Humanitarian Engineering

Degrees
- Graduate Certificate in Humanitarian Engineering and Science

Program Description
The MS degrees in Humanitarian Engineering and Science (HES) are a professional MS (non-thesis) and a thesis-based MS. These degrees are targeted to recent graduates or mid-career professionals with a BS in science and engineering who are interested in careers, research opportunities, and/or acquiring skills that will help them work effectively with communities. The degrees include a core HES curriculum plus an approved track of related courses in a science or engineering discipline.

The HES graduate certificate is designed for professionals seeking to attend school part-time or students who are seeking degrees in other departments at Mines but still desire graduate training in humanitarian engineering and science. It consists of four courses.

In both the master’s degrees and graduate certificate, a unique mix of social science, applied science, and engineering perspectives prepares students to apply knowledge about the earth to promote more sustainable and just uses of water, energy, and other earth resources and to understand and mitigate potential hazards.

To achieve the Master of Science (MS) degree, students may elect the Non-Thesis option, based exclusively upon coursework and a practicum, or the Thesis option. The thesis option is comprised of coursework in combination with individual research performed under the guidance of two faculty advisors and presented in a written thesis approved by the student’s committee. HES students have academic advisors from both the Engineering, Design & Society Division and their disciplinary track (Environmental Engineering, Geological Engineering, or Geophysics). The thesis-based MS usually takes two years to complete, while the non-thesis MS can often be completed in one year.

For more information on program curriculum please refer to the HES website: https://humanitarian.mines.edu/mshes/.

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Program Requirements
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Master of Science (Non-Thesis)
To obtain the 30 credits, students must satisfy the following program requirements: (1) 12 credits of required HES courses; (2) 3 credits of elective HES courses approved by Engineering, Design & Society; and (3) 15 credits of courses (500+ level) approved by the affiliated Department.

HES Courses (15 credits):
- EDNS577 ADVANCED ENGINEERING AND SUSTAINABLE 3.0 COMMUNITY DEVELOPMENT
- EDNS479 COMMUNITY-BASED RESEARCH 3.0
- EDNS590 RISKS IN HUMANITARIAN ENGINEERING AND SCIENCE 3.0
- EDNS580 HUMANITARIAN ENGINEERING AND SCIENCE CAPSTONE PRACTICUM 3.0
- ELECTIVES 3 credit hours of approved HES electives from list 3.0

Approved HES Electives List:
- EDNS430 CORPORATE SOCIAL RESPONSIBILITY 3.0
- EDNS475 ENGINEERING CULTURES IN THE DEVELOPING WORLD 3.0
- EDNS478 ENGINEERING AND SOCIAL JUSTICE 3.0
- EDNS480 ANTHROPOLOGY OF DEVELOPMENT 3.0
- HASS425 INTERCULTURAL COMMUNICATION 3.0
- HASS525 ENVIRONMENTAL COMMUNICATION 3.0
- HASS565 SCIENCE, TECHNOLOGY, AND SOCIETY 3.0
- MNGN482 MINE MANAGEMENT 3.0
- MNGN503 MINING TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT 3.0
- MNGN510 FUNDAMENTALS OF MINING AND MINERAL RESOURCE DEVELOPMENT 3.0
- MNGN565 MINE RISK MANAGEMENT 3.0
- MNGN567 SUSTAINABLE DEVELOPMENT AND EARTH RESOURCES 3.0
- MNGN571 ENERGY, NATURAL RESOURCES, AND SOCIETY 3.0
- PEGN530 ENVIRONMENTAL LAW AND SUSTAINABILITY 3.0
- CEEN401 LIFE CYCLE ASSESSMENT 3.0
- CEEN472 ONSITE WATER RECLAMATION AND REUSE 3.0
- CEEN477 SUSTAINABLE ENGINEERING DESIGN 3.0
- CEEN479 AIR POLLUTION 3.0
- CEEN475/575 SITE REMEDIATION ENGINEERING 3.0
- CEEN556 MINING AND THE ENVIRONMENT 3.0
- CEEN570 WATER AND WASTEWATER TREATMENT 3.0
- CEEN573 RECLAMATION OF DISTURBED LANDS 3.0
- CEEN580 CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT 3.0
- CEEN581 WATERSHED SYSTEMS MODELING 3.0
Disciplinary Tracks

Track 1: Geophysics (GPGN) (15 credits):

Degree candidates should have an undergraduate degree in geophysics, physics, quantitative earth sciences and engineering, or equivalent coursework. In addition, candidates will need to complete necessary prerequisite courses for the graduate courses.

