281. Mineral Resources of the Earth
Fall. 3(3-0)
Mineral resources; their genesis, occurrence, exploitation and use. Future projections from historic and current developments. The impact on international affairs and the welfare of nations. Field trip.

282. Energy Resources of the Earth
Winter. 3(3-0)
World energy resources of petroleum, coal, and atomic fuel. Social, political, economic and environmental problems of fuels.

295. Introductory Earth Chemistry
Winter. 3(3-0) 200 or 201 or 306, or approval of department.
Qualitative description of processes affecting distribution of elements in rocks, soils, waters, the atmosphere, and meteorites. Age of the earth. Origin of the elements. Geochemical methods to study the evolution of the mantle, crust, atmosphere and oceans.

302. Vertebrate Life of the Past
Fall. 3(3-0) One course in a physical or biological science for juniors. Interdepartmental with the Zoology Department. Fossil vertebrates from fish to man.

303. Introductory Geomorphology
Winter. 3(3-0) 200 or 201 or 306.
Descriptive course treating the geological origin and development of important surface features including special consideration of Pleistocene landforms of the Great Lakes region.

303L. Laboratory—Introductory Geomorphology
Winter. 1(0-2) 303 or concurrently.
Methods of map interpretation and use of aerial photographs in geomorphology. Supplemental field trip to study the geology of pertinent landforms.

304. Geology of Michigan
Fall. 3(3-0) 200 or 201 and/or 303; or approval of department.
A historical accounting of the physical, historical and economic geology of Michigan and its environs; a course designed for students seeking an overall picture of the rather unique Michigan geological environment.

306. Engineering Geology
Fall. 3(3-0) Credit will be given for only one of the following: 200, 201, 306. Sophomore Engineering Students. Fundamental principles of geology as applied to civil engineering practice. Minerals and rocks, aerial photographs, topographic and aerial geologic maps and geologic cross sections studied in laboratory. Source of geologic literature and maps.

307. Geology Central Appalachians
Winter. 1(0-2) 200, or 201, or 203, or concurrently.

308. Field Excursion—Central Appalachians
Spring. 2 or 3 credits. 307.
Training in the geographic, sedimentological, paleontologic, and structural principles as applied to field methods.

321. Mineralogy
(421.) Fall. 5(4-4) One term of chemistry.
Introduction to crystal systems and forms exhibited by minerals, followed by study of composition, occurrence, classification, and identification of nonmetallic minerals.

322. Mineralogy
(422.) Winter. 4(3-4) 321.
Selective qualitative analysis of minerals by blow pipe and other methods.

335. Fossil Plants, Their History and Paleoeocology
Winter. 3(3-0) One course in geology or botany or biology or approval of department. Interdepartmental with the Botany and Plant Pathology Department. History of plants through geologic time, their forms and evolution; low and high fossils, identified and reconstructed; their use in determining ancient geographic patterns, paleoenvironments, paleoclimates and community structure. Field trip.

344. Field Geology—Summer Camp
Summer 9 credits. 302, 363. Prerequisites: GLG 446, 437, 451 recommended. Methods and techniques of geological surveying and mapping. Field interpretation of geologic and paleontologic phenomena in igneous, metamorphic and sedimentary rocks in northern Michigan and Wisconsin.

A. Introduction to Field Techniques
3 credits.
Introduction to field techniques with stress on those that apply to sedimentary rocks. Stratigraphic correlation.

B. Methods of Geological Mapping
4 credits.
Plane table surveys, aerial photo and reconnaissance mapping. Examination and interpretation of structural and topographic relationships in igneous and metamorphic rocks.

C. Geologic Interpretation of Selected Areas
2 credits.
Independent mapping and interpretation.

363. Lithology
(323. 423.) Spring. 4(3-4) 321.
Processes that form igneous, metamorphic and and igneous rocks: origin, distribution, variation and occurrence of rock. Study of rock properties in the field, laboratory, and with the microscope.

400H. Honors Work
Fall, Winter, Spring. Variable credit. Approval of department.

401. Environmental Geology
Spring of odd-numbered years. 3(3-0) 200, or 201, or 306 MTI 113, or approval of department.
Quantitative solution of geological problems applied to environmental planning and management, including surface and ground water waste disposal, urban geology, and methods for prediction of geologic hazards and resources.

411. Hydrogeology
Spring. 3(3-2) One term of geology and trigonometry.
Principles of the source, occurrence, and movement of ground water. Surface and subsurface investigations of ground water and elementary ground water hydrology.

413. Glacial Geology
Spring. 3(3-2) 201.
Geological aspects of glaciers and glaciation. Theories of ice ages through geologic time. Origin and development of glacial geomorphic features. Character and chronology of the Pliocene. Laboratory techniques, with field trips to observe glacial materials and features of Michigan.
415. Physical Limnology of the Great Lakes

Spring of even-numbered years. 3(3-0)

Approval of department.

