11.6.4 DEPARTMENT OF CIVIL, CONSTRUCTION AND ENVIRONMENTAL ENGINEERING (CCEE)
Head: Professor Kenneth Fridley, Office: 262 H. M. