Humanitarian Engineering and Science

Degrees

- Graduate Certificate in Humanitarian Engineering and Science
- Master of Science in Humanitarian Engineering and Science (thesis and non-thesis options).

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 certificates, 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 Department and their disciplinary track (Data Science, Environmental Engineering, Geological Engineering, Geophysics, Robotics or Interdisciplinary). 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/.

PRIMARY CONTACT

Richard Krahenbuhl
303-384-2329
rkrahenb@mines.edu

Graduate Certificate Program Requirements

The *Humanitarian Engineering and Science (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 credits 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 credits of coursework if possible, adding an elective from the approved HES electives list below.

Required HES certificate courses (9 credits):

EDNS515	INTRODUCTION TO SCIENCE AND TECHNOLOGY STUDIES	3.0
EDNS577	ADVANCED ENGINEERING AND SUSTAINABLE COMMUNITY DEVELOPMENT	3.0
EDNS579	COMMUNITY-BASED RESEARCH METHODS	3.0
Total Semester Hrs		**9.0**

Master of Science (MS) Program Requirements

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 midcareer 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. 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.

Master of Science (non-thesis)

To obtain the 30 credits required for the MS (non-thesis), 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 approved by the affiliated department (see the six tracks detailed below).

HES MS (Non-Thesis) Core Courses (15 credits):

EDNS515	INTRODUCTION TO SCIENCE AND TECHNOLOGY STUDIES	3.0
EDNS577	ADVANCED ENGINEERING AND SUSTAINABLE COMMUNITY DEVELOPMENT	3.0
EDNS579	COMMUNITY-BASED RESEARCH METHODS	3.0
EDNS580	HUMANITARIAN ENGINEERING AND SCIENCE CAPSTONE PRACTICUM	3.0
ELECTIVE	An approved HES elective from the list below	3.0
Total Semester Hrs		**15.0**

Approved HES Electives:

EDNS590	RISKS IN HUMANITARIAN ENGINEERING AND SCIENCE	3.0
CEEN501	LIFE CYCLE ASSESSMENT	3.0
CEEN575	HAZARDOUS WASTE SITE REMEDIATION	3.0
CEEN593	SUSTAINABLE ENGINEERING DESIGN	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

CEEN595	ANALYSIS OF ENVIRONMENTAL IMPACT	3.0
EBGN553	PROJECT MANAGEMENT	3.0
HASS525	ENVIRONMENTAL COMMUNICATION	3.0
HASS526	INTERCULTURAL COMMUNICATION	3.0
HASS527	RISK COMMUNICATION	3.0
HASS565	SCIENCE, TECHNOLOGY, AND SOCIETY	3.0
HASS568	ENVIRONMENTAL JUSTICE	3.0
HASS590	ENERGY AND SOCIETY	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

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.

In addition to the core HES MS (non-thesis) curriculum (15 credits) detailed above, MS (non-thesis) students following the Geophysics track must take one required course (3 credits) and at least 12 credits of approved elective courses, as shown below. Courses not listed below that align with the student's practicum can be substituted in consultation with the degree advisor.

Required Course		
GPGN577	HUMANITARIAN GEOSCIENCE	3.0
At least four courses of the following:		
GPGN520	ELECTRICAL AND ELECTROMAGNETIC EXPLORATION	3.0
GPGN570	APPLICATIONS OF SATELLITE REMOTE SENSING	3.0
GPGN574	ADVANCED HYDROGEOPHYSICS	3.0
GPGN590	INSTRUMENTAL DESIGN IN APPLIED GEOSCIENCES	3.0
GEGN532	GEOLOGICAL DATA ANALYSIS	3.0

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.

In addition to the core HES MS (non-thesis) curriculum (15 credits) detailed above, MS (non-thesis) students following the Environmental Engineering track must take three required courses (9 credits) and at least two courses (6 credits) of approved elective courses, as shown below. Courses not listed below that align with the student's practicum can be substituted in consultation with the degree advisor.