Discusses the Great Lakes physical system, including regional geology, hydrodynamics, hydrology, ecology, and limnology interaction with the biosphere, environmental degradation and restoration. Special emphasis on topics of current interest. Field trips.

426. Optical and X-ray Mineralogy

(461.) Winter. 4(3-4) 321, PHY 230 or 239.

Theory, principle and application of the polarizing microscope and X-ray diffractometer in mineral analysis.

430. Vertebrate Paleontology

Winter. 4(3-3) ZOL 314 or approval of department. Interdepartmental with the Zoology Department.

Fossil vertebrates with emphasis on the evolution of major groups. Laboratories on modern techniques and on the identification and interpretation of fossils.

432. Introduction to Meteorology

For course description, see Interdisciplinary Courses.

433. Introductory Meteorology Laboratory

For course description, see Interdisciplinary Courses.

437. Invertebrate Paleontology

(431.) Fall. 4(3-4) 202 or ZOL 381 or approval of department. Interdepartmental with the Zoology Department.

Synthesis and evolution of major invertebrate groups; uses of fossils in correlation and delineation of geologic time; structure and morphology of fossils as related to evolutionary development.

438. Paleocology

Spring. 4(3-4) 202 or ZOL 389 or approval of department. Interdepartmental with the Zoology Department.

Distribution and abundance of marine fossils; response of skeletal morphology to environmental conditions; uses of fossils in reconstructing ancient climates and depositional environments.

445. Field Studies

Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 12 credits. Approval of department. Advanced geological or geophysical field studies.

446. Principles of Stratigraphy

(434.) Fall. 3(3-0) 437, 492 or approval of department.

Covers principles of stratigraphy and application, and exemplification of these principles to known geologic occurrences.

451. Structural Geology

Spring. 4(3-4) 202.

Description, classification, and origin of secondary structures such as folds, faults, joints, cleavages, foliations and lineations. Three-dimensional visualization stressed in economic laboratory problems involving descriptive geometry, stereographic projections, aerial, and structural geologic maps.

462. Petrology

Fall. 4(3-4) 363.

Introduction to the chemical and physical processes that are responsible for the origin and evolution of igneous and metamorphic rocks. Laboratory studies of rock suites that illustrate basic processes in petrology.

474. Geophysical Exploration Methods

Winter. 4(3-2) 201 or 306; MTH 112; PHY 230 or 239.

Techniques used in geophysical exploration, with application in petroleum prospecting, mining exploration, and engineering. Includes gravity, magnetic, seismic, electrical and other methods, and well logging. Interpretation of geophysical data.

475. Solid Earth Geophysics

Fall. 3(3-0) MTH 112; PHY 239 or 289, one term of geology.

Geophysics, including Earth's composition and structure, its dynamic character, radioactivity and age determinations, seismology and seismology, gravity and magnetic fields, heat flow, physical properties of earth materials.

479. Geotectonics

Winter of even-numbered years. 3(3-0) 451 or approval of department.

Aspects of global dynamics and geotectonics. Includes the study of major structural features, geological and geophysical evidence for crustal movements, continental drift, behavior of earth materials.

492. Sedimentology I

Fall. 2(2-3) 456 or approval of department.

Grain and aggregate properties of sediments;relationships of these properties to processes in the environment of deposition and to the pre-depositional and post-depositional history.

493. Sedimentology II

Winter. 3(3-3) 499.

Quantitative evaluation of sediment properties; sedimentary structures; regional analysis of sediment variation.

495. Geochemistry

Spring. 3(3-0) 201, CEM 192 or approval of department.


800. Special Problems

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

Special problems in hydrogeology, geomorphology and glacial geology, mineralogy and crystallography, petrology, paleontology, structural geology, and paleoecology, stratigraphy, aerogeology, geophysics, economic geology, petroleum geology, sedimentation, and geochemistry.

803. World Regional Geology

Spring of even-numbered years. 3(3-0)

One course each in structural geology, sedimentation.

World regional geology emphasizing mountain building, basin structure and associated sediments, continental drift and plate tectonics.

811. Marine Geology

Fall of even-numbered years. 3(3-2)

Approval of department.

Geomorphology, sedimentary, and chemical oceanography including origin of ocean basins, chemical loading and history of the sea, buffering and sediment-water interactions, and sediment genesis.

814. Field Glaciology

Summer. Variable credit. Approval of department.

Expeditionary camp in an area of existing glaciers providing field training in glaciology and associated disciplines. Usually conducted at the Institute field station on the Juneau Icefield, Alaska. Formal lectures given concurrently with a program of related field research.

