Old Version

Hydrology

The Hydrology program offers an undergraduate degree in Earth Science with Hydrology option. See page 52.

Graduate Program

Master of Science in Hydrology

The Master of Science degree in Hydrology requires completion of a thesis according to the general requirements of the Graduate Program.

The student's course of study must be approved by the advisory committee and must fulfill the general requirement for the master's degree and must include:

- ERTH 440, HYD 507, 508, 510, 547
- Six credits from the following: ERTH 441, ERTH 442, ERTH 443 HYD 531, HYD 532, HYD 533, HYD 541, HYD 542, HYD 543, HYD 544, or other approved 1-credit HYD courses
- HYD 591 (at least six credit hours)
- HYD 592 (two credit hours) and HYD 593 (four credit hours); credits do not apply to the 30 hours required for the M.S. degree.
- ERTH 202 or equivalent
- MATH 283 or 382 or equivalent
- At least three additional graduate-level course credits approved by the advisory committee.
- The Institute Graduate Degree Requirements must also be satisfied

Examples of courses other than hydrology which are appropriate for graduate programs in hydrology include, but are not limited to: BIOL 343, 446; CHEM 331, 332, 333, 334; ERTH 370, 403, 409, 444, 445, 448, 460; GEOL 503, 509, 547, 553; GEOP 505, 529; MATH 332, 382, 384, 410, 411, 415, 430, 435, 436, 438, 483, 486, 488, 511, 512, 533, 586, 587; PETR 445, 523, 544, 546, 564; PHYS 421, 526.

Master of Science in Hydrology Options in Petroleum and Environmental Geofluids

The Geofluids option offers multidisciplinary course curricula leading to the Master of Science Degree in Hydrology with tracks in Petroleum or Environmental studies.

The student's course of study must be approved by the advisory committee and must fulfill the general requirement for the master's degree and must include:

- ERTH 440 and 440L, ERTH 441, ERTH 460, HYD 508, HYD 510, HYD 591, HYD 592.

Geofluids Petroleum Track

- Nine credits from the following: ERTH 325, ERTH 445, GEOL 547, GEOP 546, PETR 370, PETR 345, PETR 445, PETR 546

New Version

Hydrology

The Hydrology program offers an undergraduate degree in Earth Science with Hydrology option. See page 52.

Graduate Program

Master of Science in Hydrology

The Master of Science degree in Hydrology requires completion of a thesis according to the general requirements of the Graduate Program.

The student's course of study must be approved by the advisory committee and must fulfill the general requirement for the master's degree and must include:

- ERTH 440, HYD 507, 508, 510
- Six additional credits from graduate-level hydrology courses listed in the course catalog
- HYD 591 (at least six credit hours)
- HYD 592 (two credit hours) and HYD 593 (four credit hours); credits do not apply to the 30 hours required for the M.S. degree.
- ERTH 202 or equivalent
- MATH 283, 382, 584 or equivalent
- At least three additional graduate-level course credits approved by the advisory committee.
- The Institute Graduate Degree Requirements must also be satisfied

Examples of courses other than hydrology which are appropriate for graduate programs in hydrology include, but are not limited to: BIOL 343, 446; CHEM 331, 332, 333, 334; ERTH 405, 409, 444, 445, 448, 460; GEOL 503, 509, 547, 553; GEOP 505, 529; MATH 332, 382, 384, 410, 411, 415, 435, 436, 438, 483, 486, 488, 511, 512, 533, 586, 587; PETR 445, 523, 544, 546, 564; PHYS 421, 526.

Old Version

Geofluids Environmental Track

• Nine credits from the following: ERTH 325, ERTH 422, GEOL 509, HYD 507, HYD 532, HYD 538, HYD 541, HYD 544, HYD 546, HYD 547, HYD 558.

Doctor of Philosophy in Earth and Environmental Science with Dissertation in Hydrology

Students of exceptional ability as demonstrated in previous courses or in a master's degree program may pursue a program leading to the doctoral degree.

The prospective doctoral candidate in Earth and environmental science with specialization in hydrology should develop a good background in physics, mathematics, chemistry, and geology in addition to achieving a high level of competence in the field of specialization.

With approval of the advisory committee, the student should select a program including a minimum of nine credits in graduate hydrology beyond the M.S. degree, three credits of HYD 592, six credits of HYD 593, plus additional courses in related fields. Some appropriate courses are given under the Master of Science degree requirements.

