system, and the energy systems that drive these processes. A study of the earth's materials, the earth's surface and the earth's interior.

202. Physical and Biological History of the Earth
Fall, Spring. 4(3-2)
P: GLG 201.
Origin of the Earth. Differentiation of the Earth's core, mantle and crust. Lithospheric tectonics over geologic time. Origin and evolution of the Earth's hydrosphere, atmosphere and climate. Origin and evolutionary history of biological life. Interactions of biological life with the Earth's endogenic and exogenic sy

301. Engineering Geology
Fall. 4(3-2)
R: Not open to freshmen. Open only to College of Engineering students. Not open to students with credit in GLG 201.
Principles of geology as applied to civil engineering practice. Minerals, rocks, surficial and internal processes, mitigation of destructive geological processes. Air photos, topographic-geologic maps, cross sections.

302. Geology of Michigan
Spring. 3(3-0)
P: GLG 201 or GLG 301 or ISP 203.
Integration of the geological evolution of Michigan with its social and economic development.

303. Oceanography
Fall. 4(4-0)
P: CEM 142 or CEM 152 or PHY 184 or PHY 232 or CEM 141, PHY 183 or CEM 141, PHY 231 or CEM 151, PHY 183 or CEM 151, PHY 231.
Physical, chemical, biological, and geological aspects of oceanography: ocean circulation, waves, tides, air-sea interactions, chemical properties of ocean water, ocean productivity, shoreline processes, and sediments.

321. Mineralogy and Geochemistry
Fall. 4(3-2)
P: GLG 201 or GLG 301 or concurrently; CEM 142 or CEM 152.
Geochemical properties and processes in the origin, modification, structure, dynamics and history of Earth materials. Crystallography and crystal chemistry. Mineral classification and identification.

331. Vertebrate Life of the Past
Spring. 3(3-0) Interdepartmental with Zoology.
P: BS 110 or BS 111 or juniors and above. R: Not open Zoology majors. Not open to students with credit in GLG 433.
Evolution and diversity of fossil vertebrates from fish to humans with emphasis on dinosaurs and Pleistocene events.

332. Social Impact of Paleobiology
Fall, Spring. 3(3-0)
P: ISB 200 or ISP 203 or GLG 201 or BS 110, one ISS course, one IAH course. Completion of Tier 1 writing requirement.
Impact and influence of paleobiological thought and discoveries on society, from early views on the origins of fossils to the recognition of evolution as a dominant force in shaping the design of organic life. Role of paleobiology in the development of social darwinism, evolutionary humanism, and evolutionary mysticism

335. Plants Through Time
Spring of odd-numbered years. 3(3-0) Interdepartmental with Botany and Plant Pathology. Administered by Botany and Plant Pathology.
P: BS 110 or BOT 105 or GLG 201. R: Juniors and above.
Evolutionary history of plants, the development of ecosystems, and the use of plant fossils in the reconstruction of ancient environments and climate.

351. Structural Geology
Fall. 4(3-2)
P: GLG 361, MTH 116.
Structural geology. Mechanical behavior and kinematic history of the lithosphere. Stress and strain. Deformation features such as folds, faults and microstructure. Methods of analysis and interpretation. One weekend field trip required.