825. Clay Mineralogy

Winter. 4(3-4) SLS 840, 850 or approval of department. Interdepartmental with Soil Science.

Structure and properties of clays; their origins, occurrence, and utilization. Methods of studying clays including x-ray diffraction, differential thermal analysis, infrared absorption and other chemical and physical techniques.

830. Paleobotany

Fall. 4(3-4) Approval of department.

Interdepartmental with and administered by the Botany and Plant Pathology Department.

Survey of fossil plants; their preservation, occurrence, geology, paleography, paleoecology, evolutionary history, classification and representative types. One weekend field trip to fossil plant locality.

831. Palynology

Spring of even-numbered years. 4(3-4)

Approval of department. Interdepartmental with the Botany and Plant Pathology Department.

An introduction to the principles and techniques of spore and pollen analysis, both fossil and recent, and utilization of plant micro-fossils for stratigraphic determinations and paleoecologic interpretations of past sedimentary accumulations and rocks. Includes certain algae, protozoans, similar organisms of uncertain affinity and dissociated fragments of larger organisms.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Credits</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>833</td>
<td>Advanced Invertebrate Paleontology</td>
<td>A. Micropaleontology</td>
<td>3(2-4) 437 or 438. Interdepartmental with the Zoology Department.</td>
<td>Functional and adaptive morphology of microscopic fossil invertebrates, emphasizing foraminifera, ostracoda, and conodonts.</td>
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<tr>
<td>834</td>
<td>Advanced Vertebrate Paleontology</td>
<td>Winter of even-numbered years. 3(3-0) 430</td>
<td>4</td>
<td>Approval of department. Interdepartmental with the Zoology Department. Recent advances and controversial issues in vertebrate paleontology including origin, classification, phylogeny, and stratigraphic relationships of fossil vertebrates.</td>
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<tr>
<td>843</td>
<td>Paleozoic Stratigraphy</td>
<td>Winter of even-numbered years. 4(5-0) 446, 493.</td>
<td>4</td>
<td>Classification, distribution, paleogeography, paleontology, and stratigraphic setting of strata within the Paleozoic systems. Laboratory work involves construction of correlation charts, structure and restored sections, paleoecologic, paleoecographic, and lithofacies maps, and study of certain key fossils.</td>
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<tr>
<td>852</td>
<td>Advanced Structural Geology</td>
<td>Winter of even-numbered years. 3(2-4) 451, MTH 214</td>
<td>3</td>
<td>Mathematics and physics applied to problems in structural geology.</td>
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<tr>
<td>861</td>
<td>Evolution of the Earth's Crust and Mantle</td>
<td>Spring. 3(0-0) 468.</td>
<td>4</td>
<td>The composition, mineralogy and petrology of the Earth's mantle and crust. Plate tectonics and its relation to earlier models of geodynamics, orogeny, continental drift, etc.</td>
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</tbody>
</table>
900. Special Problems
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Special problems in hydrogeology, geomorphology, geology and crystallography, petrology, paleontology, structural geology and petrofabrics, stratigraphy, aerogeology, glacial geology, mineralogy and crystal sedimentation, and geochemistry.

999. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

Earth Science

407. Earth Science for Teachers
(PHS 407.) Fall. 3(3-0) or 4(3-2).
Fundamentals of geology with introduction to geological concepts, including weathering, erosion, transportation, and deposition; study of the three classes of rocks; igneous, sedimentary and metamorphic; common minerals; the three classes of rocks, geologic time, and history of life; basic astronomy, theories of earth origin, and the earliest geologic periods through time with reference to the earth's major tectonic provinces. Laboratory includes identification of minerals, rocks, study of topographic maps; and field trips to points of geologic interest.

408. Earth Science for Teachers
(PHS 408.) Winter. 3(3-0) or 4(3-2).
Continuation of physical geology and introduction to historical geology, containing discussions of earth structures, mountain building, economic geology; geologic time, basic astronomy, theories of earth origin; the earliest geologic periods through time with reference to the earth's major tectonic provinces. Laboratory includes identification of minerals, rocks, study of topographic maps; and field trips to points of geologic interest.

409. Earth Science for Teachers
(PHS 409.) Spring. 3(3-0) or 4(3-2)
Historical development of the various geologic periods through time with reference to the evolutionary development of the physical landscape, ancient geography, past climates, diastrophic events and marine and land animals and plants. Laboratory includes the identification of important animals and plant fossils, fossil environments, geologic maps; field trips to collecting localities.

410. Earth Science Seminar for Teachers
Fall, Winter, Spring. 1(2-0) May re-enroll for a maximum of 4 credits. One earth science subject matter course or concurrently. Earth science subject matter areas will be interrelated through student presentation and discussion and their interdisciplinary significance developed.

