

## **Graduate Handbook**

### **Department of Civil, Environmental, and Construction Engineering**

#### **Purpose**

The purpose of this handbook is to provide a description of the departmental requirements for earning an advanced degree in the Civil, Environmental, and Construction Engineering Department (CECE). The general requirements for graduate degrees for the year in which the student enrolls are given in the University Catalog within the Graduate School section in both the print and on-line editions. These requirements always govern advanced degree study. The University calendar in the catalog as well as the Graduate School webpage show the deadlines that must be met by students to fulfill graduate school requirements. The requirements presented in this Handbook are intended to clarify and supplement those stated by the Graduate School, particularly as they pertain to the CECE Department. Questions about specific graduate programs that the graduate catalog and this handbook do not answer, should be directed to the Departmental Graduate Advisor in the student's specialty area, the student's Research Advisor, or the Dean of the Graduate School.

#### **The Graduate Advisor**

The Department has three graduate advisors; one who is charged with the oversight of the Environmental Engineering and Water Resources Engineering students, the second with oversight of students in the Structural Engineering, Transportation Engineering, and the Geotechnical Engineering Students, and the third for the Construction Engineering students. These Graduate Advisors are faculty members responsible for: a) the suitability of applicants to the graduate programs in their specialty area, b) overseeing the orientation of newly enrolled graduate students, c) advising the masters level graduate students who are enrolled in the courses only option, and d) monitoring the progress of each graduate student throughout their degree programs.

The Graduate Advisor will:

- 1) Counsel and advise the Master's Degree students who are in the first year of graduate school and those in the 30-hour courses only program as to the courses that they should take each semester. Departmental registration holds will not be lifted until after meeting with the graduate advisor.
- 2) Sign the Program for the Master's Degree, and the Doctoral Degree Plan
- 3) The Graduate Advisor can act as an intermediary between the student and the Departmental faculty and as an intermediary between the student and the Graduate School, in cases where one is needed. It is important to emphasize that the Research Advisor will become the principal advisor/mentor once the student joins a research group.

### **The Senior Academic Counselor**

The Senior Academic Counselor, maintains a database that tracks the progress from the time that the student's application packet is received from the graduate school until the student has completed all departmental requirements for their degree. Additionally, the counselor will aid the student with filing the necessary forms during their course of study. The academic counselor's office is located in the CECE Building Room 157.

More specifically, the Senior Academic Counselor will:

- 1) Lift academic holds and advise the student in the enrollment process and the procedures to lift other holds that are administered by other offices on campus,
- 2) Assist the student in requesting that appropriate graduate courses are transferred for credit to Texas Tech; and
- 3) Update the student with all Graduate School and Departmental deadlines that must be met to graduate in a timely manner.

It is important that the counselor receives the specified forms in a timely manner so that the student's records can be kept current. Until the forms are received, the Department, College, nor University do not recognize that the requirement has been met which may cause delays in graduation.

### **Basic Requirements for Graduate Study.**

Every student who is pursuing an M.S. or Ph.D. degree in this department, in order to attain or maintain their candidacy for their degree, must:

- 1) Be registered as outlined in the Graduate School section of the catalog per the year the student registered (online or print version);
- 2) Meet the deadlines for the degree requirements, in the most current University calendar (print or on-line version), or on the Graduate School webpage;
- 3) Submit a degree plan ("Program for the Master's Degree and Admission to Candidacy" or "Program for the Doctoral Degree"). For the Master's degree programs, the degree plan will be submitted during the student's first semester in the program. The doctoral degree plan will be submitted in accordance with the guidelines published in the current print or on-line catalog, but is usually completed during the third semester of their program.
- 4) Maintain a cumulative GPA of 3.0 or higher in graduate coursework;
- 5) Complete the required number of courses for the degree, as outlined in this handbook; and
- 6) Complete the Final Examination requirement to the satisfaction of the student's Advisory Committee by the established graduate school deadline.

Students will be released from the program if their actions fall into the following categories:

- 1) Violate the ethical code of conduct for scholastic dishonesty outlined in OP 34:12.3;

- 2) Do not pass leveling courses required by the faculty in his discipline area with a grade of B or above;
- 3) Cannot bring their cumulative GPA up to 3.0 after two suspensions; and
- 4) Fail to complete research that the student was paid to perform.

## **Registration Requirements, Coursework, and Grading**

### **A. University Enrollment Requirements**

The credit hour minimum for registration is governed by Texas Tech University Operating Policy and Procedures Manuals, OP 64.02, which states the requirements for full time study and is described below.

#### ***Full-time Study***

Normal full-time enrollment varies between 9 and 13 hours for doctoral students and between 9 and 16 hours for other graduate students in the regular semester period. Full time enrollment in a summer session is from 3 to 6 hours. During a regular semester, more than 13 hours for a doctoral student or 16 hours for other graduate students requires special permission from the graduate dean.

Students must be enrolled full time (at least 9 hours in each long term, 3 hours in each relevant summer session) to be eligible to hold fellowships, teaching assistantships, graduate part-time instructorships, research assistantships, or other appointments designed for the support of graduate study, as well as to qualify for certain types of financial aid. All international students are required by law to have full-time enrollment in every long semester. Graduate students designated Postgraduate (PGRD - those who have earned an undergraduate degree but who only take undergraduate courses) may not be appointed to teaching assistantships, graduate part-time instructorships, or research assistantships, as noted in the *Graduate Catalog*.

If a student is devoting full time to research, utilizing university facilities and faculty time, the schedule should reflect at least 9 hours enrollment (at least 3 hours each summer session). Enrollment may include research, individual study, thesis, or dissertation. Student may take only 3 hours during their final semester of their program and remain as full-time, but check with the graduate advisor to make sure you qualify.

Exceptions to full-time enrollment for employment purposes require approval by the graduate dean.

#### ***Continuous Enrollment***

Each student who has begun thesis or dissertation research must register in each regular semester and at least once each summer until the degree has been completed, unless granted an official leave of absence from the program for medical or other exceptional reasons.

## **B. Departmental Registration Requirements**

### ***On-Campus Master's Degree:***

The Department offers an on-campus Master of Science degree in Civil Engineering (MSCE) with specialization in various divisions and a Master of Environmental Engineering (MEE). The first program has specialization areas in environmental engineering, geotechnical engineering, structural engineering, transportation engineering, construction engineering, and water resources engineering. The MEE program is an ABET accredited 5-year program (4 years undergraduate work and 1 year of graduate work) where students enter that program as first-year students.