- GPGN577 HUMANITARIAN GEOSCIENCE 3.0
- GPGN533 GEOPHYSICAL DATA INTEGRATION & GEOSTATISTICS 3.0
- GPGN570 APPLICATIONS OF SATELLITE REMOTE SENSING 3.0
- GPGN574 ADVANCED HYDROGEOPHYSICS 3.0
- ELECTIVES 3 credits of approved 500-level GPGN electives 3.0

Approved GPGN Electives List:

- GPGN509 PHYSICAL AND CHEMICAL PROPERTIES AND PROCESSES IN ROCK, SOILS, AND FLUIDS 3.0
- GPGN511 ADVANCED GRAVITY AND MAGNETIC METHODS 3.0
- GPGN520 ELECTRICAL AND ELECTROMAGNETIC EXPLORATION 3.0
- GPGN530 APPLIED GEOPHYSICS 3.0
- GPGN555 EARTHQUAKE SEISMOLOGY 3.0
- GPGN561 SEISMIC DATA PROCESSING I 4.0
- GPGN605 INVERSION THEORY 3.0
- Other GPGN 500- or 600-level courses as approved by the GPGN program coordinator

Track 2: Environmental Engineering (CEEN) (15 credits):

A BS degree in a science or engineering discipline is required. Pre-requisites include two semesters of college calculus, one semester of college physics, two semesters of college chemistry, and one semester of college statistics.

Required Courses:

- CEEN550 PRINCIPLES OF ENVIRONMENTAL CHEMISTRY 3.0
- GPGN577 HUMANITARIAN GEOSCIENCE 3.0
- CEEN580 CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT 3.0

One of the Following:

- CEEN560 MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT
- CEEN562 ENVIRONMENTAL GEOMICROBIOLOGY
- CEEN566 MICROBIAL PROCESSES, ANALYSIS AND MODELING

One of the Following:

- CEEN472 ONSITE WATER RECLAMATION AND REUSE
- CEEN570 WATER AND WASTEWATER TREATMENT
- CEEN575 HAZARDOUS WASTE SITE REMEDIATION

Approved CEEN Electives List:

The following courses can be substituted for required track courses if incoming students have already taken some of the required courses:

- CEEN477 SUSTAINABLE ENGINEERING DESIGN 3.0
- CEEN479 AIR POLLUTION 3.0
- CEEN501 LIFE CYCLE ASSESSMENT 3.0
- CEEN/MNGN556 MINING AND THE ENVIRONMENT 3.0
- CEEN573 RECLAMATION OF DISTURBED LANDS 3.0
- CEEN575 HAZARDOUS WASTE SITE REMEDIATION 3.0
- CEEN581 WATERSHED SYSTEMS MODELING 3.0
- Other CEEN 500- or 600-level courses as approved by the CEEN Program Coordinator

Track 3: Geological Engineering (GEGN) (15 credits):

Degree candidates should have an undergraduate degree in engineering or the equivalent coursework. In addition, candidates will need to complete necessary prerequisite courses for the graduate courses, including engineering geology, ground-water engineering, soil mechanics, and rock mechanics.

Required Courses:

- GEGN532 GEOLOGICAL DATA ANALYSIS 3.0
- GPGN577 HUMANITARIAN GEOSCIENCE 3.0

Candidates must also take at least three of the following courses. The student and the instructor will work together to develop humanitarian themes in the project assignments within each course.

