

Underground Construction and Tunnel Engineering

Program Description

Underground Construction and Tunnel Engineering (UCTE) is an interdisciplinary field primarily involving civil engineering, construction engineering, geological engineering, and mining engineering, and secondarily involving mechanical engineering, geophysics, geology, and others. UCTE deals with the design, construction, rehabilitation and management of underground space including caverns, shafts and tunnels for commercial, transportation, water and wastewater use. UCTE is a challenging field involving complex soil and rock behavior, groundwater conditions, excavation methods, construction materials, structural design, heterogeneity, and very low tolerance for deformation due to existing infrastructure in urban environments. Students pursuing a graduate degree in UCTE will gain a strong interdisciplinary foundation in these topics.

Program Contact

Program Director: Michael Mooney

ucte.mines.edu

Program Coordinator: Rachel McDonald

Program Requirements

Master's and PhD in Underground Construction and Tunneling Engineering

MS Non-Thesis Option:

Coursework - 27.0 credits

Independent Study* - 3.0 credits

UCTE Seminar - 0.0 credits

Total Hours - 30.0

*Where possible, MS non-thesis students should complete a practically focused independent study in partnership with an industry partner; this may include student participation in an industry internship on a UCTE project.

MS Thesis Option:

Coursework - 24.0 credits

Research (minimum) - 6.0 credits

UCTE Seminar - 0.0 credits

Total Hours - 30.0

MS thesis students must write and successfully defend a thesis report of their research. Ideally, MS thesis research should be industry-focused and should provide value to industry UCTE practice.

PhD Option

Coursework (beyond BS degree) - 42.0 credits

Independent Study* - 3.0 credits

Research (minimum) - 24.0 credits

UCTE Seminar - 0.0 credits

Total Hours - 72.0

PhD students must also successfully complete qualifying examinations, write and defend a dissertation proposal, and write and defend a doctoral dissertation. PhD research is aimed at fundamentally advancing the state of the art in UCTE. PhD students are expected to submit the dissertation work for publication in scholarly journals and disseminate findings throughout industry periodicals.

*PhD students are expected to complete an internship of approximately three months in duration (with a design firm, contractor, owner, equipment manufacturer, etc., and preferably on a UCTE job site). If an internship is not available or if the student has sufficient industry experience (determined by advisor and committee), the student may complete an industry-focused research project via independent study with a UCTE faculty member and industry partner culminating with a written report and presentation.

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.

Required Coursework

The following 15 credits are required for the MS (thesis and non-thesis) and PhD degrees.

GEGN561	UNDERGROUND CONSTRUCTION ENGINEERING LABORATORY	0.5
GEGN572	ENGINEERING GEOLOGY AND GEOTECHNICS	4.0
MNGN504	UNDERGROUND CONSTRUCTION ENGINEERING IN HARD ROCK	3.0
CEEN523	UNDERGROUND CONSTRUCTION ENGINEERING IN SOFT GROUND	4.0
CEEN532	UNDERGROUND INFRASTRUCTURE CONSTRUCTION MANAGEMENT	3.0
or MNGN509	CONSTRUCTION ENGINEERING AND MANAGEMENT	

All MS and PhD students are required to attend the UCTE seminar series (0 hour); no registration is required.

MS non-thesis and PhD students must complete a practically-focused project (separate from the thesis in the case of the PhD degree), registering as an independent study in the home department of the faculty advisor (CEEN599, GEGN599, or MNGN599). This requirement may be waived for students with sufficient UC&T industry experience.

Elective Coursework

The following courses may be taken as electives to complete the MS and PhD course requirements. Students may petition for other courses not listed below to count toward the elective requirement. In addition, MS or

PhD students may petition one of the following courses to substitute for a required course if one of the required courses is not offered during the student's course of study or if a student has sufficient background in one of the required course topics. All petitions must be made to the student's advisor and thesis committee.

CEEN506	FINITE ELEMENT METHODS FOR ENGINEERS	3.0
CEEN510	ADVANCED SOIL MECHANICS	3.0
CEEN512	SOIL BEHAVIOR	3.0
CEEN541	DESIGN OF REINFORCED CONCRETE STRUCTURES II	3.0
CEEN599	INDEPENDENT STUDY IN CIVIL ENGINEERING	0.5-6
GEGN563	APPLIED NUMERICAL MODELLING FOR GEOMECHANICS	3.0
GEGN566	GROUNDWATER ENGINEERING	3.0
GEGN573	GEOLOGICAL ENGINEERING SITE INVESTIGATION	3.0
GEGN581	ANALYTICAL HYDROLOGY	3.0
GEGN672	ADVANCED GEOTECHNICS	3.0
GEGN673	ADVANCED GEOLOGICAL ENGINEERING DESIGN	3.0
GEGN599	INDEPENDENT STUDY IN ENGINEERING GEOLOGY OR ENGINEERING HYDROGEOLOGY	0.5-6
MNGN506	DESIGN AND SUPPORT OF UNDERGROUND EXCAVATIONS	3.0
MNGN507	ADVANCED DRILLING AND BLASTING	3.0
MNGN524	ADVANCED MINE VENTILATION	3.0
MNGN590	MECHANICAL EXCAVATION IN MINING	3.0
MNGN599	INDEPENDENT STUDY IN MINING ENGINEERING	0.5-6

Thesis Committee Requirements

Students must meet the general committee requirements listed in the graduate bulletin. In addition, the student's advisor or co-advisor must be a UCTE faculty member. In the case that a student is co-advised, the co-advisor will serve as an additional committee member above and beyond the minimum committee requirements.