The Graduate School has four basic plans for a master's degree work, which the Department also follows. Those options are the thesis, coursework only with written exam, research report, and internship options. The thesis option consists of 24 hours of course work and 6 hours of thesis along with research courses in which the student gets credit for research and maintains the number of hours for full time enrollment. The other options are 30-hour programs that consist of 27 hours of coursework plus three hours of either report or internship, respectively or 30 hours of course work and a written exam from instructors of your core courses.

#### **1. Thesis**

The thesis option, recognized by the Graduate School and the Department, requires a minimum of 24 hours of graduate course work and 6 hours of thesis (CE 6000); the coursework should be approved by the student's Research Advisor with oversight from the Graduate Advisor. The time to complete this option can vary from 4 to 6 semesters and is dependent upon the time to complete the research and to prepare the thesis. A typical 9 credit hour course load for first-year students is two or three lecture courses, and a varying number of research credit hours (CE 7000) if the student has selected a research advisor. After the first year, a typical course load is one or two lecture courses, research (CE 7000), and a varying number of thesis credit hours (CE 6000 for M.S. students). During the summer, when few if any lecture courses are offered, the typical course load is for thesis and research. The student and their Research Advisor will select an advisory committee during the first semester or early in the second semester consisting of two or more faculty members that the student can use for advice and guidance in the completion of their research task. After the student has completed their thesis to their major advisor's satisfaction, the student will give copies of their thesis to their committee members at least one week before the agreed upon time for the student's oral presentation and defense of their thesis. The thesis committee will give the student a grade based upon the thesis contents and the student's performance during their presentation and defense. The timeline that the graduate school sets for graduating master's students must be followed if the student is to graduate in the semester that their thesis is defended.

#### **2. Thirty Hours of Coursework**

The coursework option for the master's degree is a minimum of 30 hours of graduate coursework without a thesis. The Department has split this option and the student can select either path to

complete their requirements of a Master's Degree. The first path is a courses only option. Selecting this option, a student with a baccalaureate degree in Civil Engineering typically can complete the Master program in three semesters. Transfer of credit from other institutions is limited by the department to 6 hours for a master's degree. In addition, no more than 6 hours of individual study courses will be permitted in this option for the master's program. Towards the end of the student's last semester, they will petition the Graduate Advisor in their area of study for a comprehensive exam. The Graduate Advisor will ask a minimum of 3 professors whom the student took core classes from to prepare a list of questions over coursework. The tests will all be administered by the graduate advisor; the students will visit the professors to see if they passed or if additional questioning is needed. The report of the oral examination must be submitted by the Graduate Advisor in accordance with the graduate school guidelines if the student is to graduate in the semester that they finish the work.

### 3. The Report or Internship

The alternate path for the coursework option for the master's degree are the report or internship options. This option requires 27 hours of graduate course work and completion of CE 6330 – Master's Report in the student's final semester. The master report is essentially an independent study completed under a professor who has interest in a topic that the student would like to perform independent research either of a literary nature or using funds that the student has available. The report follows the format of a master's thesis. In the case of the report, the student writes the report with minimal help from the professor who has an interest in the topic. The student will select another professor to serve on their examination committee and when the student has their finished product, copies are given to their committee members at least one week before the agreed upon time for the student's oral presentation of his report and examination upon the report contents. The examination committee will give the student a grade based upon the report contents and the student's performance during his presentation and defense. The timeline that the graduate school sets for graduating master's students must be followed if the student is to graduate in the semester that his report is defended. The internship follows the same format of the report with a specified number of hours required and managed by the internship supervisor at the specific place of work.

The three program options for the master's degree that are offered by the department are as follows:

<b>Thesis Option</b>	<b>Report/Internship Option</b>	<b>Exam Option</b>
24 hrs - Course Work	27 hrs - Course Work	30 hrs - Course Work
6 hrs - Thesis	3 hrs – Report	Comprehensive Exam
Oral Exam	Oral Exam	30 hrs - Total
30 hrs - Total	30 hrs – Total	

### **Online Only Master's Degree:**

The CECE Department offers a completely online MS program in Civil Engineering. This is a 30-hour program with a final comprehensive component that equivalent to the 3 options of our in-person MS program. This is a general MS Program that is not concentration dependent. The courses offered within this online program are the following:

CE 5310	Numerical Methods in Engineering
CE 5315	Probabilistic Methods for Civil Engineers
CE 5319	Machine Learning for Civil Engineers
CE 5321	Advanced Soil Engineering
CE 5323	Advanced Foundation Engineering I-Shallow Foundations
CE 5326	Stability Analysis and Design of Slopes and Embankments
CE 5328	Design and Analysis of Earth Retaining Structures
CE 5331	Advanced Data Analysis
CE 5331	Advanced Transportation Planning and Network Design
CE 5331	Advanced Foundation Engineering II-Deep Foundations
CE 5331	Environmental Engineering Sustainability
CE 5351	Advanced Pavement Materials
CE 5352	Advanced Flexible Pavement Design
CE 5355	Advanced Rigid Pavement Design
CE 5356	Sustainable Material Systems and Engineering Design
CE 5360	Open Channel Hydraulics
CE 5361	Surface Water Hydrology
CE 5362	Surface Water Modeling
CE 5363	Groundwater Hydrology
CE 5364	Groundwater Transport Phenomena
CE 5366	Water Resources Management
CE 5372	Traffic Flow Theory
CE 5373	Highway Capacity Analysis
CE 5394	Natural Systems for Wastewater Treatment
CE 5318	Finite Element Methods
CONE 5332	Construction Management

<sup>a</sup>This is a new course so the number has not been defined at this writing.

### **Prerequisites to applying for the Online MS program**

A Bachelor's degree in engineering, but students with a Bachelor's Degree in Engineering-related disciplines (Biology, Chemistry, Mathematics, Geology, Geophysics, and so forth) can apply to the Online Master's program in Civil, Environmental and Construction Engineering after completion of the prerequisite classes or equivalents listed below. Students completing these courses before you apply will put them on par with engineering graduates and to help them pass the Fundamentals of Engineering (FE) examination, the first step toward a Professional Engineering (PE) license. International students must possess an engineering degree upon admission to the Online MS Program. Upon graduation students are viewed by the State of Texas Professional Engineering Board as having the equivalent of an Undergraduate Engineering Degree and can go through the licensure process to become professional engineers. Note, some graduate courses may require specific undergraduate prerequisites as noted in the catalog.

