

# Hydrologic Science and Engineering

2017-2018

## Degrees Offered

- Master of Science (Hydrology), Thesis option
- Master of Science (Hydrology), Non-thesis option
- Doctor of Philosophy (Hydrology)

## Program Description

The Hydrologic Science and Engineering (HSE) Program is an interdisciplinary graduate program comprised of faculty from several different Mines departments.

The program offers programs of study in fundamental hydrologic science and applied hydrology with engineering applications. Our program encompasses groundwater hydrology, surface-water hydrology, vadose-zone hydrology, watershed hydrology, contaminant transport and fate, contaminant remediation, hydrogeophysics, and water policy/law.

HSE requires a core study of five formal graduate courses. Programs of study are interdisciplinary in nature, and coursework is obtained from multiple departments at Mines and is approved for each student by the student's advisor and thesis committee.

To achieve the Master of Science (M.S.) degree, students may elect the Non-Thesis option, based exclusively upon coursework and an independent study project or a designated design course, or the Thesis option. The thesis option is comprised of coursework in combination with individual laboratory, modeling and/or field research performed under the guidance of a faculty advisor and presented in a written thesis approved by the student's committee.

HSE also offers a combined baccalaureate/masters degree program in which Mines students obtain an undergraduate degree as well as a Thesis or Non-thesis M.S. in Hydrology. Please see the Combined Undergraduate/Graduate Programs sections in the Graduate (<http://bulletin.mines.edu/graduate/programs>) and Undergraduate (<http://bulletin.mines.edu/undergraduate/undergraduateinformation/combinedundergraduategraduate>) Catalogs for additional information.

To achieve the Doctor of Philosophy (Ph.D.) degree, students are expected to complete a combination of coursework and novel, original research, under the guidance of a faculty advisor and Doctoral committee, which culminates in a significant scholarly contribution to a specialized field in hydrologic sciences or engineering. Full-time enrollment is expected and leads to the greatest success, although part-time enrollment may be allowed under special circumstances. All doctoral students must complete the full-time, on-campus residency requirements ([bulletin.mines.edu/graduate/registrationandtuitionclassification](http://bulletin.mines.edu/graduate/registrationandtuitionclassification)).

Currently, students will apply to the Hydrological Science & Engineering program through the Graduate School and be assigned to the HSE participating department of the student's HSE advisor. Participating units include: Chemistry and Geochemistry, Civil & Environmental Engineering (CEE), Geology and Geological Engineering (GE), Geophysical Engineering, Liberal Arts & International Studies (LAIS), Mechanical Engineering (ME), Mining Engineering (MN), and Petroleum Engineering

(PE). HSE is part of the Western Regional Graduate Program (WICHE), a recognition that designates these programs as unique within the Western United States. An important benefit of this designation is that students from several western states are given the tuition status of Colorado residents. These states include Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming.

For more information on HSE curriculum please refer to the HSE website at [hydrology.mines.edu](http://hydrology.mines.edu).

## Combined Degree Program Option

Mines undergraduate students have the opportunity to begin work on a M.S. degree in Hydrology while completing their Bachelor's degree. The Mines Combined Degree Program provides the vehicle for students to complete graduate coursework while still an undergraduate student. For more information please contact the HSE Program Coordinator Tim VanHaverbeke.

## Program Requirements

**MS Thesis:** 30 credit hours total, consisting of 24 credit hours of coursework and 6 credit hours of thesis credit. Students must also write and orally defend a research thesis.

**MS Non-Thesis:** 30 credit hours total, consisting of 27 credit hours of coursework and 3 credit hours of independent study or completion of an approved 3 credit hour Design Course\*.

**Ph.D.:** 72 total credit hours, consisting of coursework (at least 36 h post-baccalaureate), and research (at least 24 h). Students must also successfully complete qualifying examinations, write and defend a dissertation proposal, write and defend a doctoral dissertation, and are expected to submit the dissertation work for publication in scholarly journals.

## Thesis & Dissertation Committee Requirements

Students must meet the general requirements listed in the graduate catalog section *Graduate Degrees and Requirements*. In addition, the student's advisor or co-advisor must be an HSE faculty member. For M.S. thesis students, at least two committee members must be members of the HSE faculty. For doctoral students, at least 2 faculty on the committee must be a member of the HSE faculty. For PhD committee the required at-large member must meet two requirements: (1) be from a Mines department out side the student's home department and (2) not be a member of the HSE core faculty.

## Prerequisites

- baccalaureate degree in a science or engineering discipline
- college calculus: two semesters required
- differential equations: one semester required
- college physics: one semester required
- college chemistry: two semesters required
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- college statistics: one semester required

Note that some prerequisites may be completed in the first few semesters of the graduate program if approved by the HSE Director.

