

478 Urban Transportation Planning
 Spring. 3(3-0) Interdepartmental with Urban Planning. Administered by Department of Geography. R: Open only to juniors or seniors in Urban and Regional Planning or Geography or approval of department.

Principles of decision-making in urban transportation planning. Demand and supply analysis, social and environmental impacts, implementation programs. Use of computer models.

480 Senior Seminar (W)
 Fall. 3(3-0) P:M: Completion of Tier I writing requirement. R: Open only to seniors in Geography.

History, philosophy, and methodology of the geographic discipline as it has evolved within academic and social contexts.

485 Senior Seminar in Geography Education
 Spring of even years. 3(3-0) P:M: (GEO 113 or GEO 151) and (GEO 204 and GEO 206 and GEO 221 and GEO 330 or concurrently and GEO 333 or concurrently) R: Open only to Geography minors.

Geography educational standards will guide the development of knowledge and technical expertise of future K-12 teachers. Emphasis will be on continued learning of geography, integration of physical and human concepts, the role of representation (maps, etc.), and the use of current events, local observations, and technology to integrate geography into the K-12 curriculum.

490 Independent Study
 Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Approval of department.

Supervised individual study in an area supplementary to regular courses.

492 Geographic Research Problems
 Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Not open to freshmen or sophomores. Approval of department.

Supervised original research on selected aspects of geography.

494 Remote Sensing Field Techniques
 Summer. 2(0-4) P:M: (GEO 424)

Collection and processing of field data to coordinate with remotely sensed imagery. Data correction and analysis. The use of global positioning systems (GPS) receivers and of sensors for determining chlorophyll levels and other biophysical properties. Hands-on experiences; considerable time outdoors. Field trips required.

495 Field Study
 Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course.

Supervised field study in geography.

498 Internship in Geography
 Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course.

Individual experience in geography in an approved organization.

GEOLOGICAL SCIENCES GLG

Department of Geological Sciences College of Natural Science

201 The Dynamic Earth
 Fall, Spring. 4(3-2) 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.

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

303 Oceanography
 Fall. 4(4-0) P:M: (CEM 141 or CEM 142 or CEM 151 or CEM 152 or CEM 181H or CEM 182H or LBS 171) and (PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or PHY 231C or LBS 271)

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.

304 Physical and Biological History of the Earth
 Fall, Spring. 4(3-2) P:M: (GLG 201 or ISP 203) SA: GLG 202

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 life with the Earth's endogenic and exogenic systems.

306 Environmental Geomorphology
 Spring. 3(3-0) Interdepartmental with Geography. Administered by Department of Geography. P:M: (CSS 210 or GEO 203 or GEO 206 or GEO 330 or GEO 333 or GEO 259 or GLG 201 or GLG 304 or ISP 201 or ISP 203 or ISS 310 or RD 201) and completion of Tier I writing requirement.

Relationships of running water, weathering, gravity, ice, waves, wind, and biota (including humans) to terrain and soils. Evolution of landscapes. Classical and modern interpretations.

319 Introduction to Earth System Science
 Fall. 3(3-0) Interdepartmental with Entomology; Plant Biology; Zoology; Sociology. Administered by Department of Entomology. RB: Completion of one course in biological or physical science.

Systems approach to Earth as an integration of geochemical, geophysical, biological and social components. Global dynamics at a variety of spatio-temporal scales. Sustainability of the Earth system.

321 Mineralogy and Geochemistry
 Spring. 4(3-2) P:M: (GLG 201 or concurrently) and (CEM 142 or CEM 152 or CEM 182H or LBS 172) and (MTH 132 or LBS 118)

Geochemical properties and processes in the origin, modification, structure, dynamics and history of earth materials. Crystallography and crystal chemistry. Mineral classification and identification.

335 Plants Through Time
 Spring of odd years. 3(3-0) Interdepartmental with Plant Biology. Administered by Department of Plant Biology. P:M: (BS 110 or PLB 105 or GLG 201 or LBS 144 or LBS 148H) R: Open only to juniors or seniors. SA: BOT 335

Evolutionary history of plants, development of ecosystems, and use of plant fossils in the reconstruction of ancient environments and climate.

351 Structural Geology
 Fall. 4(3-2) P:M: (GLG 304 and GLG 361 or concurrently) and (MTH 114 or MTH 116 or LBS 117 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LBS 118 or LBS 119) RB: Introductory physics.

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.

361 Petrology (W)
 Fall. 4(3-2) P:M: (GLG 321) and completion of Tier I writing requirement. SA: GLG 461

Evolution, origin, occurrence and tectonic setting of igneous and metamorphic rocks. Phase relations of igneous and metamorphic systems. Studies of rocks in thin sections.

401 Plate Tectonics (W)
 Spring. 4(3-2) P:M: (GLG 304) and (MTH 114 or MTH 116 or LBS 117 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LBS 118 or LBS 119) and (PHY 183 or PHY 183B or PHY 231 or PHY 231B or PHY 231C or LBS 271) and completion of Tier I writing requirement. R: Not open to graduate students in the Department of Geological Sciences. SA: GLG 371

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.

411 Hydrogeology
 Fall. 4(3-2) RB: (MTH 114 or MTH 116 or LBS 117 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LBS 118 or LBS 119) R: Not open to freshmen or sophomores.