**Prerequisites to application for the Online MS degree for non-engineers**

<b>COURSE Title</b>	<b>TTU DESIGNATIONS</b>
Principles of Chemistry I and II	CHEM 1307, 1308
Fundamentals of Chemistry Laboratory, I and II	CHEM 1307, 1308
Calculus I, II, and III and Higher Math for Engineers and Scientists I	MATH 1451, 1452, 2450, and 3350
Physics I and II	PHYS 1408, 2401
Computational Thinking	ENGR 1330
Statics	CE 2301
Mechanics of Solids	CE3303
Mechanics of Fluids	CE3305

***Doctoral Degree:***

The Department requires a minimum of 60 hours of graduate work for the Ph.D. Degree. Most students will take more than the minimum to complete their degrees. Additional fees and/or tuition, however, will be charged if the number of doctoral hours taken exceeds 115 hours for doctoral students. However, doctoral students with more than 99 doctoral hours may be dismissed if they are not making progress toward their degree. There are no Departmental language requirements for doctoral candidates.

On the basis of 9 hours per semester and 3 hours per summer session course loads, doctoral students will require a minimum of two years earning the degree if they already have a Master's Degree. The breakdown of hours is like that stated for master's students. If the student does not have a Master's Degree, it will take about 4-6 years to complete their degree program. Note that students who already have a Master's Degree start the clock with a certain number of doctoral hours at the start of their Ph.D. programs. In either case, it is imperative that students pursue their studies in a timely fashion to avoid these financial penalties. Currently, there are no credit limitations for Master's students.

**Grading**

A grade of "CR" (for "credit") is assigned for research (CE 7000), for the thesis (CE 6000), or dissertation (CE 8000) credit hours taken each semester. A letter grade is assigned to the final enrollment in the thesis or dissertation credit hours after the student has passed his/her final oral examination.

**Program Requirements:**

The Graduate Catalog lists the courses offered by the Department, as well as graduate-level (i.e., with numbers of 5000 or greater) courses offered by other Departments on campus. As indicated in detail below, graduate-level courses from departments other than the CEE Department can be taken and counted toward a graduate student's degree plan in Departmental programs. Courses outside the

Department can be from lists as shown in the curriculums listed below, approved by the students' research advisor, or by a doctoral student's advisory committee.

### **PRELIMINARY EXAMS:**

#### **Preliminary Exam for PhD:**

There are alternative options for the preliminary exam depending upon your initial starting status. If you are starting the program with a completed Bachelor's degree, then you can proceed with one of two options. The first is a written exam as described below within the first three weeks of the second year of your program. An alternative is that you may complete the submission of a refereed journal article after which you will proceed to the oral exam portion of the preliminary exam, but this must be completed by the end of the first year of your program.

If you are starting the program with a completed Master's degree and have a refereed published paper in an appropriate journal as either the first or second author, then you may proceed directly to the oral exam where your presentation will consist of the research completed and contained within the published article. Along with the submission of the article, the reviews of the manuscript could be included for review by the committee. This preliminary exam should take place during the second semester of your program.<sup>1</sup> If no published article has been completed, and one is submitted before the end of the second semester, that article could be presented at an oral exam. If the article route is not chosen, then you will proceed to the written exam option.

#### **Format of written exam:**

Preliminary exam will be conducted by three CECE graduate faculty members agreed upon by the student and Faculty Advisor. Each faculty member will provide two questions that cover pertinent subject matter to the faculty-in-charge of the exam. Accordingly, there will be a total of 6 questions. The student will answer:

- a) both questions from his/her faculty advisor; and
- b) one question each from other two faculty members on this committee

The written exam consisting of all six questions will be made available to the student by the faculty member in charge of administering the prelim exam. The student will receive the exam from the faculty in charge with specific instructions and a timeline of when the exam must be completed (usually up to 5 days).

Faculty will have two weeks to review the answers and return evaluations to the faculty-in-charge of the preliminary exam. After the written portion of the exam is completed, the student will then proceed to scheduling the oral exam portion.

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<sup>1</sup> WCOE OP 40.20 states "...All incoming PhD students must complete their qualifying exam within the first 2 years of matriculation into the graduate program..." – The preliminary exam is scheduled as such to allow one year to complete the qualifying exam; The preliminary exam + qualifying exam must be completed within 2 years.



**Format of oral exam:**

The duration of the oral exam will be 60 minutes. The exam will have two components depending on the option selected.

**Written exam option:**

- a) An oral presentation on an independent research topic by the student for 15 minutes
- b) 45 minutes of Q&A by faculty on:
  - 1. The research topic presentation
  - 2. Written exam answers

**Published paper option:**

- a) An oral presentation on the published research article by the student for 15 minutes
- b) 45 minutes of Q&A by faculty on:
  - 1. The research topic presentation
  - 2. Basic class material completed

**Preliminary Exam Outcome/Committee Recommendations:**

Based on the student's performance, the prelim exam committee will recommend one of the following:

- a) Student passed the written and oral exam and there is no need for retake of any component
- b) Student passed some portion of the written exam, and the oral exam, and there will be focused retake of "failed" components of the written exam. In this case, the student must complete the retake the exam within the time specified by the committee, but no later than the following semester
- c) Student did not successfully complete the preliminary exam and will be advised to pursue a terminal MS degree as appropriate.

**QUALIFYING EXAMS:**

To appear for the PhD qualifying exam the student is encouraged to have submitted at least one paper in an appropriate journal and have it accepted/published by the journal. The alternative option to the published paper option is a written exam.

