Underground Construction and Tunnel Engineering

Degrees Offered

- Master of Science (Underground Construction and Tunnel Engineering), Thesis
- Master of Science (Underground Construction and Tunnel Engineering), Non-Thesis
- Doctor of Philosophy (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 degree 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 students reside in one of these departments, typically the home department of their advisor.

Program coursework is selected from multiple departments at CSM (primarily CEE, GEGN, MN) and is approved for each student by the student’s advisor and graduate committee. To achieve the M.S. 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.

Ph.D. 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. All graduate students must complete the full-time, on-campus residency requirements described in the general section of the Graduate Catalog.

Program Requirements

M.S. Non-Thesis Option:
Coursework - 27.0 credit hours

M.S. Thesis Option:
Coursework - 24.0 credit hours
Research (minimum) - 6.0 credit hours
UCTE Seminar - 0.0 credit hours
Total Hours - 30.0

Ph.D. Option
Coursework (beyond B.S. degree) - 42.0 credit hours
Independent Study* - 3.0 credit hours
Research (minimum) - 24.0 credit hours
UCTE Seminar - 0.0 credit hours
Total Hours - 72.0

**M.S. non-thesis 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). During the internship, each student completes a project-focused independent study related to an aspect of the internship. This is determined in consultation with the faculty advisor and internship sponsor. The independent study culminates with a project report and presentation. 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 with a UCTE faculty member and industry partner. The research project culminates with a written report and final presentation.

**Ph.D. 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.

Required Coursework

The following 19 credit hours are required for the M.S. (thesis and non-thesis) and Ph.D. degrees.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEGN468</td>
<td>ENGINEERING GEOLOGY AND GEOTECHNICS</td>
<td>4.0</td>
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<tr>
<td>GEGN561</td>
<td>UNDERGROUND CONSTRUCTION ENGINEERING LABORATORY 1</td>
<td>0.5</td>
</tr>
<tr>
<td>GEGN562</td>
<td>UNDERGROUND CONSTRUCTION ENGINEERING LABORATORY 2</td>
<td>0.5</td>
</tr>
<tr>
<td>CEEN513</td>
<td>ADVANCED GEOMATERIAL MECHANICS</td>
<td>4.0</td>
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a UCTE faculty member. In the case that a student is co-advised, the co-

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 Ph.D. 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 Ph.D. committee members can be from the same department.

Qualifying Exam Procedure

Students enrolled in the UCTE Ph.D. 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-

The intention of the qualifying exam is to evaluate the student’s capacity to undertake Ph.D.-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 Ph.D. candidacy.

Elective Coursework

The following courses may be taken as electives to complete the M.S. and Ph.D. course requirements. Students may petition for other courses not listed below to count towards the elective requirement. In addition, M.S. or Ph.D. 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.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEEN415</td>
<td>FOUNDATION ENGINEERING</td>
<td>3.0</td>
</tr>
<tr>
<td>CEEN506</td>
<td>FINITE ELEMENT METHODS FOR ENGINEERS</td>
<td>3.0</td>
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<tr>
<td>CEEN510</td>
<td>ADVANCED SOIL MECHANICS</td>
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<tr>
<td>CEEN541</td>
<td>DESIGN OF REINFORCED CONCRETE STRUCTURES II</td>
<td>3.0</td>
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<tr>
<td>CEEN599</td>
<td>INDEPENDENT STUDY</td>
<td>0.5-6</td>
</tr>
<tr>
<td>GEGN466</td>
<td>GROUNDWATER ENGINEERING</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN563</td>
<td>APPLIED NUMERICAL MODELLING FOR GEOMECHANICS</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN573</td>
<td>GEOLOGICAL ENGINEERING SITE INVESTIGATION</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN581</td>
<td>ANALYTICAL HYDROLOGY</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN672</td>
<td>ADVANCED GEOTECHNICS</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN673</td>
<td>ADVANCED GEOLOGICAL ENGINEERING DESIGN</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN599</td>
<td>INDEPENDENT STUDY IN ENGINEERING GEOLOGY OR ENGINEERING HYDROGEOLOGY</td>
<td>0.5-6</td>
</tr>
<tr>
<td>MNGN424</td>
<td>MINE VENTILATION</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN506</td>
<td>DESIGN AND SUPPORT OF UNDERGROUND EXCAVATIONS</td>
<td>3.0</td>
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<tr>
<td>MNGN507</td>
<td>ADVANCED DRILLING AND BLASTING</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN524</td>
<td>ADVANCED MINE VENTILATION</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN590</td>
<td>MECHANICAL EXCAVATION IN MINING</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN599</td>
<td>INDEPENDENT STUDY</td>
<td>0.5-6</td>
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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. The required coursework includes graduate level soil and rock mechanics as well as aspects of structural analysis and groundwater engineering. It is permissible for students to take these courses without having completed undergraduate courses in soil mechanics, rock mechanics, structural analysis and 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. The prerequisite courses do not count towards the requirements of the M.S. or Ph.D. degrees. Students should consult with UCTE faculty for guidance in this matter.

Director

Gabriel Walton, UCTE Director

Department of Civil & Environmental Engineering

Marte Gutierrez, J.R. Padén Distinguished Chair & Professor
Reza Hedayat, Assistant Professor
Panos Kiousis, Associate Professor
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Priscilla Nelson, Department Head & Professor