Required Courses:		
GPGN577	HUMANITARIAN GEOSCIENCE	3.0
CEEN550	PRINCIPLES OF ENVIRONMENTAL CHEMISTRY	3.0
CEEN580	CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT	3.0
At least two courses of the following:		
Environmental Microbiology		
CEEN560	MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT	3.0
CEEN562	ENVIRONMENTAL GEOMICROBIOLOGY	3.0
CEEN566	MICROBIAL PROCESSES, ANALYSIS AND MODELING	3.0
Treatment		
CEEN570	WATER AND WASTEWATER TREATMENT	3.0
CEEN575	HAZARDOUS WASTE SITE REMEDIATION	3.0
MNGN556	MINE WATER AND ENVIRONMENT	3.0
Hydrology		
CEEN555	LIMNOLOGY	3.0
CEEN581	WATERSHED SYSTEMS MODELING	3.0
GEGN582	INTEGRATED SURFACE WATER HYDROLOGY	3.0
GEGN584	FIELD METHODS IN HYDROLOGY	3.0

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, groundwater engineering, soil mechanics, and rock mechanics.

In addition to the core HES MS (non-thesis) curriculum (15 credits) detailed above, MS (non-thesis) students following the Geological Engineering track must take two required courses (6 credits) and at least three courses (9 credits) of approved elective courses, as shown below.

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 GEOENGINEERING AND GEOSCIENCES	3.0
GEGN671	LANDSLIDES: INVESTIGATION, ANALYSIS & MITIGATION	3.0

GEGN673	ADVANCED GEOLOGICAL ENGINEERING DESIGN	3.0

TRACK 4: Humanitarian Robotics (15 CREDITS):

Degree candidates should have an undergraduate degree in computer science, mechanical or electrical engineering, or robotics, or equivalent coursework. In addition, candidates will need to complete necessary prerequisite courses for the graduate courses.

In addition to the Core HES MS (non-thesis) curriculum (15 credits) detailed above, MS (non-thesis) students following the Humanitarian Robotics track must take three required course (9 credits) and at least 6 credits of approved elective courses, as shown below. Courses not listed below that align with the student's practicum can be substituted in consultation with the degree advisor.

Required Courses:		
CSCI532	ROBOT ETHICS	3.0
CSCI536	HUMAN-ROBOT INTERACTION	3.0
CSCI573	ROBOT PROGRAMMING AND PERCEPTION	3.0
At least two courses from the following:		
CSCI507	INTRODUCTION TO COMPUTER VISION	3.0
CSCI534	ROBOT PLANNING AND MANIPULATION	3.0
CSCI575	ADVANCED MACHINE LEARNING	3.0
EENG517	THEORY AND DESIGN OF ADVANCED CONTROL SYSTEMS	3.0
EENG519	ESTIMATION THEORY AND KALMAN FILTERING	3.0
MEGN540	MECHATRONICS	3.0
MEGN544	ROBOT MECHANICS: KINEMATICS, DYNAMICS, AND CONTROL	3.0
MEGN545	ADVANCED ROBOT CONTROL	3.0

TRACK 5: Data Science (DSCI) (15 CREDITS):

Degree candidates should have an undergraduate degree in computer science, mathematics, or data science or equivalent coursework. In addition, candidates will need to complete necessary prerequisite courses for the graduate courses.

In addition to the core HES MS (non-thesis) curriculum (15 credits) detailed above, MS (non-thesis) students following the Data Science track must take four required courses (12 credits) and at least 3 credits of approved elective courses, as shown below. In addition to earning the HES MS (non-thesis) degree, they will also earn the Data Science Statistical Learning Graduate Certificate.