- a) Qualifying exam (published paper option) will include:
  - 1. evaluation of the published paper(s) by the committee
  - 2. presentation of the paper
  - 3. discussion or referee comments in that publication and how the reviewer concerns were addressed (show documentation)
  - 4. presentation of a dissertation proposal (as described below) followed by questions from the committee:
- b) Qualifying exam (written exam option) will include:
  - 1. Students will receive written questions from the committee through their faculty advisor

2. Questions from the committee regarding their responses to the written questions
  3. Presentation of the dissertation proposal (as described below) followed by questions from the committee
- c) Dissertation proposal that includes the following:
1. knowledge gaps in the field (literature review)
  2. originality of topic
  3. literature review that shows an appropriate bibliography that relate to text in the dissertation proposal
  4. research design for dissertation
  5. theory and mathematical methodology for dissertation
  6. expected results
  7. preliminary conclusions
  8. anticipated dissertation completion targets and timeline
  9. expected research impact of dissertation
  10. references

### **Qualifying Exam Outcome/Committee Recommendations:**

Based on the student's performance, the qualifying exam committee will recommend one of the following:

- a) Student passed the written and oral exam and there is no need for retake of any component
- b) The committee has identified the student as "Needing Improvements" and suggest additional work to strengthen the student's knowledge in specific areas. The committee will meet with the student within 6 months to decide on whether the student has made satisfactory progress to pass the qualifying exam. If the student needs more than 6 months to complete the necessary coursework suggested by the committee, the student must seek for committee approval for an extension of the probationary period.
- c) Student did not successfully complete the qualifying exam and will be advised to pursue a terminal MS degree as appropriate.

### **Guidelines for Progress Report**

- The student must prepare a written report on a topic relevant to his/her future dissertation work or as advised by the student's research advisor.
- The report can take the form of an extensive literature review on the chosen topic, including survey of contemporary developments in relevant fields. Alternatively, the student can generate a report in the form of a draft manuscript, if substantial research data has been accrued at the time of writing the report.

### **Publication Requirements**

Pursuant to WCOE OP 40.20, PhD students are expected to have at least 2 manuscripts accepted in Tier 1 peer-reviewed journals prior to their dissertation defense.

The Final Examination for the doctoral candidate will consist of a public oral examination over the candidate's research as reported in the dissertation or in published refereed publications. The Department also reserves the

right to administer a preliminary exam to incoming Ph.D. students to assess their understanding of engineering topics covering classes taken in other universities.

### **Water Resources Engineering MSCE Option**

For thesis, report, or courses-only options, the core courses and four engineering or other appropriate electives must be taken. The additional courses for the latter two non-thesis options should be determined after consulting the graduate faculty advisor. In the list below, the following abbreviations appear in parentheses.

f = offered in fall semester  
s = offered in spring semester  
ss = offered in summer session  
[r] = rotating, non-annual course  
[course] = prerequisite

#### **Core Courses**

CE 5360 Open Channel Hydraulics (f)  
CE 5361 Surface Water Hydrology (s)  
CE 5363 Groundwater Hydrology (s)  
CE 5366 Water Resources Management (s[r])

Geographic Information Systems course (approved by advisor)\*\*

#### **Engineering Electives**

CE 5313 Probabilistic Methods of Civil Engineering  
CE 5319 Machine Learning for Civil Engineers  
CE 5349 Performance-Based Engineering  
CE 5362 Surface Water Modeling (f)  
CE 5364 Groundwater Transport Phenomena (f, [CE 5363])  
CE 5368 Surface Water Quality Modeling (s[r])  
CE 5391 Advanced Water Treatment (s, [ENVE 5307])  
Other environmental, civil, or other engineering graduate course approved by graduate advisor

#### **Non-engineering Electives**

STAT 5384 Statistics for Engineers and Scientists I (f)  
GEOG 5301 Remote Sensing of the Environment (f,s)  
Other graduate courses as approved by graduate advisor

#### **Research Courses**

CE 6000            Thesis  
CE 6330            Master's report (sign up for report the last semester before graduation)  
CE 7000            Research (only for thesis option)  
CE8000            Dissertation (12 hours)

**\*\*Possible geographic Information Systems electives include but are not limited to:**

GIST 5300 Geographic Information Systems (f,s)  
GEOL 5428 GIS in Natural Science and Engineering (f)  
NRM 5404 Aerial Terrain Analysis (f)

**Environmental Engineering MSCE and PhD Options**

For thesis, report, or the courses only options, the core courses and three engineering electives must be taken. The remaining courses should be determined after consulting the faculty advisor.

**Core Courses (Masters level only)**

CE 5391	Advanced Water Treatment (s)
CE 5191	Advanced Water Treatment Lab (s)
ENVE 5307	Advanced Physical and Chemical Wastewater Treatment (f)
ENVE 5107	Advanced Physical and Chemical Wastewater Treatment Lab (f)
ENVE 5399	Biological Municipal Wastewater Treatment (s)
ENVE 5315	Environmental Chemistry for Pollutant Management

**Core Courses (PhD level only)**

ENVE 5392	Environmental Chemodynamics
CE 5390	Advanced Math for Environmental Engineers
CE5325	Environmental Organic Chemistry
ENVE 5315	Environmental Chemistry for Pollutant Management

**Engineering Electives**

CE 5349	Performance-Based Engineering
CE 5360	Open Channel Hydraulics (f)
CE 5363	Groundwater Hydrology (s)
CE 5364	Groundwater Transport Phenomenon (f)
CE 5366	Water Resources Management
CE 5368	Surface Water Quality Modeling
CE 5383	Bioremediation of Wastes in Soil Systems*
CE 5394	Natural Systems for Wastewater Treatment
CE 5395	Solid and Hazardous Waste Treatment (s)
ENVE 5303	Design of Air Pollution Control Systems(s)
ENVE 5314	Membrane Treatment Processes
CE 5393	Chemodynamics

**Non-engineering Electives**

STAT 5385	Statistics for Engineers and Scientists I
ENTX 6345	Chemical Sources and Fates in Environmental Systems
ENTX 6371	Procedures and Techniques in Ecological Risk Assessment
ENTX 6385	Statistical Applications in Environmental Toxicology
GEOG 5300	Geographic Information System

RWFM 6305	Geospatial Technologies in Natural Resources Management
GEOL 5428	GIS in Natural Science and Engineering
G CH 5305	Environmental and Aqueous Chemistry
G CH 5350	Isotope Geochemistry
G CH 5405	Inorganic Geochemistry
PSS 6432	Advanced Soil Microbial Ecology
ENTX 6365	Fundamentals of Aquatic Toxicology

• Co-requisites; upon consent of the instructor

\* Prerequisites are CE 5385

\*\* Prerequisite is ENVE 5399

### **Research Courses**

CE 6000	Thesis
CE 6330	Master's report (sign up for report the last semester before graduation)
CE 7000	Research (only for thesis option)
CE 8000	Dissertation (12 hours)

### **Guidelines for Progress Report**

- The student must prepare a written report on a topic relevant to his/her future dissertation work or as advised by the student's research advisor.
- The report can take the form of an extensive literature review on the chosen topic, including survey of contemporary developments in relevant fields. Alternatively, the student can generate a report in the form of a draft manuscript, if substantial research data has been accrued at the time of writing the report.