**Descriptions — Geological Sciences
of
Courses**

- 361. Petrology (W)**
Spring. 4(3-2)
P: GLG 321. R: Completion of Tier I writing requirement.
Evolution, origin and occurrence of igneous and metamorphic rocks. Phase relations of igneous and metamorphic system. Studies of rocks in thin sections.
SA: GLG 461
- 371. Introduction to Geodynamics and Geophysics (W)**
Spring. 4(3-2)
P: MTH 116; PHY 183 or PHY 183B or PHY 231 or PHY 231B. R: Completion of Tier I writing requirement.
Geophysical methods of studying the structure and dynamics of the earth and planets. Plate kinematics and global geodynamic processes, plate margin processes and evolution, marine geology.
- 406. Environmental Geomorphology**
Fall of even-numbered years, Spring. 3(3-0)
Interdepartmental with Geography. Administered by Geography.
P: GEO 106 or ISP 203 or GLG 201 or GLG 301. R: Not open to freshmen and sophomores.
Relationships of running water, weathering, gravity, ice, waves, wind, and biota to terrain and soils. Evolution of landscapes. Classical and modern interpretations. Field study optional.
- 411. Hydrogeology**
Fall. 4(3-2)
P: MTH 116. R: Not open to freshmen and sophomores.
Principles of the source, occurrence and movement of groundwater emphasizing geologic factors and controls.
- 412. Glacial and Quaternary Geology**
Spring. 4(3-2) Interdepartmental with Geography.
P: GLG 201 or GLG 301 or GEO 306 or GEO 408. R: Not open to freshmen and sophomores.
Glacial and Quaternary geology with emphasis on North America and Europe. Laboratory focuses on glacial processes. One weekend field trip required.
- 421. Environmental Geochemistry**
Spring. 3(3-0)
P: GLG 201 or GLG 301; CEM 141 or CEM 151.
Natural and anthropogenic processes affecting environmental chemistry with emphasis on the water cycle. Chemical equilibria, kinetics, geochemical cycling, acid rain, carbon dioxide and the greenhouse effect. Historical perspectives and future concerns.
- 422. Organic Geochemistry**
Fall. 3(3-0)
P: CEM 141 or CEM 152 or CEM 182H; GLG 201 or GLG 301; PHY 183 or PHY 183B or PHY 231 or PHY 231B.
Organic geochemistry applied to global cycling of organic matter and diagenesis. Evaluation of the fate of bulk organic matter and individual compounds in the environment.
- 423. Environmental Geosciences**
Spring. 1(1-0)
P: GLG 201 or GLG 301.
Application of geological sciences to environmental issues ranging from global warming to geological hazards such as earthquakes.
- 426. Biogeochemistry**
Summer. 3 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Microbiology, Crop and Soil Sciences, and Zoology. Administered by Microbiology.
P: BS 110 or BS 111, CEM 143 or CEM 251.
Integration of the principles of ecology, microbiology, geochemistry, and environmental chemistry. Societal applications of research in aquatic and terrestrial habitats.
- 431. Sedimentology and Stratigraphy (W)**
Spring. 4(3-2)
P: GLG 351. R: Completion of Tier I writing requirement.
Sediments, sedimentary rocks, sedimentary processes, and depositional environments through geologic time. Facies events correlation. Fossils as tools in stratigraphy and environmental analysis. Biostratigraphy, paleoecology and taphonomy.
- 433. Vertebrate Paleontology**
Fall of even-numbered years. 4(3-2) Interdepartmental with Zoology.
P: ZOL 228. R: Not open to students with credit in GLG 331.
Fossil vertebrates with emphasis on evolution of major groups. Modern techniques of collection, identification and interpretation of fossils.
- 434. Evolutionary Paleobiology**
Fall. 4(3-2) Interdepartmental with Zoology.
P: BS 110 or GLG 201.
Patterns and processes of evolution known from the fossil record including speciation, phylogeny, extinction, heterochrony and biogeography.
- 471. Applied Geophysics**
Fall. 4(3-2)
P: MTH 133 or concurrently; PHY 184 or PHY 184B or PHY 232 or PHY 232B or concurrently. R: Not open to freshmen and sophomores.
Application of seismic, gravity, magnetic, resistivity, and electromagnetic methods to problems related to engineering studies, mineral and oil exploration, groundwater, subsurface mapping, pollution, and hazardous waste.
- 472. Principles of Modern Geophysics**
Fall of odd-numbered years. 3(3-0)
P: MTH 235; PHY 184 or PHY 184B.
Theory of solid-earth geophysics including geochronology, geothermics, geomagnetism and paleomagnetism, geodesy and gravity, rheology, and travel-time seismology.
- 481. Reservoirs and Aquifers**
Fall of odd-numbered years. 4(3-2)
P: GLG 431; GLG 461.
Principles of the origin and evolution of porous media. Porosity and permeability of sediments and sedimentary rocks. Computing techniques for evaluating reservoirs and aquifers.
- 491. Field Geology - Summer Camp (W)**
Summer. 6 credits. Given only in Utah.
P: GLG 431. R: Open only to Geological Sciences majors. Completion of Tier I writing requirement. Approval of department.
Field analysis of rock types: igneous, metamorphic, sedimentary. Structural analysis. Preparation of stratigraphic sections, geologic maps and cross sections. Air photo analysis.
- 499. Independent Study in Geological Sciences**
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to Geological Sciences juniors and seniors. Approval of department.
Advanced individual study of special topics in the geological sciences.
- 801. Seminar in Geochemistry**
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
R: Open only to graduate students in Geological Sciences.
Recent developments in geochemistry, including aqueous, biologic and mineralogic aspects.
- 802. Seminar in Geophysics and Geodynamics**
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
P: GLG 371 or GLG 471 or GLG 472. R: Open only to graduate students in Geological Sciences.
Applied, solid-earth, and theoretical geophysics, global and regional geodynamics. Plate tectonics, marine geophysics, and polar earth sciences.
- 803. Seminar in Hydrogeology**
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
P: GLG 411 or GLG 421. R: Open only to graduate students in Geological Sciences.
Occurrence, movement and composition of groundwater in geologic settings.
- 804. Seminar in Paleobiology**
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
R: Open only to graduate students in Geological Sciences.
Invertebrate, vertebrate and plant paleobiology.
- 805. Seminar in Petrology**
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
P: GLG 461. R: Open only to graduate students in Geological Sciences.
Current topics in igneous petrology.
- 806. Seminar in Sedimentology and Stratigraphy**
Fall, Spring. 0 to 0 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
R: Open only to graduate students in Geological Sciences.
Recent developments in stratigraphy and deposition, and diagenesis of sedimentary rocks.
- 807. Seminar in Structural Geology and Tectonics**
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
R: Open only to graduate students in Geological Sciences.
Rock deformation and major lithospheric structure.
- 821. Aqueous Geochemistry**
Fall of odd-numbered years. 3(2-2)
P: CE 481 or CEM 383 or CSS 455 or FW 472 or GLG 421 or GLG 422. R: Open only to graduate students.
Controls on the chemical and isotopic nature of water (fresh, marine, brine) and its solutes. Data acquisition and synthesis. Chemical modeling and evolution of water masses.
- 822. Analytical Applications for Biogeochemical Research**
Fall of even-numbered years. 3(3-0)
P: 12 credits in biological science, biochemistry, or chemistry; 6 credits in geological sciences.
Carbon and nutrient cycling in the natural environment. Oxidic and anoxic processes. Flows of carbon in lacustrine, marine, terrestrial and global ecosystems. Development of the carbon cycle over geologic time.
- 823. Isotope Geochemistry**
Spring of even-numbered years. 3(3-0)
P: CEM 151; CEM 152; PHY 183, PHY 184, or PHY 231, PHY 232. R: Open only to graduate students.
Fundamentals of isotope behavior, fractionation, and interpretation and application of isotope data. Radiogenic isotopes including geochronology and environmental tracing.

