GRADUATE CURRICULUM GUIDE

University of Connecticut
Civil Engineering Field of Study
Transportation and Urban Engineering Area of Concentration
Revised August 23, 2021

General Information

The Transportation and Urban Engineering (TUE) Area of Concentration can be selected with either the Master of Science (MS) or Doctor of Philosophy (PhD) in the Civil Engineering Field of Study. The MS degree may be either research-based (Plan A) or project-based (Plan B). Plan A students often pursue further PhD studies, or careers in research and development in government and private institutes. The PhD in Civil Engineering prepares students for research and teaching careers in civil engineering, including higher education, private foundations, and state, local, or federal government agencies.

Requirements

The MS and the PhD requirements in Civil Engineering / Transportation and Urban Engineering conform to The Graduate School requirements laid out above. The specific requirements for coursework and research are described below.

MS Plan A requirements

A total of 30 credits are required for graduation, with a minimum of 21 credits of coursework in Civil Engineering or related areas and a minimum of 9 credits of Master's Thesis Research (GRAD 5950). A student usually enrolls in GRAD 5950 credits after completing at least 12 credits of coursework and it is the student's responsibility to coordinate with the research advisor (and secondarily, with the research committee) on the research plan and requirements for graduation. All MS Plan A students in the Transportation and Urban Engineering area of Concentration are required to take courses as follows:

- Three (3) of the following five courses (9 credits):
    - CE 5200 Operations Research in Civil and Environmental Engineering
    - CE 5720 Street and Highway Design
    - CE 5730 Transportation Planning
    - CE 5740 Traffic Engineering I
    - CE 5750 Pavement Design
- One or more courses in Civil Engineering in the Transportation and Urban Engineering specialization (minimum 3 credits)
- Two or more courses outside of Civil Engineering / Transportation and Urban Engineering (minimum 6 credits)
- If the student's prior degrees are in an area other than civil engineering, the following background preparation courses are required if not previously taken:
    - CE 2251 Probability and Statistics in Civil and Environmental Engineering
    - CE 2211 Engineering Economics
    - CE 2710 Transportation Engineering and Planning
    - MATH 2110Q Multivariable calculus
- Students must register for and attend CE 5030 Seminar in Transportation and Urban Engineering every semester in which they are either enrolled full time or supported by a graduate assistantship. Master's Plan A students are expected to present their research once in their final year of study.

The remaining courses may be selected in consultation with the advisor.

A Plan A M.S. requires the submission of an M.S. Thesis, in the form of a submission-ready paper manuscript, and an oral defense for graduation. The oral defense fulfills the role of the final examination for the M.S. degree. The scope, content and length of the M.S. thesis results from the agreement between the research advisor and the student. An advisory committee of at least two additional faculty members will also evaluate the originality and quality of the thesis prior to graduation. In general, the thesis should present the methodology and results of novel, independent research conducted by the student. Thus, Plan A M.S. thesis cannot be solely literature reviews or replicate research already published in the scientific literature. As a standard, the M.S. thesis should constitute the basis for a journal paper submission and may be structured as such.

MS Plan B requirements

A total of 30 credits are required for Plan B Master's, with a minimum of 30 credits of coursework in Civil Engineering or related area, including 3 credits as a practice-oriented project taken as CE 5020 Graduate Independent Study in Civil Engineering. All MS Plan B students in the Transportation and Urban Engineering area of Concentration are required to take courses as follows:

- Three of the following five courses (9 credits):
    - CE 5200 Operations Research in Civil and Environmental Engineering
    - CE 5720 Street and Highway Design
    - CE 5730 Transportation Planning
    - CE 5740 Traffic Engineering I
    - CE 5750 Pavement Design
- Two or more courses in Civil Engineering in the Transportation and Urban Engineering specialization (minimum 6 credits)
- Two or more courses outside of Civil Engineering / Transportation and Urban Engineering (minimum 6 credits)
- If the student's prior degrees are in an area other than civil engineering, the following background preparation courses are required if not previously taken:
    - CE 2251 Probability and Statistics in Civil and Environmental Engineering
    - CE 2211 Engineering Economics
    - CE 2710 Transportation Engineering
    - MATH 2110Q Multivariable calculus
- Students must register for and attend CE 5030 Seminar in Transportation and Urban Engineering every semester in which they are either enrolled full time or supported by a graduate assistantship.

The remaining courses may be selected in consultation with the advisor.

The final examination (oral exam) consists of an oral presentation of the CE 5020 final master's project to a faculty examination committee, followed by questions from the committee. The project report must be delivered to the examination committee two weeks before the date of the final examination.

PhD requirements

Coursework

If a student is admitted to the Ph.D. program with only a B.S. degree, at least 30 credits of coursework are required. If the student has a M.S. degree, the minimum requirement is 15 credits beyond the M.S, degree. All Ph.D. students are required to take or demonstrate proficiency in the following courses prior to taking the General Exam:

- Three of the following five courses:
    - CE 5200 Operations Research in Civil and Environmental Engineering

- CE 5720 Street and Highway Design
- CE 5730 Transportation Planning
- CE 5740 Traffic Engineering I
- CE 5750 Pavement Design

- If the student's prior degrees are in an area other than civil engineering, the following background preparation courses are required if not previously taken:
  - CE 2251 Probability and Statistics in Civil and Environmental Engineering
  - CE 2211 Engineering Economics
  - CE 2710 Transportation Engineering
  - MATH 2110Q Multivariable calculus
- Students must register for and attend CE 5030 Seminar in Transportation and Urban Engineering every semester in which they are either enrolled full time or supported by a graduate assistantship. PhD students are expected to present their research once each academic year.

The advisory committee may substitute the above with equivalent courses. The remaining credits may be taken in one of the three areas of concentration with courses selected in consultation with the advisory committee.

Steps for Graduation

There are five steps to graduation as outlined below. Please note that these represent specific requirements in addition to Graduate School and Civil Engineering program requirements. Note that the Graduate School requires at least five (5) faculty to participate in the General Exam and the Final Exam for the PhD. Not all of these faculty need to be members of the students' advisory committee.

1. Plan of Study

- For a student admitted to the Ph.D. program with a previously earned M.S., the POS must be filed within the first 2 semesters (or before completion of 12 credits of coursework)
- For a student admitted to the Ph.D. program without a previously earned M.S., the POS must be filed within the first 4 semesters (or before completion of 18 credits of coursework)
- The Plan of Study must be signed by the student, major advisor and at least two associate advisors selected by the student in consultation with the advisor.

2. General Exam

In addition to the requirements established by the CEE department, students enrolled in the TUE concentration area must complete all course requirements before the general exam can be taken. This is usually after four semesters of PhD study. The TUE faculty administer the exam on request by a student annually.

The General Examination for TUE is given in three parts:

- First, a written exam testing the student on TUE fundamentals. The written portion of the exam consists of four questions, one each from the three selected Transportation Core courses, and one from the area of emphasis outside of CE/Transportation. The exam is four hours long and each part may be open or closed book according to the examiner's decision.
- Second, a take home exam that evaluates the student's ability to carry out independent research in the field of study. Each student will be assigned an open-ended problem in an area closely aligned with the student's potential dissertation topic. As part of the narrative, the student is expected to formulate a hypothesis, carry out a literature review, describe a study approach, identify analysis techniques, and discuss potential results. The student would have two days to complete this take home exam.

- Third, an oral presentation presenting the student's solution to the open-ended problem assigned in the second part of the general exam. In the oral portion, the student makes a 20-minute presentation of the response and answers questions about this proposal (part 2 of the general exam) and the answers to the written questions (part 1 of the general exam).

The timing of the three parts is as follows:

- One week before the written portion is administered; the examiners announce whether each part will be open or closed book.
- The independent research problem is assigned on the day of the written exam. The student is expected to submit a response within two days.
- The oral presentation will be held within a week after the part 2 response is due.

3. <u>Dissertation Research Proposal Defense</u>

- First, the student must submit a proposal narrative. This narrative should include the following in a format that works well for the chosen topic: 1) introduction setting the context and motivation for the proposed research, 2) a review of relevant background literature, 3) clear description of the proposed study design and methodology, 4) expected contributions from the research, and 5) conclusion summarizing the proposed work.
- Second, the student presents their proposal to the advisory committee and two external reviewers in a 20-minute presentation of the research proposal and answers questions about this proposal.
- It is recommended that the dissertation proposal is submitted for approval in the semester after a student passes the General Exam, but the maximum time is one year after passing the General Exam.

4. <u>Publications</u>

In addition to Graduate School requirements, at the time of degree completion the Civil Engineering Program requires that a Ph.D. student must prepare three journal papers: At least 1 published or in press, 1 accepted and 1 submitted for journal publication. However, it is important that the three papers together address a larger, coherent research question (as outlined in the Dissertation Proposal above) and that they are not isolated bodies of work.

5. <u>Dissertation Defense</u>

- First, the student must submit a written dissertation. For the written dissertation, the three papers can be woven together with introduction and conclusion sections to submit as an integrated Ph.D. dissertation. The Ph.D. dissertation must be submitted to the advisory committee 14 days prior to the date of the defense.
- Second, the student appears for an oral dissertation defense. The student makes a presentation about the dissertation work of about 30 minutes in length. The dissertation defense can be scheduled a minimum of 6 months after the proposal defense. First the student must complete and submit the CEE PhD Checklist Form. Once the Checklist Form has been submitted, the student may work with CEE Department staff to find a room and time for the defense.

GRADUATE SCHOOL RULES APPLYING TO ALL PROGRAMS

Course Rules

- Up to 6 credits of 3000 & 4000-level courses (that are not open to sophomores) may be applied towards any graduate degree.
- Up to 6 credits of courses taken as a non-degree student may be applied towards any graduate degree.

Provisional Status

- If a student is admitted with an undergraduate GPA under 3.0, he/she is admitted under Provisional Status.
- If a matriculated graduate student's GPA drops below 3.0, he/she goes into Provisional Status.
- While registered under Provisional Status, a student is **not eligible to receive funding as a Graduate Assistant and cannot graduate.**
- To go off Provisional Status, a student must complete 12 credits of graduate level courses with at least a 3.0 GPA.

Continuous Registration

- You must maintain uninterrupted registration with the Graduate School every semester until you complete your degree requirements. Your options are:
    - Registration in courses or GRAD 5950/6950, subject to tuition charge (unless tuition is waived because you are supported as a GA).
    - 0 credit "continuous registration" in GRAD 5998/5999/6998/6999, subject only to registration fees.
- If you fail to matriculate under one of these options, your registration status will lapse and your advisor will have to petition to reinstate your registration in order to complete your degree. You will incur additional penalty fees, as well as paying all fees for semesters in which you should have been registered.

THE THESIS AND DISSERTATION

Content & Format

- The format of the thesis or dissertation must conform **exactly to Graduate School regulations**. Your thesis or dissertation will not be accepted if any of these rules are violated. The graduate school website provides these rules. We recommend that you ask another student or your advisor for a sample of a thesis or dissertation that was accepted as an example if you are unsure how to interpret the rules.
- The thesis or dissertation must constitute original work by the student resulting in ground-breaking, seminal findings in the field of study, which are presented in an oral final examination according to Graduate School regulations.
- The literature review must be exhaustive and clearly show how the thesis or dissertation builds significantly on previous research. Simply itemizing the content of each background paper is not adequate; all papers discussed in a literature review must be tied together and explicitly related to the research topic.
- It is necessary to demonstrate the contributions of the research in the conclusions.
- The Civil Engineering field of study offers the option of preparing the dissertation as a series of peer-reviewed journal papers. The TUE faculty recommends that students follow this format.

Timing

- The time to write an MS thesis is usually about 2 to 3 semesters; for a PhD dissertation, usually about 5 to 8 semesters.
- Revisions to an individual thesis or dissertation chapter will take at least six (6) weeks from the first time a complete draft is provided to the major advisor. Students are encouraged to provide drafts one section or chapter at a time when possible, as soon as the work documented is completed.

- Once the major advisor is satisfied the thesis or dissertation is ready, a copy is provided to each member of the final exam committee, which consists of the major advisor and two associate advisors, and two additional faculty (five total) for a PhD dissertation. A final examination date and time is set at least two weeks from the time the copies are provided to the examination committee.
- Note that the Graduate School requires several additional requirements, including a form that must be signed by the Advisory Committee one week before the date of the defense.

Table 1: COURSE PROGRAM

<table>
<tr><td>Background Preparation[1]
CE 2211 Engineering Economics
CE 2251 Probability & Statistics in CEE
CE 2710 Transportation Engineering
MATH 2110Q Multivariable calculus

Transportation Core[1]
CE 5200 Operations Research in CEE
CE 5720 Highway Engineering – Design
CE 5730 Transportation Planning
CE 5740 Traffic Engineering I
CE 5750 Pavement Design</td><td>CE/Transportation & Systems Specialization
CE 5090 Sustainable & Resilient Infrastructure Systems
CE 5090 Advanced Modeling and Simulation in Civil and Transportation Systems
CE 5570 Bituminous Materials
CE 5715 Sustainable Transportation
CE 5725 Transportation Safety
CE 5735 Public Transportation Systems
CE 6725 Statistical and Econometric Methods for Transportation Data Analysis
CE 6730 Travel Demand Forecasting
CE 6735 Transportation Network Analysis
CE 6740 Traffic Engineering II</td></tr>
<tr><td colspan="2">Suggested Courses outside CE/Transportation</td></tr>
<tr><td><u>Chemical Engineering (CHEG)</u>
5336 Optimization
5367 Polymer Rheology
5368 Polymer Rheology and Processing Laboratory
5358 Composite materials
5352 Polymer Properties</td><td><u>Civil Engineering (CE)</u>
5125 Reliability for Engineers
5130 Numerical methods in Civil Engineering
5164 Finite Element Methods in Applied Mechanics I
5166 Finite Element Methods in Applied Mechanics II
5541 Advanced Soil Mechanics
5544 Geosynthetics in Geotechnical Design</td></tr>
<tr><td><u>Communication (COMM)</u>
5100 Persuasion Theory and Research
5120 Communication Campaigns

