826. Research Design in Geography
Winter, Spring. 3(3-0) Approval of department.
Formalized approach to research and writing in geography: identification of geographic problems and their relative importance, structuring and testing hypotheses, data acquisition, and tests for validity.

827. Contemporary Theory and Methodology in Geographic Research
(816.) Spring. 3(3-0) Approval of department.
Examination of the forward edges of geographic research, particularly with respect to its relation to other disciplines, scientific methodology in general, and the evolution of geography as a professional scholarly discipline.

828. Seminar in Recreation Geography
Spring. 3(3-0) 309 or approval of instructor.
Selected current problems in recreation geography in the U.S. and abroad.

834. Seminar in Physical Geography
Winter, Spring. 3(3-0) May re-enroll for a maximum of 9 credits. Approval of department.
Analysis of classical and contemporary problems in physical geography treated as follows: climatology (winter), biogeography (spring), geomorphology (spring).

835. Seminar in Location Theory
Fall. 3(3-0) Approval of department.
Recent developments and research in location analysis and regional science.

836. Population Geography Seminar
Spring. 3(3-0) Approval of department.
Studies of particular topics and problems in population geography.

IDC. Interdisciplinary Seminar on Africa
For course description, see Interdisciplinary Courses.

850. Advanced Field Techniques
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits.
Instruction and practical training in the selection, data-gathering, on-site analysis, and preparation of geographic field problems.

855. Seminar in Geographic Education
Spring. 3(3-0) Approval of department.
Treatment of selected topics in geographic education.

870. Seminar in Medical Geography
Winter. 3(3-0).
Spatio-environmental analysis of selected health problems.

909. Research
Fall, Winter, Spring. Variable credit. Approval of department.

901. Problems in Cultural Geography
Fall, Winter, Spring. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.
Special research problems.

902. Problems in Physical Geography
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits.
Supervised research in specific topics of physical geography.

906. Problems in Economic Geography
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.
Special research problems.

908. Problems in Political Geography
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department, 416.
Special research problems.

910. Problems in Historical Geography
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.
Special research problems in historical geography.

912. Independent Study in Regional Geography
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 15 credits. Approval of department.
Individual studies in regional geography.

918. Problems in Geography
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 9 credits. Approval of department.
Research on specific geographical problems.

934. Problems in Population
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 9 credits. Approval of department.
Special research problems.

970. Problems in Medical Geography
Fall, Winter, Spring. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.
Selected research topics in medical geography.

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

GEOLOGY

College of Natural Science

200. The Geology of Man's Environment
Fall, Winter, Spring. 3(3-0)
Not open to Geology majors. Credit will be given in only one of the following: 300, 301, 308.
The relation of geological processes and Earth materials to man. The nature and evolution of the Earth life and upon it. Man's exploitation of the non-renewable resources of the Earth.

200L. Laboratory—Geology of Man's Environment
Fall, Winter, Spring. 1(0-3)
200 or concurrently.
The geological reasoning concerning the nature and evolution of the Earth.
321. Mineralogy
Central Appalachians during spring vacation. General geology of the Central Introduction to crystal systems and forms ex­
tonologic, and Training in stratigraphic, sedimentological, Economic and chemical importance of minerals; forms, field trip to study the geology of pertinent land­

322. Mineralogy
 civil engineering practice. Minerals and rocks, ore concurrently.

306. Engineering Geology
Fall. 3(3-2) 200 or 201, or concurrently. Fundamental principles of geology as applied to civil engineering practice. Minerals and rocks, aerial photographs, topographic and aerol 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 202, or concurrently. General geology of the Central Appalachians. A preparatory course for 308. Field excursions--Central Appalachians during spring vacation.

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

321. Mineralogy
(Fall.) 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
(Winter. 4(3-4) 381. Economic and chemical importance of minerals; mineralogy of non-silicates; practical crystal­lography; geochemistry of minerals.

335. Fossil Plants, Their History and Paleoeology
Spring. 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 form and evolution; how and where found, classified and reconstructed; their use in determining ancient geographic patterns, paleo­environments, paleoclimates and ancient community structure. Field work.

344. Field Geology—Summer Camp
Summer. 2 credits. 202, 361. Trig­onometry; GLG 446, 437, 451 recommended. Methods and techniques of geological surveying and mapping. Field interpretation of geologi­cal phenomena in igneous, metamorphic and sedimentary rocks in northern Michigan and Wisconsin.