Required Courses		
DSCI503	ADVANCED DATA SCIENCE	
DSCI530	STATISTICAL METHODS I	3.0
DSCI560	INTRODUCTION TO KEY STATISTICAL LEARNING METHODS I	3.0
DSCI561	INTRODUCTION TO KEY STATISTICAL LEARNING METHODS II	3.0
At least one course of the following:		
MATH532	SPATIAL STATISTICS	3.0
MATH533	TIME SERIES AND ITS APPLICATIONS	NaN
MATH536	ADVANCED STATISTICAL MODELING	3.0
MATH537	MULTIVARIATE ANALYSIS	3.0
MATH582	STATISTICS PRACTICUM	3.0

TRACK 6: Interdisciplinary (15 CREDITS):

In addition to the core HES MS (non-thesis) curriculum (15 credits) detailed above, MS (non-thesis) students following the Interdisciplinary track will work with their advisor to choose an additional 15 credits that best match their intellectual interests. As with our other tracks, at least 12 of these credits need to be engineering or applied science courses. Students seeking this track are required to identify their desired focus area when applying and identify possible courses upon matriculation. They will then work with their advisor to ensure that the student meets the course prerequisites and that the courses are offered on an appropriate timetable according to their anticipated graduation date.

Master of Science (thesis)

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

HES MS (thesis) Core Courses (12 credits):

EDNS515	INTRODUCTION TO SCIENCE AND TECHNOLOGY STUDIES	3.0
EDNS577	ADVANCED ENGINEERING AND SUSTAINABLE COMMUNITY DEVELOPMENT	3.0
EDNS579	COMMUNITY-BASED RESEARCH METHODS	3.0
ELECTIVE	3 credits of approved HES electives from list below	3.0

Approved HES Electives:

EDNS590	RISKS IN HUMANITARIAN ENGINEERING AND SCIENCE	3.0
CEEN501	LIFE CYCLE ASSESSMENT	3.0
CEEN575	HAZARDOUS WASTE SITE REMEDIATION	3.0
CEEN593	SUSTAINABLE ENGINEERING DESIGN	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
CEEN595	ANALYSIS OF ENVIRONMENTAL IMPACT	3.0
EBGN553	PROJECT MANAGEMENT	3.0
HASS525	ENVIRONMENTAL COMMUNICATION	3.0
HASS526	INTERCULTURAL COMMUNICATION	3.0
HASS527	RISK COMMUNICATION	3.0
HASS565	SCIENCE, TECHNOLOGY, AND SOCIETY	3.0
HASS568	ENVIRONMENTAL JUSTICE	3.0
HASS590	ENERGY AND SOCIETY	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

Disciplinary Tracks

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

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

In addition to the core HES MS (thesis) curriculum (12 credits) detailed above, MS (thesis) students following the Geophysics track must take one required course (3 credits), at least 9 credits of approved elective courses, and 6 credits of independent thesis research, as shown below. Courses not listed below that align with the student's thesis can be substituted in consultation with the degree advisor.

Required Course		
GPGN577	HUMANITARIAN GEOSCIENCE	3.0
At least three courses of the following:		
GPGN520	ELECTRICAL AND ELECTROMAGNETIC EXPLORATION	3.0
GPGN570	APPLICATIONS OF SATELLITE REMOTE SENSING	3.0
GPGN574	ADVANCED HYDROGEOPHYSICS	3.0
GPGN590	INSTRUMENTAL DESIGN IN APPLIED GEOSCIENCES	3.0
GEGN532	GEOLOGICAL DATA ANALYSIS	3.0
And:		
GPGN707	GRADUATE THESIS / DISSERTATION RESEARCH CREDIT	6.0

Track 2: Environmental Engineering (CEEN) (18 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.

In addition to the Core HES MS (thesis) curriculum (12 credits) detailed above, MS (thesis) students following the Environmental Engineering track must take one required course (3 credits), at least two courses (6 credits) of approved elective courses, and 6 credits of independent thesis research, as shown below. Courses not listed below that align with the student's thesis can be substituted in consultation with the degree advisor.