Research fields appropriate for the doctoral candidate include regional hydrology, groundwater recharge, vadose zone hydrology, stochastic subsurface hydrology, hydrogeochemistry, isotope hydrology, hydroclimatology, pollutant transport, aquifer restoration, multi-phase flow of immiscible fluids, deterministic and stochastic numerical aquifer simulation, finite difference and finite element numerical methods, and field instrumentation. Interdisciplinary programs in the Earth science fields are encouraged.

Graduate Certificate Program in Hydrology

The Hydrology Certificate program is aimed at working professionals or students who wish to increase their qualifications in Hydrology outside of a degree program. The program covers fundamentals of atmospheric, surface, and subsurface hydrology while leaving flexibility to focus on related areas of particular individual interest. The Certificate requires a minimum of 15 credit hours of graduate and upper division course work as follows:

• ERTH 440 (3), ERTH 441 (1), ERTH 442 (1), ERTH 443 (1)
• HYD 510 (3)
• Additional credits of advisor-approved graduate-level coursework (6)

New Version

Doctor of Philosophy in Earth and Environmental Science with Dissertation in Hydrology

Students of exceptional ability as demonstrated in previous courses or in a master's degree program may pursue a program leading to the doctoral degree.

The prospective doctoral candidate in Earth and environmental science with specialization in hydrology should develop a good background in physics, mathematics, chemistry, and geology in addition to achieving a high level of competence in the field of specialization.

With approval of the advisory committee, the student should select a program including a minimum of nine credits of graduate coursework beyond the M.S. degree, three credits of HYD 592, six credits of HYD 593, plus additional courses in related fields. Some appropriate courses are given under the Master of Science degree requirements.

Research fields appropriate for the doctoral candidate include regional hydrology, groundwater recharge, vadose zone hydrology, stochastic subsurface hydrology, hydrogeochemistry, isotope hydrology, hydroclimatology, pollutant transport, aquifer restoration, multi-phase flow of immiscible fluids, deterministic and stochastic numerical aquifer simulation, finite difference and finite element numerical methods, and field instrumentation. Interdisciplinary programs in the Earth science fields are encouraged.

Graduate Certificate Program in Hydrology

The Hydrology Certificate program is aimed at working professionals or students who wish to increase their qualifications in Hydrology outside of a degree program. The program covers fundamentals of atmospheric, surface, and subsurface hydrology while leaving flexibility to focus on related areas of particular individual interest. The Certificate requires a minimum of 15 credit hours of graduate and upper division course work as follows:

• ERTH 440 (3)
• Twelve credits of additional advisor-approved upper division or graduate-level coursework

Examples of available distance education courses include: HYD 507, 510, 511, 513, 514, 534, 547, 550, 560

Old Version

Hydrology Graduate Courses:

HYD 500, Directed Research, cr to be arranged

This course may not be used to fulfill graduate degree requirements.

Research under the guidance of a faculty member.

HYD 507, Hydrogeochemistry, 3 cr, 3 cl hrs

Prerequisite: CHEM 122

Pre- or Corequisite: ERTH 440 Offered fall semesters

The thermodynamics and aqueous chemistry of natural waters, with emphasis on groundwater. Chemical equilibrium concepts, surface chemistry, redox reactions, and biochemistry. The interaction of water with the atmosphere and geologic materials. Basic concepts applied to problems of groundwater quality evolution, water use, and groundwater contamination. Shares lecture with ERTH 407, with additional expectations for graduate credit. (Same as CHEM 531 and GEOC 507.)

HYD 508, Flow and Transport in Hydrologic Systems, 4 cr, 3 cl hrs, 3 lab/recitation hrs

Prerequisites: ERTH 440, 440L and 510

Offered spring semester

Principles of flow and transport in hydrological systems, including rivers, lakes, aquifers, the vadose zone, glaciers and the lower atmosphere. Fluid mechanical and thermodynamic properties, fluid statics, fluid dynamics, including mass, momentum and energy conservation, and transport of heat, particles and non-reactive chemicals with fluid flow. Single and multiphase laminar flow in porous and fractured permeable media. Turbulence and related topics that are of particular interest to hydrologists.