### **Guidelines for Ph.D. Qualifying Exam**

- The qualifying exam consists of a written and an oral examination. The written exam contains a set of questions related to the student's coursework or area of research. Each committee member will contribute a question with input from the student's advisor. The advisor will compile all questions and distribute all questions to the student at once. The student will have one week to respond to questions and return the completed written exam to the advisor.
- Upon completion of the written exam, the committee should conduct an oral examination to ask further questions related to the written portion or allow students to clarify answers to the written questions.
- The committee should conclude based on the written and oral exams whether the student's performance is satisfactory, needing improvement, or failure.
- In the case of "needing improvement", the committee will provide suggestions on additional work to strengthen the student's knowledge in specific areas. The committee will meet with the student within 6 months to decide on whether the student has made satisfactory progress to pass the qualifying exam. If the student needs more than 6 months to complete the necessary coursework suggested by the committee, the student must seek for committee approval for an extension of the probationary period.

## Guidelines for Research Proposal

- The student must prepare a written research proposal describing the literature framework of the proposed research, defining the objectives of the dissertation work, and outlining a logical and feasible plan of research activities to fulfill the objectives.
- Student should have a draft manuscript related to the student's dissertation topic at the time of completing the research proposal.

## Publication Requirements

Pursuant to WCOE OP 40.20, PhD students are expected to have at least 2 manuscripts accepted in peer-reviewed journals or indexed conference proceedings (list of acceptable conferences determined by the Department Chair) prior to their dissertation defense.

### *Master of Environmental Engineering Degree Program*

Course Requirements for the MENVE degree include 21 hours of core courses and 9 additional hours either the engineering or non-engineering electives. In place of a thesis, report or comprehensive exam students take a 2-semester design course. **Only students who have completed the undergraduate requirements of the MENVE degree can choose this option.**

#### Core Courses

ENVE 5305	Environmental System Design I
ENVE 5306	Environmental System Design II
ENVE 5315	Environmental Chemistry For Pollutant Management
CE 5363	Groundwater Hydrology
CE 5364	Groundwater Transport Phenomenon (f)
ENVE 5303	Design of Air Pollution Control Systems(s)
CE 5395	Solid and Hazardous Waste Treatment (s)

#### Engineering Electives

CE 5349	Performance-Based Engineering
CE 5366	Water Resources Management
CE 5368	Surface Water Quality Modeling
CE 5383	Bioremediation of Wastes in Soil Systems*
ENVE 5314	Membrane Treatment Processes
CE 5393	Chemodynamics

#### Non-engineering Electives

STAT 5385	Statistics for Engineers and Scientists I
ENTX 6345	Chemical Sources and Fates in Environmental Systems
ENTX 6371	Procedures and Techniques in Ecological Risk Assessment
ENTX 6385	Statistical Applications in Environmental Toxicology
GEOG 5300	Geographic Information System
RWFM 6305	Geospatial Technologies in Natural Resources Management
GEOL 5428	GIS in Natural Science and Engineering

G CH 5305	Environmental and Aqueous Chemistry
G CH 5350	Isotope Geochemistry
G CH 5405	Inorganic Geochemistry
PSS 6432	Advanced Soil Microbial Ecology
ENTX 6365	Fundamentals of Aquatic Toxicology

### **Course Requirements for the M.Sc. and Ph.D. Programs in Structural, Geotechnical and Transportation disciplines**

The courses offered in Structural, Geotechnical or Transportation specializations are listed below. Students are advised to give priority to common courses and courses in their chosen area of specialization when registering for courses each semester.

Students may also register for courses not listed below with the approval of the departmental graduate advisor. Those students engaged in MS thesis or doctoral dissertation research should seek guidance from their faculty research advisor regarding the choice of courses. In these instances, the graduate advisor will follow recommendations from the students' faculty research advisor.

1. **Master's (non-thesis) degree (Course only option):** The students pursuing Master's (non-thesis) degree: Course only option is required to complete a total of 30 credits of graduate level coursework.
2. **Master's (non-thesis) degree (Report option):** The students pursuing Master's (non-thesis) degree: Report option are required to complete a total of 30 credits of graduate level coursework and CE 6330: M.S. Report.
3. **Master's (thesis) degree:** The students pursuing Master's (thesis) degree are required to complete a total of 24 credits of graduate level coursework and 6 hours of CE 6000-Master's thesis.
4. **Doctoral degree:** The students pursuing Ph.D. degree are required to complete a total of 60 credits of graduate level coursework and 12 hours of CE 8000-Doctoral dissertation.

#### **Courses Common to all three Areas of Specialization:**

CE 5310	Numerical Methods in Engineering (or ME 5301)
CE 5318	Finite Element Methods in Continuum Mechanics (or ME 5345)
CE 5315	Probabilistic Methods for Civil Engineers
CE 5319	Machine Learning for Civil Engineers

#### **I. Courses in Structural Engineering Specialization**

CE 5341	Structural Reliability
CE 5346	Structural Dynamics I
CE 5340	Advanced Structural Analysis I
CE 5342	Advanced Design of Steel Structures [pre-req. CE4342 or CE5344]
CE 5343	Advanced Reinforced Concrete Design
CE 5344	Design of Steel Structures
CE 5347	Structural Dynamics II
CE 5349	Performance Based Engineering

#### **II. Courses in Geotechnical Engineering Specialization**

CE 5321	Advanced Soil Engineering I
CE 5322	Site Characterization
CE 5323	Advanced Foundation Engineering I (Shallow Foundations)
CE 5324	Geotechnical Practice in Expansive Soils
CE 5325	Advanced Foundation Engineering II (Deep Foundations)
CE 5326	Stability Analysis and Design of Slopes and Embankments
CE 5328	Design and Analysis of Earth Retaining Structures

### **III. Courses in Transportation Engineering Specialization**

CE 5351	Advanced Pavement Materials
CE 5352	Flexible Pavement Systems
CE 5354	Advanced Concrete Materials
CE 5355	Rigid Pavement Design
CE 5356	Sustainable Material Systems and Engineering Design
CE 5371	Advanced Geometric Design of Highways
CE 5372	Advanced Traffic Engineering I (Highway Capacity Analysis)
CE 5373	Advanced Traffic Engineering II (Traffic Flow Theory and Control)
CE 5331	Transportation Planning
CE 5331	Advanced Transportation Engineering Models
CE 5331	Advanced Transportation Planning and Network Design Fundamentals

### **IV. Courses in Construction Engineering Specialization**

CONE 5302	Construction Safety and Risk Management
CONE 5304	Sustainable Building Design and Construction
CONE 5320	Construction Cost Estimating
CONE 5322	Construction Management
CONE 5332	BIM and 4D Modeling

#### **Research Courses**

CE 6000	Master's Thesis
CE 6330	Master's report (sign up for report the last semester before graduation)
CE 7000	Research
CE 8000	Doctoral Dissertation

### **Construction Engineering Discipline**

This section describes the graduate course curriculum within the construction engineering discipline. It also provides course completion requirements for students pursuing graduate degrees in this specialty.