Required Course:		
GPGN577	HUMANITARIAN GEOSCIENCE	3.0
At least three courses of the following:		
CEEN550	PRINCIPLES OF ENVIRONMENTAL CHEMISTRY	3.0
CEEN580	CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT	3.0
Environmental Microbiology		
CEEN560	MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT	3.0
CEEN562	ENVIRONMENTAL GEOMICROBIOLOGY	3.0
CEEN566	MICROBIAL PROCESSES, ANALYSIS AND MODELING	3.0
Treatment		
CEEN570	WATER AND WASTEWATER TREATMENT	3.0
CEEN575	HAZARDOUS WASTE SITE REMEDIATION	3.0
MNGN556	MINE WATER AND ENVIRONMENT	3.0
Hydrology		
CEEN555	LIMNOLOGY	3.0
CEEN581	WATERSHED SYSTEMS MODELING	3.0
GEGN582	INTEGRATED SURFACE WATER HYDROLOGY	3.0
GEGN584	FIELD METHODS IN HYDROLOGY	3.0
And		
CEEN707	GRADUATE THESIS / DISSERTATION RESEARCH CREDIT	6.0

Track 3: Geological Engineering (GEGN) (18 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, groundwater engineering, soil mechanics, and rock mechanics.

In addition to the Core HES MS (thesis) curriculum (12 credits) detailed above, MS (thesis) students following the Geological Engineering track must take two required courses (6 credits), at least two courses (6 credits) of approved elective courses, and 6 credits of independent thesis research, as shown below.

Required Course:		
GEGN532	GEOLOGICAL DATA ANALYSIS	3.0
GPGN577	HUMANITARIAN GEOSCIENCE	3.0
At least two of the following courses:		
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 GEOENGINEERING AND GEOSCIENCES	3.0
GEGN671	LANDSLIDES: INVESTIGATION, ANALYSIS & MITIGATION	3.0

GEGN673	ADVANCED GEOLOGICAL ENGINEERING DESIGN	3.0
And:		
GEGN707	GRADUATE THESIS / DISSERTATION RESEARCH CREDIT	6.0

Track 4: Humanitarian Robotics (18 CREDITS):

Degree candidates should have an undergraduate degree in computer science, mechanical or electrical engineering, or robotics or equivalent coursework. In addition, candidates will need to complete necessary prerequisite courses for the graduate courses.

In addition to the core HES MS (thesis) curriculum (12 credits) detailed above, MS (thesis) students following the Humanitarian Robotics track must take three required course (9 credits), at least 3 credits of approved elective courses, and 6 credits of independent thesis research, as shown below. Courses not listed below that align with the student's thesis can be substituted in consultation with the degree advisor.

Required Courses:		
CSCI532	ROBOT ETHICS	3.0
CSCI536	HUMAN-ROBOT INTERACTION	3.0
CSCI573	ROBOT PROGRAMMING AND PERCEPTION	3.0
At least one course from the following:		
CSCI507	INTRODUCTION TO COMPUTER VISION	3.0
CSCI534	ROBOT PLANNING AND MANIPULATION	3.0
CSCI575	ADVANCED MACHINE LEARNING	3.0
EENG517	THEORY AND DESIGN OF ADVANCED CONTROL SYSTEMS	3.0
EENG519	ESTIMATION THEORY AND KALMAN FILTERING	3.0
MEGN540	MECHATRONICS	3.0
MEGN544	ROBOT MECHANICS: KINEMATICS, DYNAMICS, AND CONTROL	3.0
MEGN545	ADVANCED ROBOT CONTROL	3.0
And:		
CSCI707	GRADUATE THESIS / DISSERTATION RESEARCH CREDIT	6.0

Track 5: Data Science (DSCI) (18 CREDITS):

Degree candidates should have an undergraduate degree in computer science, mathematics, or data science or equivalent coursework. In addition, candidates will need to complete necessary prerequisite courses for the graduate courses.