HYD 510, 510D, Quantitative Methods in Hydrology, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisite: MATH 231; Pre or Corequisite ERTH 440

Offered fall semester

Introduction to the methods of mathematical physics used in hydrologic science. Presented in the context of mathematical models of water and energy balances, fluid flow, and heat & solute transport. Application to aquifers, the vadose zone, land-surface runoff, rivers, and the atmospheric boundary layer. Methods span advanced engineering calculus, including numerics and differential equations. Use of software (Matlab, Maple, and COMSOL Multiphysics) for problem solving and solution presentation. Programming with Matlab.

New Version

Hydrology Graduate Courses:

HYD 500, Directed Research, cr to be arranged

This course may not be used to fulfill graduate degree requirements.

Research under the guidance of a faculty member.

HYD 507, 507D, Hydrogeochemistry, 3 cr, 3 cl hrs

Prerequisite: CHEM 122; Pre or Corequisite: ERTH 440

Offered fall semester

The thermodynamics and aqueous chemistry of natural waters, with emphasis on groundwater. Chemical equilibrium concepts, surface chemistry, redox reactions, and biochemistry. The interaction of water with the atmosphere and geologic materials. Basic concepts applied to problems of groundwater quality evolution, water use, and groundwater contamination. Shares lecture with ERTH 407, with additional expectations for graduate credit. (Same as CHEM 531 and GEOC 507.)

HYD 508, Flow and Transport in Hydrologic Systems, 4 cr, 3 cl hrs, 3 lab/recitation hrs

Prerequisites: ERTH 440, 440L and 510

Offered spring semester

Principles of flow and transport in hydrological systems, including rivers, lakes, aquifers, the vadose zone, glaciers and the lower atmosphere. Fluid mechanical and thermodynamic properties, fluid statics, fluid dynamics, including mass, momentum and energy conservation, and transport of heat, particles and non-reactive chemicals with fluid flow. Single and multiphase laminar flow in porous and fractured permeable media. Turbulence and related topics that are of particular interest to hydrologists.

HYD 510, 510D, Quantitative Methods in Hydrology, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisite: MATH 231; Pre or Corequisite ERTH 440

Offered fall semester

Introduction to the methods of mathematical physics used in hydrologic science. Presented in the context of mathematical models of water and energy balances, fluid flow, and heat & solute transport. Application to aquifers, the vadose zone, land-surface runoff, rivers, and the atmospheric boundary layer. Methods span advanced engineering calculus, including numerics and differential equations. Use of software (Matlab, Maple, and COMSOL Multiphysics) for problem solving and solution presentation. Programming with Matlab.

Old Version

HYD 531, 531D, Aquifer Mechanics, 1 cr, 1 cl hr

~~*Prerequisite: ERTH 440 and 440L Offered spring semester*~~

~~Physics of flow to wells, steady-state and transient solutions to well hydraulics equations, image well theory, responses of aquifers to perturbations.~~

HYD 532, 532D, Vadose Zone Dynamics, 1 cr, 1 cl hr

~~*Prerequisite: ERTH 440, 440L, 442, HYD 510*~~

~~*Offered spring semester*~~

~~Physical processes governing fluid, solute, heat, and gas transport through the vadose zone; plant water uptake; applications of the model HYDRUS1D for the evaluation of these physical processes.~~

HYD 533, 533D, Runoff and Flood Processes, 1 cr, 1 cl hr

~~*Corequisite: ERTH 440 and 440L or HYD 510*~~

~~*Offered spring semester*~~

~~Processes leading to runoff formation in watersheds and the transformation of a flood pulse through a channel network system. Emphasis on physical mechanisms and their treatment in models.~~

New Version

HYD 511, 511D, Groundwater Hydrology, 3 cr, 3 cl hrs

Prerequisite: ERTH 440

Offered alternate spring semesters

Study of the occurrence, movement, and chemical and isotopic composition of groundwater. Hydrogeologic properties. Groundwater recharge and stream/aquifer interaction, flow net and hydrograph analysis. Groundwater exploration using geologic and geophysical methods. Groundwater in different geological, climate, and physiographic regimes. Characterization of groundwater using stable isotopes and major ion analysis. Physics of flow to wells, steady- state and transient solutions to well hydraulics equations, image well theory, responses of aquifers to perturbations. Role of groundwater in contaminant migration and heat transfer. (Shares lecture with ERTH 411, with additional expectations for graduate credit)