825. Clay Mineralogy and Soils Genesis
Spring of even-numbered years. 4(3-2) Interdepartmental with Crop and Soil Sciences. Administered by Crop and Soil Sciences.
R: Open only to graduate students in College of Agriculture and Natural Resources, College of Engineering, or College of Natural Science.
Mineral structures. X-ray diffraction, pedogenic processes, and mineral transformations and stability.

830. Paleobotany
Fall of even-numbered years. 3(2-3) Interdepartmental with Botany and Plant Pathology. Administered by Botany and Plant Pathology.
R: Open only to graduate students. Approval of department.
Survey of fossil plants: preservation, occurrence, geological relations, taphonomy, whole plant reconstruction, evolutionary history, and paleoecology.

831. Quantitative Paleobiology
Spring of even-numbered years. 3(2-2) Interdepartmental with Zoology.
P: GLG 431 or ZOL 345.
Analysis of paleobiological problems using quantitative techniques such as cladistics, morphometrics, ordination, and stereology.

861. Evolution of the Crust and Mantle
Fall of even-numbered years. 3(3-0)
P: GLG 461. R: Open only to graduate students.
Origin and evolution of the Earth's crust and mantle. Petrology, tectonics and geophysics of the Earth.

862. Igneous Petrology
Fall of odd-numbered years. 4(3-2)
P: GLG 461. R: Open only to graduate students.
Origin and evolution of magmatic systems. Relationship of igneous activity to tectonic setting.

863. Mineral-Water Interactions
Spring of odd-numbered years. 4(3-2) Interdepartmental with Crop and Soil Sciences.
R: Open only to graduate students in Crop and Soil Sciences or Geological Sciences or Geography.
Mineralogy, petrology and geochemistry of fluid-rock reactions in geologic, sedimentary and geochemical cycles. Rock and mineral weathering, soil formation, genesis and burial diagenesis of sediments and sedimentary rocks, and metamorphism.