All students pursuing MSCE degrees are required to complete the four construction engineering core courses. Those pursuing the MSCE Degree (thesis Option) must complete a minimum of two additional courses from the following list of elective courses in construction engineering. Similarly, those pursuing the MSCE (non-thesis) degree must complete a minimum of three additional courses from elective construction engineering courses. The remaining courses may be selected from other elective courses.

All students pursuing doctoral degrees in construction engineering are expected to complete all eight construction engineering graduate courses (both core and elective courses). The remaining courses may be selected from the list of other elective courses.



The students may include courses other than those listed below in their degree plans with the approval from the students' research advisor or the departmental graduate advisor.

In the list below, the following abbreviations appear in parentheses.

f = offered in fall semester

s = offered in spring semester

ss = offered in summer session

[r] = rotating, non-annual course

[course] = prerequisite

### **Construction Engineering Core Courses**

CONE 5302 Construction Safety and Risk Management [f]

CONE 5320 Construction Cost Estimating and Control [f]

CONE 5322 Construction Management [s]

CONE 5332 BIM and 4D Modeling [s]

### **Construction Engineering Elective Courses**

CONE 5031 Independent Study of Construction [r] [No more than 6 hours allowed for masters]

CONE 5304 Sustainable Building Design and Construction [r]

CONE 5314 Masonry Design and Construction [r]

CONE 5331 Special Topics in Construction Engineering [r]

### **Other Suggested Electives**

CE 5310 Numerical Methods in Engineering (or ME 5301) [f]

IE 5307 Loss Assessment and Control [s]

ARCH 5334 Advanced Studies in Construction Technology [r]

ISQS 5331. Information Technology and Operations Management [r]

MGT 5372 Leadership and Ethics [r]

BA 5321 Negotiation and Business Law

LARC 5314 Landscape Architecture Grading and Drainage [f]

### **Research Courses**

CE 6000 Master's Thesis

CE 6330 Master's report (sign up for report the last semester before graduation)

CE 7000 Research

CE 8000 Doctoral Dissertation

### **Timeline for Completion of Requirements for the M.S. and Ph.D. Degrees**

The following discussion lists the explicit requirements for the MSCE and the Ph.D. degrees. Note that a checklist for each degree can be found in a later section of this Handbook. The student and their Graduate Advisor or Research Advisor should each maintain a copy of this checklist in order to ascertain the progress the student is making toward their degree. Also, the student should consult the Graduate Catalog for the year entering the program to determine the Graduate School requirements that must be met to complete their degree.

<b>Master's Timeline-Thesis Option</b>	
<b>Do the following:</b>	<b>By the Following Deadline:</b>
Choose the student's Research Advisor and at least one other faculty member to be on the student's advisory committee	During two months of your first long semester
Complete a research project as supervised by the student's Research Advisor, write up the student's results in a thesis, which follows Graduate School guidelines.	Whenever completed and then undergo and submit the required number of corrected copies of the student's thesis to the Graduate School according to the guidelines set by them each semester.

### **Final Examination for Master's Students**

#### **A. Final Oral Examination for MSCE Degree with Thesis**

The Final Oral Examination consists of an oral presentation, in seminar format, of the student's research results, followed immediately by an oral examination session in which the committee members ask the student questions about their research project and related subjects. The presentation for the MSCE degree is open to the public; typically, it is made to their committee. The defense of the thesis is normally closed to the public and will consist of questioning of the candidate by the committee on the material in the thesis document. The student must present copies of the student's thesis to their committee at least a week before the oral examination. Following the oral examination, the student's committee will decide if the student has passed the examination or not, and they will recommend changes in the thesis based on their review. When the committee has decided that the student has passed the examination and they have corrected the thesis according to their instructions, the student must prepare a final copy of their thesis and submit it to the Graduate School for approval. It is important that the student pay close attention to the deadlines and thesis format requirements set by the Graduate School when completing their MSCE degree requirements.

The student who is arranging for the defense of their thesis must follow the dates set by the Graduate School in the Academic Calendar if the student is to receive their degree in the semester that the student plans to complete their graduate program. Failure to follow the Graduate School's guidelines will result in addition fees associated with the requirement for continued enrollment until the degree is granted. It has been Departmental policy to require the student to enroll in three hours of CE 6000 if the thesis has not been reviewed by the committee members before the semester ends, enroll for 1 hour of CE 6000 if all work has been completed before the first last class day of the previous semester. As soon as a date and time has been arranged with the committee members for the student's Final Oral Examination, the student should reserve the room for the defense through the Departmental Secretary at the front desk. The title, as well as a copy of an abstract, should be posted on departmental bulletin boards at least a week before the presentation date.