HYD 513, 513D, Watershed Dynamics & Ecohydrology, 3 cr, 3 cl hrs

Prerequisite: ERTH 440

Offered alternate spring semesters

Processes governing hydrological flow rates and pathways through watershed systems: hillslope runoff production and in-channel flood routing. Emphasis on physical mechanisms and their treatment in models, as well as observations made in the field. Interactions between terrestrial plants and water, nutrients, and light resources in semiarid ecosystems and riparian zones. Vegetation induced flow roughness, ecohydrological processes and dynamics, and simple numerical models. (Shares lecture with ERTH 413, with additional expectations for graduate credit)

HYD 514, 514D, Vadose Zone Hydrology, 3 cr, 3 cl hrs

Prerequisite: ERTH 440

Offered alternate fall semesters

Physics of unsaturated flow in porous media, multiphase flow, potentials and water retention, unsaturated hydraulic conductivity, transient flow problems. Mathematical modeling of variable-density flow. Analysis of slope stability, drainage through mine tailings and rock piles, hazardous waste migration, soil moisture controls on evapotranspiration and vegetation growth. (Shares lecture with ERTH 414, with additional expectations for graduate credit)

Old Version

HYD 534, 534D, Introduction to Remote Sensing, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisite: PHYS 122 or consent of instructor

Introduction to the theory and practical use of remotely sensed satellite images. Principles of radiation physics; sensor systems; data acquisition; image analysis; classification schemes. Remote sensing applications to atmospheric sciences, hydrology, mineral and oil exploration, natural hazards monitoring, and land and resources management. Become familiar with ERDAS Imagine remote sensing software. Laboratory exercises using ERDAS Imagine deal primarily with computer analysis of remotely sensed images with some field exercises. Shares lecture/lab with ERTH 434, with additional expectations for graduate credit. (Same as GEOL/GEOP 534)

HYD 535, Engineering and Science Applications of Vadose Zone Modeling, 1 cr, 1 cl hr

~~*Prerequisites: ERTH 440, ERTH 442, HYD 510 or consent of instructor*~~

~~Application of the HYDRUS models in 1, 2, and 3-dimensions, and COMSOL Multiphysics, for the evaluation of variably saturated flow and transport. After an introduction to the HYDRUS models, hydrology and engineering students will work on their own HYDRUS application dealing with typical geotechnical, agricultural, and ecohydrological simulations including slope stability, drainage through tailings and rock piles, hazardous waste migration, soil moisture controls on evapotranspiration and vegetation growth.~~

HYD 536, Advanced Remote Sensing, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisite: ERTH 434 or HYD 534 or GEOL 534
Offered on demand

This class deals with quantitative remote sensing for determination of the components of the energy balance (net radiation, latent and sensible heat fluxes, soil heat flux) and soil moisture, hyperspectral and multispectral image processing, radar and microwave imagery. In addition, advanced applications for geology, geophysics and geochemistry will be discussed. Shares lecture/lab with ERTH 436, with additional expectations for graduate credit. (Same as GEOL 536)

New Version

HYD 516, 516D, Geofluids, 3 cr, 3 cl hrs

Corequisites: ERTH 440, HYD 511 or PETR 445
Offered alternate spring semesters

The role of groundwater in geologic processes. Fluid flow impelling mechanisms within the earth's crust to depths of 10 km. The role of groundwater in petroleum generation/migration, overpressure/underpressure formation in sedimentary basins, hydrothermal ore deposit formation, contact metamorphism, geothermal systems, seismicity, slope failure, sediment transport, and glaciation.

HYD 520, Data-driven Modeling in Science and Engineering, 3 cr, 3 cl hrs

Prerequisites: MATH 283 or 382 and MATH 335 or consent of instructor

Statistical learning techniques and data assimilation for science and engineering applications. Focus is on practical applications and the understanding of the assumptions underlying techniques, allowing students to learn the basics of useful tools for data-driven modeling and revisit their theoretical and practical underpinnings as needed. Topics may include supervised and unsupervised learning, regression, classification, importance sampling, ensemble forecasting, and Kalman Filtering. The codes R and Python will be used. (Same as GEOP 520)

HYD 534, 534D, Introduction to Remote Sensing, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisite: PHYS 122 or consent of instructor