871. Seismology and Geodynamics (MTC)
Fall of even-numbered years, Spring of even-numbered years. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course.
P: MTH 234, PHY 184.
Seismological theory, earthquakes. Quantitative modeling of the applications to Earth structure, seismic source mechanisms and geodynamics. Behavior and deformation of the lithosphere.

881. Sedimentary Petrology
Fall of even-numbered years. 4(3-2)
P: GLG 431, GLG 461.
Origin of sedimentary particles and their chemical and physical alterations after deposition. Geochemical cycles in Earth history.

891. Special Problems in Geochemistry
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to graduate students in Geological Sciences. Approval of department.
Individual study on problems in geochemistry, including aqueous, biologic, and mineralogic aspects.

892. Special Problems in Geophysics and Geodynamics
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
P: GLG 371 or GLG 471 or GLG 472. R: Open only to graduate students in Geological Sciences. Approval of department.
Individual study on problems in applied and solid-earth geophysics, global and regional geodynamics, and polar earth sciences.

893. Special Problems in Hydrogeology
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
P: GLG 411 or GLG 421. R: Open only to graduate students in Geological Sciences. Approval of department.
Individual study on the movement, occurrence and composition of groundwater in geologic environments.

894. Special Problems in Paleobiology
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to graduate students in Geological Sciences. Approval of department.
Individual study on invertebrate, vertebrate and plant paleobiology.

895. Special Problems in Petrology
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
P: GLG 461. R: Open only to graduate students in Geological Sciences. Approval of department.
Individual study on current problems in petrology.

896. Special Problems in Sedimentology and Stratigraphy
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to graduate students in Geological Sciences. Approval of department.
Individual study on problems in sedimentology and stratigraphy.

897. Special Problems in Structural Geology and Tectonics
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
P: GLG 351. R: Open only to graduate students in the Department of Geological Sciences. Approval of department.
Individual study on rock deformation or major expressions of deformation. From two to seven weeks of field study during semester breaks may be required for certain research projects.

898. Special Problems in Environmental Geosciences
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to graduate students in the Department of Geological Sciences. Approval of department.
Individual study on problems in environmental geosciences.

899. Master's Thesis Research
Fall, Spring, Summer. 1 to 10 credits. A student may earn a maximum of 24 credits in all enrollments for this course.
R: Open only to M.S. students in Geological Sciences.

999. Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 48 credits. A student may earn a maximum of 99 credits in all enrollments for this course.
R: Open only to Ph.D. students in Geological Sciences.

GERMAN

GRM

Department of Linguistics and Germanic, Slavic, Asian and African Languages College of Arts and Letters

101. Elementary German I
Fall, Spring, Summer. 4(4-1)
R: No previous experience in German or designated score on German Placement Test. Not open to students with credit in GRM 150.
German language, civilization, and culture for beginning students. Work on all language skills with emphasis on speaking.

102. Elementary German II
Fall, Spring, Summer. 4(4-1)
P: GRM 101 or designated score on German placement test. R: Not open to students with credit in GRM 150 or GRM 200.
Further study of German language, civilization, and culture for beginning students. Continued work on all language skills with emphasis on speaking.

150. Review of Elementary German
Fall, Spring. 4(4-1)
R: Open only to students with high school credit in German and designated score on German Placement Test. Not open to students with credit in GRM 101 or GRM 102.
Review of first-year college German for students who had German in high school and who need to strengthen communication skills, vocabulary, grammar and pronunciation before study at the 200 level.

200. Second-Year German I with Review
Fall. 4(4-1)
P: Designated score on German placement test or approval of department. R: Not open to students with credit in GRM 102 or GRM 201.
Rapid review and strengthening of vocabulary, grammar, and communication skills for incoming freshmen and transfer students. Reading, viewing, and discussion of a broad range of cultural texts and materials from the German-speaking world.

201. Second-Year German I
Fall, Spring. 4(4-0)
P: GRM 102. Not open to students with credit in GRM 200.
Intermediate-level development of all language skills. Reading, viewing, and discussion of a broad range of cultural materials from the German-speaking world.

202. Second-Year German II
Fall, Spring. 4(4-0)
P: GRM 200 or GRM 201 or designated score on German placement test.
Further intermediate-level work on all language skills, based on topics such as popular music, literature, film, current events, and culture. Transition course to advanced work in German studies.

290. Independent Study
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course.
R: Approval of department.
Special projects arranged by an individual student and a faculty member in areas supplementing regular course offerings.