In addition to the core HES MS (thesis) curriculum (12 credits) detailed above, MS (thesis) students following the Data Science track must take four required courses (12 credits) and 6 credits of independent thesis research, as shown below. In addition to earning the HES MS (thesis) degree, they will also earn the Data Science Statistical Learning Graduate Certificate.

Required Courses		
DSCI503	ADVANCED DATA SCIENCE	
DSCI530	STATISTICAL METHODS I	3.0
DSCI560	INTRODUCTION TO KEY STATISTICAL LEARNING METHODS I	3.0
DSCI561	INTRODUCTION TO KEY STATISTICAL LEARNING METHODS II	3.0
And:		
MATH707	GRADUATE THESIS / DISSERTATION RESEARCH CREDIT	6.0

Track 6: Interdisciplinary (18 CREDITS):

In addition to the core HES MS (thesis) curriculum (12 credits) detailed above, MS (thesis) students following the Interdisciplinary track will work with their advisor to choose an additional 12 elective credits that best match their intellectual interests and take 6 credits of independent thesis research. The 12 elective credits need to be engineering or applied science courses. Students seeking this track are required to identify their desired focus area when applying and identify possible courses upon matriculation. They will then work with their advisor to ensure that the student meets the course prerequisites and that the courses are offered on an appropriate timetable according to their anticipated graduation date.

Mines' Combined Undergraduate/Graduate Degree Program

Students enrolled in Mines' combined undergraduate/graduate program may double count up to 6 credits of graduate coursework to fulfill requirements of both their undergraduate and graduate degree programs. These courses must have been passed with B- or better, not be substitutes for required coursework, and meet all other university, department, and program requirements for graduate credit.

Students are advised to consult with their undergraduate and graduate advisors for appropriate courses to double count upon admission to the combined program.

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.

EDNS515. INTRODUCTION TO SCIENCE AND TECHNOLOGY STUDIES. 3.0 Semester Hrs.
This course engages scholarship on the inextricable link between science, engineering and the various social contexts within which scientists and engineers work. We begin by critically reflecting on the question, What are science and engineering for? We then explore key conceptual domains in the social scientific study of science and engineering, including knowledge, agency, and expertise. We will learn from a diverse set of social scientific experts who study and collaborate with scientists and engineers. Students will leave the course with a better understanding of how social scientific inquiry can aid in understanding, and practicing, science and engineering. They will also have a clearer articulation of their individual professional commitments and how those fit with more traditional understandings of science and engineering.
Course Learning Outcomes

- By the end of this course, students will have demonstrated the ability to:
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EDNS544. INNOV8X. 3.0 Semester Hrs.
Innov8x introduces concepts and tools to accelerate the design, validation and adoption of innovations in support of creative problem solving. Using an entrepreneurial mindset, we learn how to identify and frame problems that beneficiaries and stakeholders face. We attempt to design and test practical solutions to those problems in collaboration with those who experience the problems. We apply beneficiary discovery, pretotyping, business model design (social, economic and environmental), constrained creativity, efficient experimentation, and rapid iteration. While resolving challenges involves technical solutions, an important aspect of this course is directly engaging beneficiaries and stakeholders in social contexts to develop solutions with strong impact potential. Innov8x is grounded in collaborative creativity theory at the intersection of organizational behavior (social psychology), design principles, entrepreneurship and innovation management.
Course Learning Outcomes

- Frame and translate complex ambiguous problems into actionable opportunities for innovation
- Conduct effective, objective and ongoing beneficiary discovery in efficient ways
- Combine tools and methods to quickly test assumptions and secure beneficiary acceptance
- Develop creative approaches to navigate real and perceived constraints
- Leverage mentor and stakeholder support through credible communication based on research • Launch innovative solutions with the advocacy of beneficiaries and stakeholders
- Create value by solving complex problems that straddle technical and social domains
- Launch innovative solutions with the advocacy of beneficiaries and stakeholders