<u>Economics (ECON)</u>
5201 Microeconomics I
5202 Macroeconomics I
5301 Mathematical Economics
5311-5312 Applied Econometrics I-II</td><td><u>Computer Science and Engineering (CSE)</u>
5500 Algorithms
5506 Computational Complexity
5705 Discrete Optimization
5713 Data Mining
5717 Big Data Analytics
5820 Machine Learning</td></tr>
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[1]Equivalent courses taken prior to entering the program may be substituted. For CE 2710, any engineering design course is acceptable.

Electrical and Computer Engineering (ECE): 6104 Information, Control and Games 6108 Linear Programming and Network Flows 6111 Applied Probabilistic and Stochastic Processes 6125 Digital Image Processing 6141 Neural Networks for Classification and Optimization 6142 Fuzzy and Neural Approaches to Engineering 6143 Pattern Recognition and Neural Networks 6437 Computational Methods for Optimization	Geography (GEOG) 5100 Location Analysis 5110 Regional Development and Policy 5130 GIS in Transportation 5220 Geography of Sustainable Development 5290 Advanced Urban Geography 5500 Fundamentals of GIS 5510 Application Issues in GIS 5512 Introduction to Spatial Data Science 5516 Fundamentals of Spatial Database Systems 5519 Spatial Big Data Analytics 5520 GIS Modeling of the Urban Environment 5600 Spatial Data Analysis 5610 Spatial Statistics and Modeling 5612 Spatial Econometrics
Environmental Engineering (ENVE) 5320 Quantitative Methods for Engineers 5330 Probabilistic Methods in Engineering Systems 5331 Predictive Analytics for Scientists and Engineers	
Geology (GEOL) 6510 Fundamentals of Seismology 6520 Advanced Seismology 6530 Geophysical Inverse Theory	Management (MGMT) 5800 Strategy, Policy, and Planning 6201 Seminar in Organization Behavior 6202 Research Methods in Strategic Management 6203 Contemporary Research in Organizational Behavior
Materials Science and Engineering (MSE) 5322 Materials Characterization 5364 Advanced Composites	Operations and Information Management (OPIM) 5103 Managerial Statistics 5110 Operations Management 5181 Introduction to Data Analytics 5501 Visual Analytics 5502 Big Data Analytics with Hadoop 5503 Big Data Analytics with R 5604 Predictive Modeling 5641 Operations Research in Management 5668 Project Risk and Cost Management 5671 Decision Support Systems 6201 Research Methods for Operations and Information Management
Mathematics (MATH) 5530 Mathematical Modeling 5580 Optimization 5635 Intro to Operations Research	
Mechanical Engineering (ME) 5410 Theory of Elasticity 5433 Theory of Plasticity 5511 Principles of Optimum Design 6511 Advanced Optimum Design	
Psychological Sciences (PSYC) 3104E Environmental Psychology (Hartford campus) 5703 Advanced Social Psychology	Statistics (STAT)[2] 5105 Quantitative Methods in the Behavioral Sciences 5225 Data Management and Programming in R & SAS 5315 Analysis of Experiments 5361 Statistical Computing 5405 Applied Statistics for Data Science 5415 Advanced Statistical Methods 5505-5605 Applied Statistics I-II 5515 Design of Experiments 5525 Sampling Theory 5585-5685 Mathematical Statistics I-II 5665 Applied Multivariate Analysis 5675 Bayesian Data Analysis 5825 Applied Time Series
Public Policy (PP) 5327 Analysis for Management Decision Making 5331 Quantitative Methods for Public Policy 5332 Advanced Quantitative Methods 5333 Principles and Methods of Survey Research II 5340 Introduction to Public Policy and Management 5375 Economic Analysis for Public Policy and Management 5383 Advanced Questionnaire Design	

[2]STAT 5315 is generally sufficient preparation for the analysis needed for an MS thesis. STAT 5505-5605 is preferred for the advanced statistical analysis required for a Ph.D. dissertation, or a MS thesis requiring specialized statistical analysis.