Introduction to the theory and practical use of remotely sensed satellite images. Principles of radiation physics; sensor systems; data acquisition; image analysis; classification schemes. Remote sensing applications to atmospheric sciences, hydrology, mineral and oil exploration, natural hazards monitoring, and land and resources management. Become familiar with ERDAS Imagine remote sensing software. Laboratory exercises using ERDAS Imagine deal primarily with computer analysis of remotely sensed images with some field exercises. Shares lecture/lab with ERTH 434, with additional expectations for graduate credit. (Same as GEOL/GEOP 534)

Old Version

HYD 538, Advanced Geographic Information Systems, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisite: Consent of instructor

Advanced topics in geographic information systems (GIS) with a focus on applications in environmental sciences. Emphasis on theoretical aspects and practical applications of GIS science and technology and its integration with remote sensing data and field measurements. Computing exercises and programming projects utilizing GIS software. Discussion of GIS integration with environmental modeling. Shares lecture/lab with ENVS 438, with additional expectations for graduate credit. (Same as GEOL 538)

HYD 541, 541D, Water Resources Management, 1 cr, 1 cl hr

Prerequisite: ERTH 440 and 440L

Offered alternate spring semesters

Social and economic basis for administering water. Comparison of American Indian and European attitudes toward the hydrological system. Fundamentals of water law and policy in the United States.

HYD 542, 542D, Hillslope Hydrology, 1 cr, 1 cl hr

~~*Prerequisites: ERTH 440, 440L, 442, HYD 510, HYD 532 or consent of instructor*~~

~~Physical processes governing water flow through hillslope systems and into receiving streams.~~

HYD 543, 543D, Ecohydrology, 1 cr, 1 cl hr

~~*Prerequisites: ERTH 440 and 440L*~~

~~Interactions between terrestrial plants and water, nutrients, and light resources in semiarid environments. Ecohydrological processes, dynamics, and simple models.~~

HYD 544, 544D, Groundwater Remediation, 1 cr, 1 cl hr

~~*Prerequisites: ERTH 440, HYD 507, HYD 510 Pre- or corequisite ERTH 441*~~

~~*Offered alternate spring semesters*~~

~~Coverage of accepted and emerging techniques to remove or control groundwater contaminants. Emphasis is placed on the suitability of techniques for dealing with inorganic, organic, and biological contaminants.~~

HYD 546, 546D, Contaminant Hydrology, 3 cr, 3 cl hrs

Prerequisites: ERTH 440; HYD 507 Corequisite: HYD 508

Offered alternate fall semesters

The physics, chemistry, and biology of inorganic, organic, and microbial contaminants in groundwater and surface water systems. Mechanisms by which contaminants are introduced. Transport and transformations of contaminants in surface waters, the vadose zone, and the saturated zones. Movement, capillary trapping, and solubility of relatively immiscible organic liquids. Contaminant isolation and remediation techniques. (Same as GEOC 546.)

New Version

HYD 536, Advanced Remote Sensing, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisite: ERTH 434 or HYD 534 or GEOL 534

Offered on demand

This class deals with quantitative remote sensing for determination of the components of the energy balance (net radiation, latent and sensible heat fluxes, soil heat flux) and soil moisture, hyperspectral and multispectral image processing, radar and microwave imagery. In addition, advanced applications for geology, geophysics and geochemistry will be discussed. Shares lecture/lab with ERTH 436, with additional expectations for graduate credit. (Same as GEOL 536)

HYD 538, Advanced Geographic Information Systems, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisite: Consent of instructor

Advanced topics in geographic information systems (GIS) with a focus on applications in environmental sciences. Emphasis on theoretical aspects and practical applications of GIS science and technology and its integration with remote sensing data and field measurements. Computing exercises and programming projects utilizing GIS software. Discussion of GIS integration with environmental modeling. Shares lecture/lab with ENVS 438, with additional expectations for graduate credit. (Same as GEOL 538)

HYD 541, 541D, Water Resources Management, 1 cr, 1 cl hr

Prerequisite: ERTH 440

Offered on demand

Social and economic basis for administering water. Comparison of American Indian and European attitudes toward the hydrological system. Fundamentals of water law and policy in the United States.

