

Underground Construction and Tunnel Engineering

Degrees Offered

- Master of Science in Underground Construction and Tunnel Engineering, Non-Thesis
- Master of Science in Underground Construction and Tunnel Engineering, Thesis
- Doctor of Philosophy in Underground Construction and Tunnel Engineering
- Graduate Certificate in Underground Construction and Tunnel Engineering

Program Description

Underground Construction and Tunnel Engineering (UCTE) is an interdisciplinary field primarily involving civil engineering, geological engineering and mining engineering, and secondarily involving mechanical engineering, electrical 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 flow, 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 and interdisciplinary foundation in these topics.

The graduate program in UCTE is offered jointly by the Departments of Civil & Environmental Engineering (CEE), Geology & Geological Engineering (GEGN), and Mining Engineering (MN). UCTE faculty from each department are collectively responsible for the operations of the program. Participating thesis students reside in one of these departments, typically the home department of their advisor.

Program coursework is selected from multiple departments at Mines (primarily CEE, GEGN, MN) and is approved for each student by the student's advisor and graduate committee. To earn the Certificate, students will complete four specified online courses. To achieve the MS degree, students may elect the non-thesis option based upon coursework and an independent study report tied to a required internship. Students may alternatively select the thesis option comprised of coursework and a research project performed under the guidance of a UCTE faculty advisor and presented in a written thesis approved by the student's thesis committee.

PhD students are expected to complete a combination of coursework and novel, original research under the guidance of a UCTE faculty advisor and doctoral committee, which culminates in a significant scholarly contribution to a specialized field in UCTE. Full-time enrollment is encouraged and leads to the greatest success, although part-time enrollment is permissible for working professionals.

Program Requirements

Masters 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 3 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 six 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 18 credits are required for the MS (thesis and non-thesis) and PhD degrees.

GEGN468	ENGINEERING GEOLOGY AND GEOTECHNICS	4.0
GEGN561	UNDERGROUND CONSTRUCTION ENGINEERING LABORATORY 1	0.5
GEGN562	UNDERGROUND CONSTRUCTION ENGINEERING LABORATORY 2	0.5
CEEN523	UNDERGROUND CONSTRUCTION ENGINEERING IN SOFT GROUND	4.0
MNGN504	UNDERGROUND CONSTRUCTION ENGINEERING IN HARD ROCK	3.0
CEEN512	SOIL BEHAVIOR	3.0
MNGN509	CONSTRUCTION ENGINEERING AND MANAGEMENT	3.0

All MS and PhD students are required to attend the UCTE seminar series (0 h); 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 towards 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.

CEEN415	FOUNDATION ENGINEERING	3.0
CEEN506	FINITE ELEMENT METHODS FOR ENGINEERS	3.0
CEEN510	ADVANCED SOIL MECHANICS	3.0
CEEN541	DESIGN OF REINFORCED CONCRETE STRUCTURES II	3.0
CEEN599	INDEPENDENT STUDY	0.5-6
GEGN466	GROUNDWATER ENGINEERING	3.0
GEGN563	APPLIED NUMERICAL MODELLING FOR GEOMECHANICS	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

MNGN424	MINE VENTILATION	3.0
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	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 (4) 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 CSM 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 (2) 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 twenty-four (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 (4) 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. With the exception of the 400-level coursework allowed by the graduate catalog, undergraduate level coursework to address any prerequisite deficiencies does not count towards 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 construction management principles.

Applicants for the certificate are required to 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
MNGN504	UNDERGROUND CONSTRUCTION ENGINEERING IN HARD ROCK	3.0
MNGN509	CONSTRUCTION ENGINEERING AND MANAGEMENT	3.0
Total Semester Hrs		10.0

Program Director

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