445. Field Studies
Fall, Winter, Spring, Summer. 1-9 credits. May re-enroll for a maximum of 15 credits. Approval of department.
Experience and techniques in field investigation of the near surface layers of the earth.

446. Laboratory Investigations
Fall, Winter, Spring, Summer. 1-6 credits. May re-enroll for a maximum of 15 credits. 445 or concurrently.
Independent laboratory investigation of materials and phenomena obtained from field studies.

GERMAN AND RUSSIAN

College of Arts and Letters

Students who have had high school work in the foreign language in which they wish to continue their studies must take a placement examination in that language. Placement in the appropriate course is determined by the results of this examination. University credit is not given for courses waived by performance on the placement examination.

German and Russian Courses

299. Special Projects
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 8 credits. Approval of department.
Work in areas outside regular course offerings.

303. Folklore
Spring. 3(3-0)
Folk heritage of peoples as revealed in their legends, superstitions, ballads, folksongs, hero tales, sayings, customs, and beliefs. Historical development of traditional lore as a reflection of social attitudes and the sources for national mythologies.

417. Scandinavian Contributions to Literary Tradition
Fall. 3(3-0) Approval of department.
Development and influence of the ideas, forms and motifs of the Scandinavian literatures in the literatures of the world.

418. Scandinavian Contributions to Literary Tradition
Winter. 3(3-0) Approval of department.
Continuation of 417.

419. Scandinavian Contributions to Literary Tradition
Spring. 3(3-0) Approval of department.
Continuation of 418.

499. Special Projects
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 18 credits. Approval of department.
Work in areas outside regular course offerings.

825. Comparative Literature: Studies in Theme and Idea
Fall. 3(3-0) May re-enroll for a maximum of 9 credits. Interdepartmental with the departments of Romance Languages and English and administered by the Romance Languages Department. Myths, archetypes, Topoi, significant ideas and intellectual currents in different periods and cultural traditions.

836. Comparative Literature: Literature and Other Disciplines
Winter. 3(3-0) May re-enroll for a maximum of 9 credits. Interdepartmental with the departments of Romance Languages and English and administered by the Romance Languages Department.

857. Comparative Literature: Methods in the Study of Comparative Literature
Fall. 3(3-0) Interdepartmental with the English and Romance Languages Departments and administered by the English Department. Rationale and techniques of study in comparative literature.

902. Comparative Literature: Studies in Form and Genre
Fall, Winter, Spring. 3(3-0) May re-enroll for a maximum of 9 credits. Interdepartmental with the English and Romance Languages Departments and administered by the English Department.
Development and interrelationships of individual and collective forms and genres of literatures of the Western world, including the drama, tragedy, the novel, the short story, the theory and forms of poetry, popular literature, and the tale.

903. Comparative Literature: Studies in Periodization
Fall, Winter, Spring. 3(3-0) May re-enroll for a maximum of 9 credits.
Interdepartmental with the English and Romance Languages Departments and administered by the English Department.
Analyses of the manner in which various genres, conventions and continuing traditions of literature interact with the creative and critical climates of particular periods and movements, such as classicism, the Baroque, the gothic, romanticism, in qualifying or modifying characteristic literary works.

987. Seminar: Special Topics in Comparative Literature
Spring. 3(3-0) May re-enroll for a maximum of 9 credits. Advanced graduates. Interdepartmental with the departments of Romance Languages and English and administered by the Romance Languages Department.

German

101. Elementary German
Fall, Winter, Spring. 5(5-0)
German language, civilization, and culture. Development of language skills in contemporary German. Independent practice in the language laboratory.

102. Elementary German
Fall, Winter, Spring. 5(5-0)
Continuation of 101.

103. Elementary German
Fall, Winter, Spring. 5(5-0)
Continuation of 102.

201. Intermediate German—Regular
Fall, Winter, Spring. 4(3-1)
Intermediate study of the language and administrative by the Romance Languages Department. Students may not receive credit for both 201 and 211. Systematic review of grammar, oral practice, intensive and extensive reading of modern texts. This course or equivalent is required of majors and those planning to take advanced work in German.

202. Intermediate German—Regular
Fall, Winter, Spring. 4(3-1)
Students may not receive credit for both 202 and 211.
Continuation of 201.

203. Intermediate German—Regular
Fall, Winter, Spring. 4(3-1)
Students may not receive credit for both 202 and 211.
Continuation of 202.

211. Intermediate German—Reading
Fall, Winter, Spring. 4(4-0)
For students primarily interested in learning to read German. Review of grammar, reading in a variety of materials. Not open to those planning to take advanced work in German.