HYD 546, 546D, Contaminant Hydrology, 3 cr, 3 cl hrs

Prerequisites: ERTH 440; HYD 507 Corequisite: HYD 508

Offered on demand

The physics, chemistry, and biology of inorganic, organic, and microbial contaminants in groundwater and surface water systems. Mechanisms by which contaminants are introduced. Transport and transformations of contaminants in surface waters, the vadose zone, and the saturated zones. Movement, capillary trapping, and solubility of relatively immiscible organic liquids. Contaminant isolation and remediation techniques. (Same as GEOC 546.)

Old Version

HYD 547, Hydrological Modeling, 3 cr, 3 cl hrs

Prerequisites: ERTH 440, HYD 508, HYD 510

Analysis and synthesis of issues in hydrologic science. Related engineering problem solving. Conceptual modeling process: model conceptualization and parameterization, model diagnosis, testing and validation, and model prediction. Conceptual models for testing scientific hypotheses, assimilating data, developing policy, and solving engineering design and operational problems. Applications to land-surface, surface water, vadose zone, and groundwater, singly and together, and to their interfaces with the atmosphere and oceans.

HYD 548, Laboratory and Field Methods in Hydrology, 3 cr, 1 cl hr, 6 lab hrs

~~*Prerequisite: Consent of instructor*~~

~~*Offered on demand*~~

~~Instrumentation and methodologies used in hydrological investigations in a field or laboratory setting. Course topics may range across a variety of physical and chemical hydrological techniques in vadose, groundwater and surface hydrology. Examples of potential topical areas include, but are not limited to, aquifer, lake and stream sample collection, storage and analysis, aquifer and watershed characterization, discharge measurements and tracer tests, land surface-atmosphere flux measurements, and hydrologic field campaigns.~~

HYD 552, Fluid/Surface Interactions, 3 cr, 3 cl hrs

~~*Prerequisite: Consent of instructor*~~

~~*Offered in alternate years*~~

~~The physics and chemistry of interfaces, focusing on the behavior of multifluid systems both in the presence and absence of solids. How basic interactions among microscopic particles can explain macroscopic phenomena. Application-oriented, focusing on interactions important in hydrology, petroleum engineering, and environmental engineering. (Same as PETR 552)~~

HYD 554, Environmental Physics for Evapotranspiration, 3 cr, 3 cl hrs

~~*Prerequisites: ERTH 440; HYD 508; or consent of instructor.*~~

~~The first part of the course includes elements of environmental physics: radiation balance of the Earth's surface; transfer of momentum, heat, and mass; and crop micrometeorology. The second part focuses on vegetation water use and evapotranspiration: measurement methods; evaluation from meteorological observations; and prediction of spatial and temporal distribution of regional evapotranspiration using remote sensing.~~

New Version

HYD 547, Hydrological Modeling, 3 cr, 3 cl hrs

Prerequisites: ERTH 440, HYD 508, HYD 510

Offered alternate spring semesters

Analysis and synthesis of issues in hydrologic science. Related engineering problem solving. Conceptual modeling process: model conceptualization and parameterization, model diagnosis, testing and validation, and model prediction. Conceptual models for testing scientific hypotheses, assimilating data, developing policy, and solving engineering design and operational problems. Applications to land-surface, surface water, vadose zone, and groundwater, singly and together, and to their interfaces with the atmosphere and oceans.

HYD 550, 550D, Cave and Karst Systems, 3 cr, 3 cl hrs

Prerequisites: CHEM 121 & 122; and either any 100 level ERTH or BIOL 111

Offered alternate spring semesters

A system-based study of caves and karstic terrains over time including formation mechanisms (speleogenesis), hydrology, geochemistry, mineralogy, and geomicrobiology. Emphasis on caves as interactive microcosms cross-cutting many disciplines. Shares lecture with ERTH 450, with additional expectations for graduate credit.

HYD 550L, Cave and Karst Lab, 1 cr, 3 lab hrs

Offered alternate spring semesters

Corequisite: HYD 550

Survey of techniques applicable to various aspects of speleology and karst studies. Project-based lab, developed for each student in consultation with instructor. Shares lab with ERTH 450L, with additional expectations for graduate credit.