- GEGN563 APPLIED NUMERICAL MODELLING FOR GEOMECHANICS 3.0
- GEGN570 CASE HISTORIES IN GEOLOGICAL ENGINEERING AND HYDROGEOLOGY 3.0
- GEGN573 GEOLOGICAL ENGINEERING SITE INVESTIGATION 3.0
- GEGN575 APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS 3.0
- GEGN580 APPLIED REMOTE SENSING FOR GEOTECHNICAL AND GEOSCIENCES 3.0
- GEGN671 LANDSLIDES: INVESTIGATION, ANALYSIS & MITIGATION 3.0
- GEGN673 ADVANCED GEOLOGICAL ENGINEERING DESIGN 3.0

Master of Science (Thesis)

To obtain the 30 credits, students must satisfy the following program requirements: (1) 9 credits of required HES courses; (2) 3 credits of elective HES classes approved by Engineering, Design & Society; (3) 12 credits of approved Disciplinary Track classes (500+ level); and (4) 6 credits of MS thesis research on a thesis topic approved by HES faculty in the Engineering, Design, & Society Division and the affiliated disciplinary track.

HES Courses (12 credits in addition to the 6 credit hour thesis):

- EDNS577 ADVANCED ENGINEERING AND SUSTAINABLE COMMUNITY DEVELOPMENT 3.0
- EDNS479 COMMUNITY-BASED RESEARCH 3.0
Disciplinary Tracks

Track 1: Geophysics (GPGN) Courses and Thesis (18 credits):

- **GPGN577** HUMANITARIAN GEOSCIENCE 3.0
- **GPGN533** GEOPHYSICAL DATA INTEGRATION & GEOSTATISTICS 3.0
- **GPGN570** APPLICATIONS OF SATELLITE REMOTE SENSING 3.0
- **GPGN574** ADVANCED HYDROGEOPHYSICS 3.0
- **GPGN707** GRADUATE THESIS / DISSERTATION RESEARCH CREDIT 6.0

Track 2: Environmental Engineering (CEEN) Courses and Thesis (18 credits):

- **GPGN577** HUMANITARIAN GEOSCIENCE 3.0
- **CEEN707** GRADUATE THESIS / DISSERTATION RESEARCH CREDIT 1-15

Choose three of the following four options:

- **CEEN550** PRINCIPLES OF ENVIRONMENTAL CHEMISTRY 3.0
- **CEEN580** CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT 3.0

One of the following:

- **CEEN560** MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT
- **CEEN562** ENVIRONMENTAL GEOMICROBIOLOGY
- **CEEN566** MICROBIAL PROCESSES, ANALYSIS AND MODELING

One of the following:

- **CEEN472** ONSITE WATER RECLAMATION AND REUSE
- **CEEN570** WATER AND WASTEWATER TREATMENT
- **CEEN575** HAZARDOUS WASTE SITE REMEDIATION

Approved CEEN Electives:

- The courses listed in the Approved CEEN Electives List above can be substituted for required track courses if incoming students have already taken some of the required courses.

Track 3: Geological Engineering Courses and Thesis (18 credits):

- **GPGN577** HUMANITARIAN GEOSCIENCE 3.0
- **GEGN707** GRADUATE THESIS / DISSERTATION RESEARCH CREDIT 1-15

Students must take two of the following courses:

- **GEGN563** APPLIED NUMERICAL MODELLING FOR GEOMECHANICS 3.0
- **GEGN570** CASE HISTORIES IN GEOLOGICAL ENGINEERING AND HYDROGEOLOGY 3.0

Mines’ Combined Undergraduate / Graduate Degree Program

Students enrolled in Mines’ combined undergraduate/graduate program may double count up to six hours of credits which were used in fulfilling the requirements of their undergraduate degree at Mines, towards their graduate program. Any courses that count towards the graduate degree requirements as either “Required Coursework” or “Elective Coursework”, as defined above, may be used for the purposes of double-counting at the discretion of the advisor (MS Non-Thesis) or thesis committee (MS Thesis or PhD.). These courses must have been passed with a “B-” or better and meet all other University, Department, Division, and Program requirements for graduate credit.

Graduate Certificate

The HES certificate is an online or residential program designed for working professionals as well as graduate students who are enrolled in other degrees at Mines but wish to gain knowledge in humanitarian engineering and science. To obtain a graduate certificate, students must complete a minimum of 9 credit hours of the following courses. Students may not double-count courses from their undergraduate degrees. Students who have already taken one of the classes as undergraduates must find a suitable replacement, to be approved by the HES Director. Students are encouraged to take 12 credit hours of coursework if possible.