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.
Course Learning Outcomes

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EDNS579. COMMUNITY-BASED RESEARCH METHODS. 3.0 Semester Hrs.
Engineers and applied scientists face challenges that are profoundly sociotechnical 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 graduate students with the conceptual and methodological tools to conduct community-based research. Graduate 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 related to their ongoing independent research or practicums.
Course Learning Outcomes

- During this course students will learn to:

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.
Course Learning Outcomes

- • Identify successful practices for humanitarian projects in real settings (ABET a,h,j) • Determine different ways in which previous humanitarian projects could have been improved to yield more successful technical and social results (ABET a,b,h,j) • Determine effective engineering methods for different humanitarian applications (ABET b,c,h,j) • Work in teams to design, execute and evaluate a project with stakeholders (ABET a,b,c,d,e,j,k) • Gain experience in engaging and communicating with community members and stakeholders (ABET c,d,f,h,i,j,k) • Develop stronger professional communication skills through written assignments, group projects, discussions, presentations, and community engagement (ABET g,f,h,i,j,k)

EDNS590. RISKS IN HUMANITARIAN ENGINEERING AND SCIENCE. 3.0 Semester Hrs.
(I) This course provides students with opportunities to consider the risks related to humanitarian projects?or any projects that effect and involve people. These risks might include things that different scientific and engineering disciplines typically consider, as well as those that may be pertinent to project stakeholder perspectives. Guided by social scientific insights related to risk, students in this class will gain new tools for defining problems in ways that are relevant and appropriate for multiple contexts. Students will read, discuss, and analyze material together and to undertake independent research to deepen their understandings of chosen topics. 3 semester hours.
Course Learning Outcomes

- • Analyze humanitarian science and engineering projects using established evaluation criteria (ABET a,h,j) • Identify the most successful practices for humanitarian science and engineering (ABET a,h,j) • Determine different ways in which previous engineering or scientific projects could have been improved to yield more successful technical and social results (ABET a,b,h,j) • Gain conceptual tools for and experience in engaging and communicating with community members and stakeholders (ABET c,d,f,h,i,j,k) • Develop stronger professional communication skills through written assignments, group projects, discussions, presentations, and community engagement (ABET g,f,h,i,j,k)

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.

Program Director

Richard Krahenbuhl, Associate Research Professor, Geophysics

Associate Program Director

Elizabeth Reddy, Assistant Professor, Engineering, Design & Society

Assistant Professor, Engineering, Design & Society

Dorit Hammerling, Associate Professor

Department of Civil & Environmental Engineering

Junko Munakata Marr, Professor and Department Head

Director of Computer Science

Thomas Williams, Associate Professor, Director of MIRROR Lab

Department of Engineering, Design & Society

Stephanie Claussen, Research Professor

Alina Handorean, Teaching Professor

Marie Stettler Kleine, Assistant Professor

Juan Lucena, Professor and Director, Humanitarian Engineering Undergraduate Programs

Carrie McClelland, Teaching Professor

Kevin Moore, Professor and Executive Director of Humanitarian Engineering Undergraduate Programs

Dean Nieusma, Associate Professor and Department Head

Elizabeth Reddy, Assistant Professor

Jessica Smith, Professor

Department of Electrical Engineering

Kathryn Johnson, Professor

Kevin Moore, Professor and Executive Director of Humanitarian Engineering Undergraduate Programs

Department of Geology and Geological Engineering

Paul Santi, Professor

Department of Geophysics

Richard Krahenbuhl, Associate Research Professor

Jeffrey Shragge, Associate Professor

Department of Humanities, Arts & Social Sciences

Jon Leydens, Professor

Department of Mining Engineering

Nicole Smith, Assistant Professor

Affiliate Faculty

Chris Anderson, Principal of Yirri Global

Teaching Assistant Professors

Cara Phillips

Syd Slouka

Assistant Professor

Yangming Shi