Old Version

HYD 555, Advanced Aqueous Geochemistry, 3 cr, 3 cl hrs

~~*Prerequisite: HYD 507 or consent of instructor*~~

~~Advanced topics in aqueous geochemistry, including chemical weathering, surface reactivity, colloidal phenomena, environmental organic chemistry, process-based reactive transport modeling, and other topics of interest to those enrolled.~~

HYD 558, Environmental Tracers in Hydrology, 3 cr, 3 cl hrs

Prerequisites: ERTH 440; HYD 507 Offered in alternate years

Atomic structure and abundances of environmental isotopes. Stable isotope fractionation. Mass spectrometry. Applications of the stable isotopes of hydrogen, oxygen, and carbon to meteorology and hydrology. Radioactive decay and radionuclide production. Applications of tritium, 3He, 14C, 36Cl , and other radionuclides. Application of Cl-, Br, chlorofluorocarbons and other environmental tracers to hydrologic problems.

HYD 560, Applied Groundwater Hydrology, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisites: HYD 508

Offered on demand

Topics for in-depth investigation may include well design, aquifer pumping test design and interpretation, groundwater flow simulation, and aquifer contamination. Field experiments, field trips, lab analysis, computer work, technical report preparation, and oral presentations.

HYD 570, Seminar in Hydrology, 2 cr, 2 cl hrs

Review and discussion of papers relating to hydrology.

HYD 571, 571D, 572, Advanced Topics in Hydrology, 1–3 cr each semester

Offered on demand

Study of special topics in hydrology.

New Version

HYD 558, Tracers in Hydrology, 3 cr, 3 cl hrs

Prerequisites: ERTH 440; HYD 507

Offered in alternate fall semesters

Environmental and artificial tracers in hydrology. Environmental tracer topics may include: atomic structure and abundances of environmental isotopes, stable isotope fractionation, mass spectrometry; applications of the stable isotopes of hydrogen, oxygen, and carbon to meteorology and hydrology; radioactive decay and radionuclide production; applications of tritium, 3He, 14C, 36Cl, and other radionuclides; application of Cl, Br and CFCs to hydrologic problems; and carbon, nitrogen, and phosphorus isotopes for nutrient cycling in soils and freshwater systems. Artificial tracer topics may include: fluorescent and salt tracers, drifting particles, and dissolved gas tracers. Planning and execution of tracer experiments and the analysis and interpretation of tracer data with solute transport equations, convolution integral methods, and end-member mixing analysis.

HYD 560, Advanced Well Hydraulics, 3 cr, 2 cl hrs, 3 lab hrs

Prerequisites: HYD 511

Offered on demand

Topics for in-depth investigation may include production and monitoring well design, aquifer pumping test design and analysis. Aquifer test analysis for unconfined aquifers, fractured bedrock aquifers, anisotropic aquifers, partially penetrating wells, and leaky confining units. Hydrogeologic field work including long-term aquifer test.

HYD 562, Fluvial Geomorphology, 3 cr, 3 cl hrs

Prerequisites: ERTH 440

Offered in alternate spring semesters

Interactions of water and sediment flow in fluvial systems. Sediment transport rates and particle size dependence. Physical controls on channel morphology, bedforms, and microhabitat distribution. Hydraulic geometry and bank-full flow analysis, with implications for floodplain development. Basin morphometric relationships with climate and flood routing. Case studies of fluvial system response to disturbances such as wildfire, avulsion, land use change, climate change, and stream restoration. (Same as GEOL 562)

HYD 570, Seminar in Hydrology, 1 cr, 1 cl hrs

Review and discussion of papers relating to hydrology.

HYD 571, 571D, 572, Advanced Topics in Hydrology, 1–3 cr each semester

Offered on demand

Study of special topics in hydrology.

Old Version

HYD 581, Directed Study, cr to be arranged

Study under the guidance of a member of the graduate faculty. In general, subject matter will supplement that available in the other graduate course offerings.

HYD 587, Analysis of Time Series and Spatial Data, 3 cr, 3 cl hrs

~~*Offered in alternate years*~~

~~An introductory overview of methods for analyzing temporal and spatial series with an emphasis on scientific applications. Linear systems in continuous and discrete time, Fourier analysis, spectral estimation, convolution and deconvolution, filtering, the z and Laplace transforms, stationary and nonstationary time series, ARIMA modeling, forecasting, and generalizations to multidimensional and multichannel applications. (Same as MATH 587 and GEOP 505)~~

HYD 590, Independent Study, cr to be arranged

Organized independent student research coordinated with a faculty member and documented in a final written report.