#### **Timelines for Ph.D. in CE**

<b>Actions</b>	<b>Completed by Deadline</b>
Choose research advisor.	By the end of the first semester
Choose at least 2 but no more than 4 other faculty members to be on the student's advisory	By the end of the first year

committee.  Fill out, obtain signatures on, and submit “Program for the Doctor Degree” to the Graduate School.	
Submit a written report to the committee on subject related to the student’s dissertation topic and meet with committee to deliver an oral presentation on the student’s progress.	Timing at the discretion of the advisor and the student’s committee but typically before the end of the student’s second year.  <i>Refer to Guidelines for Progress Report.</i>
Fill out, obtain signatures on, and submit “Program for the Doctor Degree” to the Graduate School.	By the beginning of the student’s second year
Successfully complete a qualifying exam (oral + written)	By the end of the third semester for students entering the Ph.D. program with a M.S. in Civil or Environmental Engineering. <sup>1</sup>  By the end the fourth semester for students entering the Ph.D. program with a B.S. degree.  <i>Refer to WCOE OP 40.20.</i> <i>Refer to Guidelines for Ph.D. Qualifying Exam.</i>
Be admitted into candidacy for the doctoral degree.	The research advisor will submit the student’s name for candidacy after his/her successful completion of the qualifying exam.
Submit a written original research proposal (RP) to the student’s committee, deliver an oral presentation on the proposal to the committee, and successfully defend it.	By the end of the 3 <sup>rd</sup> year of graduate studies and at least one year prior to the dissertation defense.  <i>Refer to Guidelines for Research Proposal.</i>
Complete a formal draft of dissertation that follows Graduate School guidelines, undergo oral defense, which must be announced in accordance to Graduate School guidelines, submit corrected dissertation to the Graduate School.	Within 4 years of admission to candidacy  <i>Refer to Publication Requirements</i>

<sup>1</sup>Students entering with a M.S. in a field other than Civil or Environmental Engineering may take longer with permission of their advisor.

#### **B. Final Exam for the Courses Only Master’s Program Students**

Students in the last semester of their program will petition the Graduate Advisor for their division to prepare a comprehensive exam over courses in their curriculum. These exams must be completed at least two days before the Graduate School’s deadline for the Final Day for Master’s Candidates to Submit Comprehensive Exam Reports. The Graduate Advisor will ask two or three professors in the division who have had the student in core courses to prepare questions for the exam. This exam can consist of written or oral questions that the professor

will evaluate. Each professor can set the requirements for their portion of the exam, whether it is timed or not, open book or closed book, and so forth. The Graduate Advisor will then receive the evaluations from the faculty after the exams have been graded to determine whether the student has successfully completed the exam or needs to be reevaluated through further questioning by one or more of the examiners.

### **C. Final Exam for Non-Thesis Master's Program Students**

The Final Oral Examination for students doing the Report or Internship option will consist of an oral presentation, in seminar format, of the student's research results or internship project, followed immediately by an oral examination session in which the committee members ask the student questions about their presentation and related subjects. The presentation for the MSCE degree is open to the public; typically, it is made to their committee. The defense of the presentation is closed to the public and will consist of questioning of the candidate by the committee on the material in their document presented. The student must present copies of their report to their committee at least a week before the oral examination. Following the oral examination, the student's committee will decide if the student has passed the examination or not, and they will recommend changes in the report based on their review. When the committee has decided that the student has passed the examination and they have corrected the report according to their instructions, a report of the exam results will be submitted to the Graduate School for approval. It is important that the student pay close attention to the deadlines set by the Graduate School when completing their MSCE degree requirements.

### **Final Oral Examination for Ph.D. Degree**

The Final Oral Examination must be announced via a formal announcement that follows format guidelines established by the Graduate School. The examination may not be administered until at least three weeks after the announcement has been submitted to the Graduate School. Copies of this announcement will be mailed throughout the campus, and the student will select a graduate school dean's representative to serve as an additional member of the student's committee to participate in the final oral examination and report to the Graduate School about the examination. The student's Faculty Advisor must approve the first written draft of the dissertation before the oral examination is scheduled.

The final oral examination for the Ph.D. degree will consist of a public presentation of the student's research results in the form of a 20-50-minute seminar. This presentation will be followed by a period of questions from the public audience, then a closed-door oral examination by their advisory committee. The student must present a copy of their dissertation to each member of the committee (including the dean's representative) at least a week before the date of their final examination. Following the oral examination, the committee will decide if the student has passed the examination or not, and they will recommend changes in the dissertation based on their review. When the committee has decided that the student has passed the examination and has corrected the dissertation according to their instructions, the student must prepare a final copy of the dissertation and submit it to the Graduate School for approval. The Faculty Advisor will notify the Graduate School at this time that the student has successfully completed the final oral examination. It is important that the student pay close attention to the deadlines and dissertation format requirements set by the Graduate School when completing Ph.D. degree requirements. Failure to do so will result in additional fees and tuition costs similar to those outlined for the Master's Student in the previous section.

As soon as a date/time has been arranged with the committee members for the Final Examination, the student needs to reserve a room for the dissertation defense through the Departmental Secretary at the front desk. To clarify the process by which a doctoral student obtains preliminary approval of their dissertation from their doctoral committee members prior to the scheduling of their final oral examination with the Graduate School, the following procedure is established.

- 1) The committee members will provide an evaluation of the dissertation within seven days of its acceptance from the candidate for review.
- 2) If a committee member feels that major changes are required, this will be communicated to the candidate within the seven-day period. Such major changes will have to be made by the student and the committee members will have another seven days to evaluate the revised dissertation once they accept it for review.
- 3) If only minor changes are required, the committee member will give preliminary approval to the dissertation. (Note that some modifications of the dissertation will undoubtedly still be required after the dissertation defense. However, these will be of a relatively minor nature and will not involve, for example, the rewriting of an entire chapter.)
- 4) If the candidate receives no communication from a committee member by the end of the seven-day period, it will be assumed that committee member has given preliminary approval to the dissertation.

## APPENDICES

### Appendix A: Leveling Requirement

Leveling requirements for students entering the Master's program without an undergraduate degree in Civil Engineering. Transcripts of other engineering degrees will be evaluated to determine which leveling courses will be needed for candidates entering the two classes of the departmental graduate programs.

#### Environmental Engineering/Water Resources Engineering

**Note:** The Graduate Advisor will evaluate the student's transcript and make decisions about which leveling courses; the student will be required to take. Undergraduate courses will not count toward the graduate degree. There are graduate course numbers for both CE 3354 and CE 3372.

<b>MATH</b>	MATH 1451 - Calculus I MATH 1452 - Calculus II MATH 2450 - Calculus III MATH 3342 - Mathematical Statistics for Engineers and Scientists MATH 3350 – Higher Math for Engineers and Scientists I
<b>CHEMISTRY</b>	CHEM 1307 - Principles of Chemistry I CHEM 1307 - Principles of Chemistry I Lab CHEM 1308 - Principles of Chemistry II CHEM 1308 - Principles of Chemistry II Lab
<b>PHYSICS</b>	PHYS 1408 - Principles of Physics I
<b>COMPUTER SCIENCE</b>	Engr 1330 - Computational Thinking <sup>c</sup>
<b>CIVIL ENGINEERING</b>	CE 2301 - Statics CE 3303 - Mechanics of Solids CE 3305 - Mechanics of Fluids CE 3354 - Engineering Hydrology

<sup>c</sup> May be waived if student can demonstrate proficiency in computer-based problem-solving capacity

#### STRUCTURES/GEOTECHNICAL/TRANSPORTATION

The Departmental Advisor for these MS/Ph.D programs reserves the right to waive or substitute courses as required.