## Required Curriculum

Students will work with their academic advisors and graduate thesis committees to establish plans of study that best fit their individual interests and goals. Each student will develop and submit a plan of study to their advisor during the first semester of enrollment. Doctoral students may transfer in credits from an earned M.S. graduate program according to requirements listed in the Graduate Degrees and Requirements (bulletin.mines.edu/graduate/programs) section of the graduate catalog, and after approval by the student's thesis committee.

## Core Curriculum

Curriculum areas of emphasis consist of core courses, and electives. Core courses include the following:

GEGN466	GROUNDWATER ENGINEERING	3.0
GEGN582	INTEGRATED SURFACE WATER HYDROLOGY	3.0
CEEN550	PRINCIPLES OF ENVIRONMENTAL CHEMISTRY	3.0
CEEN584 or CEEN580	SUBSURFACE CONTAMINANT TRANSPORT CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT	3.0
GEGN585	FLUID MECHANICS FOR HYDROLOGY	2.0
<b>Total Semester Hrs</b>		<b>14.0</b>

If a student has completed a Fluid Mechanics course this core requirement will be waived once an HSE Waiver Form is approved.

An HSE seminar is also required and will typically have a 598 course number. These are one-credit reading and discussion seminars. PhD students are required to complete at least two during their studies, and M.S. students must complete one seminar. The seminar courses are taught nearly every semester, with different topics depending on the instructor.

Students who plan to incorporate hydrochemistry into their research may elect to replace CEEN550 with a two-course combination that includes an aqueous inorganic chemistry course (CHGC509) and an environmental organic chemistry course (CEEN511).

A grade of B- or better is required in all core classes for graduation.

For Non Thesis MS students, the following is a list of **Design Courses\*** that may be completed in lieu of an Independent Study:

CEEN515	HILLSLOPE HYDROLOGY AND STABILITY	3.0
CEEN581	WATERSHED SYSTEMS MODELING	3.0
CEEN575	HAZARDOUS WASTE SITE REMEDIATION	3.0
CEEN584	SUBSURFACE CONTAMINANT TRANSPORT	3.0
GEGN532	GEOLOGICAL DATA ANALYSIS	3.0
GEGN575	APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS	3.0
GEGN583	MATHEMATICAL MODELING OF GROUNDWATER SYSTEMS	3.0
GEGN584	FIELD METHODS IN HYDROLOGY	3.0
GEGN586	NUMERICAL MODELING OF GEOCHEMICAL SYSTEMS	3.0

**Elective courses** may be chosen from the approved list below or as approved by your advisor or thesis committee.

CEEN471	WATER AND WASTEWATER TREATMENT SYSTEMS ANALYSIS AND DESIGN	3.0
CEEN511	UNSATURATED SOIL MECHANICS	3.0
CEEN512	SOIL BEHAVIOR	3.0
CEEN515	HILLSLOPE HYDROLOGY AND STABILITY	3.0
CEEN560	MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT	3.0
CEEN562	ENVIRONMENTAL GEOMICROBIOLOGY	3.0
CEEN570	WATER AND WASTEWATER TREATMENT	3.0
CEEN571	ADVANCED WATER TREATMENT ENGINEERING AND WATER REUSE	3.0
CEEN575	HAZARDOUS WASTE SITE REMEDIATION	3.0
CEEN581	WATERSHED SYSTEMS MODELING	3.0
CEEN582	MATHEMATICAL MODELING OF ENVIRONMENTAL SYSTEMS	3.0
CEEN611	MULTIPHASE CONTAMINANT TRANSPORT	3.0
GEGN470	GROUND-WATER ENGINEERING DESIGN	3.0
GEGN532	GEOLOGICAL DATA ANALYSIS	3.0
GEGN573	GEOLOGICAL ENGINEERING SITE INVESTIGATION	3.0
GEGN575	APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS	3.0
GEGN581	ANALYTICAL HYDROLOGY	3.0
GEGN584	FIELD METHODS IN HYDROLOGY	3.0
GEGN586	NUMERICAL MODELING OF GEOCHEMICAL SYSTEMS	3.0
GEOL540	ISOTOPE GEOCHEMISTRY AND GEOCHRONOLOGY	3.0
GPGN470	APPLICATIONS OF SATELLITE REMOTE SENSING	3.0
MATH530	STATISTICAL METHODS I	3.0
MATH531	STATISTICAL METHODS II	3.0
MATH532	SPATIAL STATISTICS	3.0
EBGN510	NATURAL RESOURCE ECONOMICS	3.0
LAIS588	WATER POLITICS AND POLICY	3.0

## Directors

Terri Hogue, HSE Director, Civil & Environmental Engineering

Kamini Singha, HSE Associate Director, Geology & Geological Engineering

## Department of Chemistry and Geochemistry

James Ranville, Professor

Bettina Voelker, Professor

## Department of Civil & Environmental Engineering

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Ning Lu, Professor

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John Spear, Professor

## **Department of Geology and Geological Engineering**

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