HYD 591, Thesis (master's program), cr to be arranged

HYD 592, Graduate Seminar, 1 cr, 1 cl hr

Prerequisite: Graduate standing

Offered spring semesters

Seminar presentations by graduate students on their current research topics. M.S. students must present at least one seminar; Ph.D. students must present at least one seminar in each of two different semesters. Graded on S/U basis; credits earned may not be applied towards the 30 credits required for the M.S. degree (same as GEOB 592, GEOL 592, GEOC 592, GEOP 592)

HYD 593, Seminar, 1 cr, 1 cl hr

Prerequisite: Graduate standing

Offered fall and spring semesters

Seminar presentations by faculty, students, and outside speakers. Includes both Department and hydrology- specific seminars. Graded on *S/U* basis. Satisfactory performance consists of regular attendance at approved seminars. Credit earned may not be applied towards the 30 credits required for the M.S. degree. (Same as GEOB 593, GEOC 593, GEOL 593, GEOP 593)

HYD 595, Dissertation (doctoral degree program), cr to be arranged

Prerequisite: Successful completion of PhD candidacy exam and Academic Advisor recommendation for candidacy.

New Version

HYD 581, Directed Study, cr to be arranged

Study under the guidance of a member of the graduate faculty. In general, subject matter will supplement that available in the other graduate course offerings.

HYD 586, Field Methods in Hydrology, 2 cr

Prerequisite: Consent of instructor

Offered Summers (2 weeks); NMT students should register for this course in the spring semester.

Instrumentation and methodologies used in hydrological investigations in a field setting. Course topics may range across a variety of physical and chemical hydrological techniques in vadose, groundwater and surface hydrology. Examples of potential topical areas include, but are not limited to, aquifer, lake and stream sample collection, storage and analysis; aquifer and watershed characterization; discharge measurements and tracer tests; land surface-atmosphere flux, groundwater geophysics, measurements; and hydrologic field campaigns.

HYD 590, Independent Study, cr to be arranged

Organized independent student research coordinated with a faculty member and documented in a final written report.

HYD 591, Thesis (master's program), cr to be arranged

HYD 592, Graduate Seminar, 1 cr, 1 cl hr

Prerequisite: Graduate standing

Offered spring semesters

Seminar presentations by graduate students on their current research topics. M.S. students must present at least one seminar; Ph.D. students must present at least one seminar in each of two different semesters. Graded on S/U basis; credits earned may not be applied towards the 30 credits required for the M.S. degree (same as GEOB 592, GEOL 592, GEOC 592, GEOP 592)

HYD 593, Seminar, 1 cr, 1 cl hr

Prerequisite: Graduate standing

Offered fall and spring semesters

Seminar presentations by faculty, students, and outside speakers. Includes both Department and hydrology- specific seminars. Graded on *S/U* basis. Satisfactory performance consists of regular attendance at approved seminars. Credit earned may not be applied towards the 30 credits required for the M.S. degree. (Same as GEOB 593, GEOC 593, GEOL 593, GEOP 593)

HYD 595, Dissertation (doctoral degree program), cr to be arranged

Prerequisite: Successful completion of PhD candidacy exam and Academic Advisor recommendation for candidacy.

Old Version

New Version

Other Sections of the Catalog:

GEOL 562, Fluvial Geomorphology, 3 cr, 3 cl hrs

Prerequisites: ERTH 440

Offered in alternate spring semesters

Interactions of water and sediment flow in fluvial systems. Sediment transport rates and particle size dependence. Physical controls on channel morphology, bedforms, and microhabitat distribution. Hydraulic geometry and bank-full flow analysis, with implications for floodplain development. Basin morphometric relationships with climate and flood routing. Case studies of fluvial system response to disturbances such as wildfire, avulsion, land use change, climate change, and stream restoration. (Same as HYD 562)

GEOP 520, Data-driven Modeling in Science and Engineering, 3 cr, 3 cl hrs

Prerequisites: MATH 283 or 382 and MATH 335 or consent of instructor

Statistical learning techniques and data assimilation for science and engineering applications. Focus is on practical applications and the understanding of the assumptions underlying techniques, allowing students to learn the basics of useful tools for data-driven modeling and revisit their theoretical and practical underpinnings as needed. Topics may include supervised and unsupervised learning, regression, classification, importance sampling, ensemble forecasting, and Kalman Filtering. The codes R and Python will be used. (Same as HYD 520)