<u>Mathematics</u>	Math 1451: Calculus I Math 1452: Calculus II Math 2450: Calculus III Math 3350: Higher Math for Engineers and Scientists I
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### Chemistry

Chem 1307: Principles of Chem I  
Chem 1107: Prin. of Chem I Lab  
Chem 1308: Principles of Chem II  
Chem 1108: Prin. of Chem II Lab

### Physics

Phys 1408: Principles of Physics I

### Civil Engineering

CE 2301: Statics  
CE 3121: Geotechnical Engr. Lab  
CE 3303: Mechanics of Solids  
CE 3321: Intro to Geotechnical Engr.  
CE 3341: Principles of Structural Design  
CE 3440: Structural Analysis I

### Computer Science

3-hour course in computer science

## **CONSTRUCTING ENGINEERING AND MANAGEMENT**

### **MATH**

MATH 1451 [MATH 2413]: Calculus I  
MATH 1452 [MATH 2414]: Calculus II (Prereq. MATH 1451)  
MATH 2450 [MATH 2415]: Calculus III (Prereq. MATH 1452/1352)  
MATH 3342: Statistics for Engineers & Scientists (Prereq. MATH 2450/Departmental consent)  
(**Alternatively** IE 3341 or MATH 4342)<sup>a</sup>  
MATH 3350: Higher Mathematics for Engineers & Scientists (Differential Equations) (Prereq. MATH 1452/Departmental Consent)

### **PHYSICS**

PHYS 1408 [PHYS2325/2125/2425] – Principles of Physics I) (Prereq. MATH 1451/2323)

### **CIVIL ENGINEERING**

CE 2301: Statics (Prereq. MATH 1452, PHYS 1408 **May be taken concurrently**)  
CE 3303: Mechanics of Solids (Prereq. CE 2301 or ME 2301)  
CE 3305: Mechanics of Fluids (Prereq. CE 2301 or ME 2301)

### **Recommended Courses (Check prerequisites)**

CE 2101: Materials for Constructed Facilities  
CE 3321: Introduction to Geotechnical Engineering  
CE 3121: Geotechnical Engineering Laboratory  
CONE 3302: MEP Systems & Design for Construction  
CONE 4324: Construction Contracts and Specifications  
CE 3440: Structural Analysis I  
CE 3341: Principles of Structural Design  
CE 3361 Transportation Engineering

<sup>a</sup> May be waived if student has passed a course in statistics

## Appendix B: New Graduate Student Information:

1. Faculty will evaluate the student's work ethic by what is done in the classroom. This is especially important for incoming students since often their reputation for class work is made in the first semester. Faculty will notice the student's efforts in class, the student's homework, and the student's grades. Cheating on tests, copying of homework, plagiarism (the copying of another's work without adequate referencing of the author) is not conducive to gaining favor in the eyes of the faculty.
2. Plagiarism is a problem that graduate students continue to practice semester after semester; do not fall prey to this practice. Plagiarism is defined in OP 34.12.3.b as

"Plagiarism" includes, but is not limited to, the appropriation of, buying, receiving as a gift, or obtaining by any means material that is attributable in whole or in part to another source, including words, ideas, illustrations, structure, computer code, other expression and media, and presenting that material as one's own academic work being offered for credit.

Plagiarism of material in research papers or class work can really impacts the student's course grade.

**Find out how to reference a direct quote from the author that you want to include in the paper or else review the reference passage and cast the author's thoughts in the student's own words while referencing the passage to the author.**

3. The Senior Academic Counselor handles student academic affairs and is one of the student's most important contacts in the department. He is available to advise and help with academic problems concerning transcripts, schedules, scholarships, and so forth.
4. Buy books for classes; these are the tools for the course. Don't expect classmates to allow you to copy the pages of their text since zeroxing the textbook breaks the spine of most books.
5. Each semester, sign-up for next semester's classes occur approximately 4 weeks before the end of the semester (sign up time for classes are in November and April). **Students need to see the graduate advisor to get approval of the class schedule** so that the academic hold on the class sign-up privileges can be lifted. The Graduate Advisor will have a signup-sheet with set times available outside Mrs. Andrews office so that a suitable time can be selected. This needs to be done in a timely manner before the end of the semester because the Graduate Advisor may not be available during the breaks or that much during the summer. Nobody else can help you on this.
6. You will need to sign up for 9 class hours if on scholarship. Scholarships will be ended when you receive a research assistantship (with benefits, hourly workers will keep the scholarship). Scholarships will be awarded on a competitive basis and you must obtain a cumulative 3.5 GPA to be awarded a scholarship if not granted a scholarship upon entrance to the program and then maintain a 3.5 GPA to continue to receive a scholarship at the start of the next scholarship year. The scholarship year runs from September thru August and during that time only in-state tuition will be charged to the student.
7. **Before the end of the student's first semester at Texas Tech, we need to get the student's program of courses approved.** This is a new requirement of the graduate school. We can always change the courses on the program. All that is needed is a filled out short form that shows that you are taking this course instead of the one on the previously approved program and then get my signature on the form.
8. Students who accept research assistantships at any time will be responsible to their faculty employers for producing the deliverables such as an acceptable thesis and information for a publication or a finished paper suitable for submission to a professional journal as the case may be in a timely manner. Research projects have deadlines for submitting the deliverables such as technical reports or publications; submission of the final reports by the date agreed upon is often contingent on the faculty receiving further research funds from that agency. You are being paid for the assigned work and should be able to finish the work in the time frame you and the Research Advisor agree to.
9. If you do not have an oral defense scheduled for the thesis or master's report in the semester set down for graduation, you will have to enroll for 3 hours of thesis work, CE 6000, in each semester until



graduation. This will require that you finish the defense of the thesis or report by the date set by the Graduate School for submission of the results of the oral defense. Ideally, you should graduate the last month that you are being paid. The graduate advisor will not sign a practical work release form unless you and the student's Research Advisor confirm that graduation will occur in the semester entered on the form. This becomes a problem that must then be resolved at great cost with International Office (IO) personnel.