Source, occurrence, and movement of groundwater emphasizing geologic factors and controls.

412 Glacial and Quaternary Geology
 Spring. 4(3-2) Interdepartmental with Geography. RB: (GLG 201 or GEO 306 or GEO 408) R: Not open to freshmen or sophomores.

Glacial and Quaternary geology with emphasis on North America and Europe. Laboratory focuses on glacial processes. One weekend field trip required.

419 Advanced Earth System Science
 Spring. 3(2-2) Interdepartmental with Entomology; Plant Biology; Zoology; Sociology. Administered by Department of Entomology. P:M: (ENT 319)

Systems science theory applied to analysis of the biological, geological, physical, and social causes and consequences of global changes. Issues of sustaining the Earth system.

Geological Sciences—GLG

- 421 Environmental Geochemistry**
Spring. 4(3-2) RB: (GLG 201) and (CEM 141 or CEM 151 or CEM 181H or LBS 171)

Natural and anthropogenic processes affecting environmental chemistry with emphasis on the water cycle. Chemical equilibria, kinetics, geochemical cycling, acid rain, carbon dioxide, heavy metals, toxic organics, global change and the greenhouse effect.

- 422 Aquatic and Marine Organic Geochemistry (W)**
Fall. 3(3-0) P:M: (CEM 141 or CEM 142 or CEM 151 or CEM 152 or CEM 181H or CEM 182H or LBS 171) and completion of Tier I writing requirement. RB: (GLG 201 or GLG 304)

Organic geochemistry applied to global cycling of organic matter and diagenesis in aquatic and marine environments. Use of stable isotopes and molecular analyses to trace the fate of bulk organic matter and individual compounds in the environment.

- 426 Biogeochemistry**
Summer. 3 credits. Summer: Given only at W.K. Kellogg Biological Station. Interdepartmental with Microbiology and Molecular Genetics; Crop and Soil Sciences; Zoology. Administered by Department of Microbiology and Molecular Genetics. RB: (BS 110 or LBS 144 or LBS 148H or BS 111 or LBS 145 or LBS 149H) and (CEM 143 or CEM 251) SA: MPH 426

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:M: (GLG 351) and 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 years. 4(3-2) Interdepartmental with Zoology. P:M: (ZOL 328)

Fossil vertebrates with emphasis on evolution and interrelationships of major groups. Modern techniques of identification and interpretation of fossils.

- 434 Evolutionary Paleobiology**
Fall. 4(3-2) Interdepartmental with Zoology. RB: (BS 110 or GLG 304 or LBS 144 or LBS 148H)

Patterns and processes of evolution known from the fossil record including speciation, phylogeny, extinction, heterochrony and biogeography.

- 470 Principles of Modern Geophysics**
Fall of odd years. 3(3-0) P:M: (GLG 201) and (MTH 234 or concurrently or MTH 254H or concurrently or LBS 220 or concurrently) and (PHY 183 or PHY 183B or PHY 193H or PHY 233B or LBS 271) SA: GLG 472

Theory of solid-earth geophysics including geochronology, geothermics, geomagnetism and paleomagnetism, geodesy and gravity, rheology, and travel-time seismology.

- 471 Applied Geophysics**
Spring. 4(3-2) P:M: (MTH 133 or concurrently or LBS 119 or concurrently) and (PHY 184 or concurrently or PHY 184B or concurrently or PHY 232 or concurrently or PHY 232B or concurrently or PHY 232C or concurrently or PHY 294H or concurrently or LBS 272 or concurrently) R: Not open to freshmen or 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.

- 481 Reservoirs and Aquifers**
Spring of even years. 3(3-0) P:M: (GLG 431 or concurrently)

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. Summer: Park City, Utah. P:M: (GLG 431) and completion of Tier I writing requirement. R: Open only to students in the Department of Geological Sciences. 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 juniors or seniors in the Department of Geological Sciences. Approval of department; application required.

Advanced individual study of special topics in the 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:M: (GRM 101) or designated score on German placement test. Not open to students with credit in GRM 150.

Further study of German language, civilization, and culture for beginning students. Continued work on all language skills with emphasis on speaking.

- 103 Self-Paced Elementary German I**
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course. RB: Some German coursework in High School. Not open to students with credit in GRM 101.

Self-paced introduction to German language, civilization and culture including web-based activities.

- 104 Self-Paced Elementary German II**
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course. P:M: (GRM 101 or GRM 103) or designated score on German placement test. RB: Some German coursework in High School. Not open to students with credit in GRM 102.

Further self-paced study of German language, civilization, and culture for beginning students including web-based activities.

- 200 Second-Year German I with Review**
Fall. 4(4-1) P:M: (GRM 102) or designated score on German placement test. 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:M: (GRM 102) or designated score on German placement test. 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:M: (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.

- 301 Advanced German Language and Culture I**
Fall, Spring. 3(3-0) P:M: (GRM 202) or designated score on German placement test.

Work on advanced speaking, listening comprehension, reading, and writing skills through intensive work with authentic texts dealing with contemporary issues relating to the German-speaking world. Selected review of grammar and syntax.

- 302 Advanced German Language and Culture II**
Fall, Spring. 3(3-0) P:M: (GRM 301)

Further work on advanced speaking, listening comprehension, reading and writing skills, through intensive work with original texts dealing with contemporary issues relating to the German-speaking world.