The committee for PhD students enrolled in the UCTE degree program shall be composed of a minimum of four faculty members:

- The student's advisor
- Two core UCTE faculty members representing two of three core UCTE departments (Civil Engineering, Geological Engineering, Mining Engineering)
- An external committee member, who has no connection to the student or their research (this member should not come from any of the three core UCTE departments, other than in exceptional circumstances); this member will chair the committee and must be a permanent Mines faculty member

Additional committee members may be added as appropriate, including off-campus representatives from industry and academia.

Given the interdisciplinary nature of the UCTE degree program, no more than two of the four PhD committee members can be from the same department.

Qualifying Exam Procedure

Students enrolled in the UCTE PhD program are expected to have passed a qualifying exam by the end of their first year of study. This qualifying exam will be administered by a sub-committee of UCTE faculty. If a UCTE faculty member is serving on this sub-committee for the qualifying exam of a student they are advising, they will act as a non-voting member for that exam.

The intention of the qualifying exam is to evaluate the student's capacity to undertake PhD-level research; this includes their ability to think critically, to apply core UCTE concepts to abstract problems, and to develop methods to test scientific hypotheses. The format of the exam will include a written component and an oral exam, approximately two hours in length. Prior to their oral exam, the student will be assigned two tasks:

- The student will be provided a research topic which has some relevance to their research, but is not directly related. The student will be required to submit an 8–10 page literature review on this topic to their committee 24 hours prior to their oral exam. During the oral exam, the student will be asked questions related to their literature review.
- The student will be provided with four questions which will represent a significant portion of their oral exam. These questions will be designed to assess the student's ability to consider analysis, design, and research questions critically. The core UCTE curriculum will serve as foundational knowledge for these questions. As the student's response will be oral (no written response to the questions will be submitted), the questions will require students to suggest problem solving approaches rather than to directly implement them. Based on the student's response to each question, follow-up questions will be asked.

If the student fails their first qualifying exam, they may be given an opportunity to attempt a second qualifying exam at the discretion of the committee who administered their first exam. If the student fails their second qualifying exam, they will not be admitted to PhD candidacy.

Prerequisites

Students will enter the UCTE programs with a variety of backgrounds. Because the UCTE degrees are engineering degrees, the required prerequisite courses for the UCTE programs include basic engineering coursework, and specifically: 1) Strength of Materials or Mechanics of Materials, and 2) Fluid Mechanics. These prerequisite courses may be completed during the first semester of the graduate program if approved by the UCTE program faculty. It is permissible for students to take graduate-level courses without having completed the corresponding undergraduate courses to address areas where key competencies are lacking, such as in soil mechanics, rock mechanics, structural analysis or groundwater engineering. However, students may choose to complete undergraduate courses in these topics prior to or concurrently during enrollment in the required graduate program courses. Undergraduate-level coursework to address any prerequisite deficiencies does not count toward the requirements of the MS or PhD degrees. Students should consult with UCTE faculty for guidance in this matter.

Program Requirements

Graduate Certificate in Underground Construction and Tunnel Engineering

The interdisciplinary Graduate Certificate in Underground Construction and Tunnel Engineering (UCTE) is comprised of the three signature courses listed below. The two anchor courses teach UCTE in hard rock and soft ground while the remaining course teaches underground infrastructure construction management principles.

Applicants for the certificate are required to be admitted into the combined BS + MS program or have an undergraduate degree in science or engineering, with geotechnical and mechanics of materials coursework, to be admitted into the certificate program. Students working toward the UCTE graduate certificate are required to successfully complete 10 credits, as detailed below. The courses taken for the graduate certificate can be used towards a master's or PhD degree at Mines.

CEEN523	UNDERGROUND CONSTRUCTION ENGINEERING IN SOFT GROUND	4.0
CEEN532	UNDERGROUND INFRASTRUCTURE CONSTRUCTION MANAGEMENT	3.0
or MNGN509	CONSTRUCTION ENGINEERING AND MANAGEMENT	
MNGN504	UNDERGROUND CONSTRUCTION ENGINEERING IN HARD ROCK	3.0
Total Semester Hrs		10.0

Program Director

Michael Mooney, UCTE Director, Grewcock Distinguished Chair

Department of Civil & Environmental Engineering

Reza Hedayat, Associate Professor

Michael Mooney, Grewcock Distinguished Chair & Professor

Yangming Shi, Assistant Professor

Lori Tunstall, Assistant Professor

Alexandra Wayllace, Teaching Associate Professor

Department of Geology & Geological Engineering

Gabriel Walton, Associate Professor

Department of Mining Engineering

Rennie Kaunda, Assistant Professor

Priscilla Nelson, Professor

Jamal Rostami, Professor