Required HES certificate courses (9 credits):

- **EDNS577** ADVANCED ENGINEERING AND SUSTAINABLE COMMUNITY DEVELOPMENT 3.0
- **EDNS479** COMMUNITY-BASED RESEARCH 3.0
- **EDNS590** RISKS IN HUMANITARIAN ENGINEERING AND SCIENCE 3.0

Courses

**EDNS515. INTRODUCTION TO ENGINEERING IN SOCIETY.** 3.0 Semester Hrs.

This course engages scholarship on the inextricable link between engineering and the various social contexts within which engineers work. We begin by critically reflecting on the question, “What is engineering for?” We then explore key conceptual domains in the social scientific study of engineering, including knowledge, agency, and expertise. We will learn from a diverse set of social scientific experts who study and collaborate with engineers. Students will leave the course with a better understanding of how social scientific inquiry can aid in understanding, and practicing, engineering. They will also have a clearer articulation of their individual professional commitments and how those fit with more traditional understandings of engineering.
EDNS577. ADVANCED ENGINEERING AND SUSTAINABLE COMMUNITY DEVELOPMENT. 3.0 Semester Hrs.
Analyzes the relationship between engineering and sustainable community development (SCD) from historical, political, ethical, cultural, and practical perspectives. Students will study and analyze different dimensions of sustainability, development, and "helping", and the role that engineering might play in each. Will include critical explorations of strengths and limitations of dominant methods in engineering problem solving, design and research for working in SCD. Through case-studies, students will analyze and evaluate projects in SCD and develop criteria for their evaluation. 3 hours lecture and discussion; 3 semester hours.

EDNS580. HUMANITARIAN ENGINEERING AND SCIENCE CAPSTONE PRACTICUM. 3.0 Semester Hrs.
(I, II, S) This course allows students to practice the concepts, theories and methods learned in HES courses with the goal of making relevant their academic training to real world problems. This practicum can be achieved through a number of possibilities approved by HES director, including supervision and/or shadowing in HES-related activities, engaging in a social enterprise where they do problem definition, impact gap analysis and layout a business canvas, and designing and carrying out a project or fieldwork of their own, etc. Prerequisite: EDNS570, EDNS479. 3 hours research; 3 semester hours.

EDNS590. RISKS IN HUMANITARIAN ENGINEERING AND SCIENCE. 3.0 Semester Hrs.
(I) This course provides students with opportunities learn about risk and ways of analyzing engineering and scientific projects in relation to risks, and to develop multiple mitigation steps. The students will learn tools to develop their own designs while also evaluating associated risks along multiple dimensions and searching out synergies. 3 hours lecture; 3 semester hours.

EDNS598. SPECIAL TOPICS IN ENGINEERING DESIGN & SOCIETY. 6.0 Semester Hrs.
(I, II, S) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once, but no more than twice for the same course content. Prerequisite: none. Variable credit: 0 to 6 credit hours. Repeatable for credit under different titles.

EDNS599. INDEPENDENT STUDY. 0.5-6 Semester Hr.
Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Variable credit: 0.5 to 6 credit hours. Repeatable for credit under different topics/experience and maximums vary by department. Contact the Department for credit limits toward the degree. Independent Study form must be completed and submitted to the Registrar.

EDNS479. COMMUNITY-BASED RESEARCH. 3.0 Semester Hrs.
Engineers and applied scientists face challenges that are profoundly socio-technical in nature, and communities are increasingly calling for greater participation in the decisions that affect them. Understanding the diverse perspectives of communities and being able to establish positive working relationships with their members is therefore crucial to the socially responsible practice of engineering and applied science. This course provides students with the conceptual and methodological tools to conduct community-based research. Students will learn ethnographic field methods and participatory research strategies, and critically assess the strengths and limitations of these through a final original research project. Prerequisite: HASS100 or graduate student standing. Co-requisite: HASS200 or graduate student standing.