355. Lithology
(323, 423.) Spring. 4(3-4) 321. Processes that form igneous, metamorphic and and igneous rocks, distribution, variation, occurrence, and graphology of rock. Study of rock properties in the field, in 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 206; MTH 113, or approval of department. Quantitative solution of geological problems applied to environmental planning and manage­ment, including soil 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 glacier and morainic features. Character and chronology of the Pleis­tocene. 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, chemistry, sedimentology interaction with the bios, 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 239 or 259. 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.

437. Intercratere Paleontology
Fall. 4(3-4) 202 or ZOL 381 or approval of department. Interdepartmental with the Zoology Department. Systematics and evolution of marine inverte­brates; uses of fossils in correlation and deline­ation of geologic time; structure and morphology of fossils as related to evolutionary develop­ment.

438. Paleoeology
Winter. 4(3-4) 203 or ZOL 399 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. 3(4-0) 303. 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, areal, 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. Exploration Geophysics
Winter. 4(3-3) 201 or 306; MTH 113, or PHY 239 or 259. Techniques used in geophysical exploration, with application in petroleum prospecting, minerals exploration, and engineering. Includes gravity, magnetics, seismic, electrical and other methods, and well logging. Interpretation of geophysical data.
491. Geotectonics
Winter of even-numbered years. 3(3-0)
Applies the laws of mechanics to analyze the development of geological structures. Aims at unifying the study of earth materials by relating their occurrence to processes in the earth's crust and mantle, including mountain building, river patterns, and faulting. Includes the study of the earth's history, focusing on the evolution of its crustal and mantle properties. Utilizes geophysical methods to explore the earth's interior and surface. Emphasizes the study of geological structures and their relationships to processes in the earth's crust and mantle. Recommended for students interested in understanding the geological evolution of the earth. 3 credits. 492. Sedimentology
Fall. 3(2-3) 450
Focuses on the study of sediments and sedimentary rocks, including their origin, distribution, and classification. Uses geological, chemical, and physical properties of sediments to determine their depositional environments and paleoclimatic conditions. Includes the study of sedimentary structures, stratigraphic successions, and the processes of sedimentation. Recommended for students interested in sedimentary geology. 3 credits. 493. Petroleum Geology
Fall. 3(2-3) 452
Introduces the principles of petroleum geology, emphasizing exploration, recovery, and development methods. Applications of exploration, recovery, and development technologies and methods. Recommended for students interested in petroleum geology. 3 credits. 494. Applied Petroleum Geology
Winter. 3(1-4) 483
Offers practical training in petroleum exploration, covering topics such as geophysical methods, petrophysical properties, and reservoir engineering. Recommended for students interested in petroleum geology. 4 credits. 495. Geochemistry
Spring. 3(3-0) 201, CME 152 or approval of department
Focuses on the chemical composition of rocks, minerals, and solutions, and the processes that control their formation and evolution. Includes the study of mineralogy, petrology, and geochemical processes. Recommended for students interested in the chemical composition of rocks and minerals. 3 credits. 496. Special Problems
Fall, Winter, Spring, Summer. Variable credit. Approval of department
Offered as a flexible course that allows students to study advanced topics in geological sciences, tailored to their interests and needs. Recommended for students interested in conducting independent research. Variable credit. 1 credit. 497. World Regional Geology
Spring. 3(3-0) 477
One course each in structural geology, sedimentation, and paleontology. Focuses on the geological evolution, drainage basins, and sedimentary deposits of major regions of the world. Recommended for students interested in the geological evolution of the world's major regions. 3 credits.
576. Topics in Geophysics Spring. 1 to 3 credits. May re-enroll for a maximum of 12 credits. Approval of department. Topics and problems in geophysics, such as tectonophysics, terrestrial heat flow, processing and analysis of geophysical data, geomagnetism, paleomagnetism, high-pressure geophysics.

572. Exploratory Seismology Fall of even-numbered years. 4(2-4)
474. Theory and technique of field seismic exploration methods. An associated geophysical survey will be conducted and a report prepared.

573. Seismology I Winter of odd-numbered years. 3(3-0)
MTH 215 or concurrently; PHY 299 or concurrently.
Theory and application of seismic wave propagation in earth materials.

574. Seismology II Spring of odd-numbered years. 3(3-0) or 783 or approval of department.
Continuation of 573.

575. Advanced Geophysical Exploration I Fall of odd-numbered years. 4(3-3)
474. Theory and technique of gravity and magnetic methods, and their use in geophysical exploration. Associated practical exercises and laboratory work.

576. Advanced Geophysical Exploration II Winter of even-numbered years. 4(3-2)
474, MTH 214.
Methods and techniques in geophysical exploration, including electrical, electromagnetic, radioactive, magnetotelluric, and the physical principles of well logging. Associated practical exercises.

579. Rock Magnetism and Paleomagnetism Spring of even-numbered years. 3(3-0)
321, 475, one year mathematics, one year physics; or engineering or physics majors.
Geomagnetism, and application to earth science. Character and history of the Earth's magnetic field, physics of remanent magnetism, magnetic properties of minerals and rocks, paleomagnetism, experimental results and procedures.

584. Regional Petroleum Geology Spring of odd-numbered years. 3(3-0)
Approval of department.
Regional study of tectonics, stratigraphy and sedimentation in the U.S. and their relationship to petroleum occurrences in sedimentary basins. Analysis of petroleum distribution with emphasis on creative thinking in petroleum exploration. Practice in the analysis of petroleum possibilities in selected foreign areas.

591. Advanced Sedimentology A. RECENT DEVELOPMENTS IN SEDIMENTOLOGY (864.) Spring. 3(2-4) May re-enroll for a maximum of 12 credits. 493, approval of department.
New techniques for study of sediments and sedimentary rocks. Discussion of significant new findings in the field of sedimentology.
B. QUANTITATIVE ANALYSIS OF SEDIMENTS (864.) Spring. 3(2-4) May re-enroll for a maximum of 12 credits. 493, approval of department.
Representation and analysis of sediment variations from microscale to regional scale. Definition of efficient empirical variables. Role of mathematical and stochastic models.

C. ENVIRONMENTAL SEDIMENTOLOGY (864.) Spring. 3(2-4) May re-enroll for a maximum of 12 credits. 493, approval of department.
Determination of rates of sediment erosion, transport, and deposition. Partitioning of deposited sediment with regard to sources. Sediment as a biologic substrate.

D. ANALYSIS OF DEPOSITIONAL ENVIRONMENTS (864.) Spring. 3(2-4) May re-enroll for a maximum of 12 credits. 493, approval of department.
Depositional processes, common depositional environments, migration of environments, environmental interpretations of three dimensional patterns of variation in sedimentary rocks.

593. Carbonate Sedimentation Fall of odd-numbered years. 3(3-2)
Approval of department.
Genesis of carbonate sediments including carbonatesecreting organisms, effect of environment on mineralogy, depositional environments, and the dolomite problem. Field trips.

595. Topics in Geochemistry A. THERMODYNAMICS IN GEOLoGY Fall. 1 to 3 credits. May re-enroll for a maximum of 12 credits. 493, 495.
Interpretation and prediction of natural mineral assemblages from thermochmicaI studies. High pressure and high temperature techniques in petrology. Phase equilibrium studies and diffusion phenomena in natural systems.
B. AQUEOUS GEOCHEMISTRY Fall. 1 to 3 credits. May re-enroll for a maximum of 12 credits. 493, 495.
Ideal and non-ideal solutions; ion activities in natural waters, carbonate sedimentation, evaporation, precipitates, colloids, chemical weathering and diagenesis. Importance of organic species in natural waters and their effect in metal complexing. Redox reactions.
C. ANALYTICAL GEOCHEMISTRY Fall. 1 to 3 credits. May re-enroll for a maximum of 13 credits. 492, 495.
Instrumental techniques for the analysis of geological materials. Topics on application of X-ray diffraction, X-ray fluorescence, neutron activation analysis, and atomic absorption spectrometry. Recently developed techniques in geochemistry will be discussed.

597. Isotope Geochemistry (892.) Winter of odd-numbered years. 3(3-0) or 495 or approval of department.
The abundances of stable and radiogenic isotopes and their variations in nature. Applications to geochronology and petrography. Principles and application of neutron activation analysis to geological problems.

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

900. Special Problems Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Special problems in hydrogeology, geomorphology and glacial geology, mineralogy and crystallogy, petrology, paleontology, structural geology and petroleum geology, 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(3-3)
Fundamentals of climatology and its relationship to weathering in rocks; agents of erosion, transportation, and deposition; study of the common minerals; the three classes of rocks, and igneous, sedimentary and metamorphic processes; geomorphologic highs including glaciers, volcanoes, oceans, lakes, deserts, caves and others. Laboratory includes identification of minerals, rocks, study of topographic maps; and field trips to points of geologic interest.

410. Earth Science Seminar for Teachers Fall. 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 inter-related through student presentation and discussion and their interdisciplinary significance developed.

445. Field Studies Fall, Winter, Spring, Summer. 1 to 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. 1 to 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

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 source for national mythologies.

417. Scandinavian Contributions to Literary Tradition Fall. 3(3-0) Approval of department. Interdepartmental with the departments of English and Romance Languages. 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. Interdepartmental with the departments of English and Romance Languages. Continuation of 417.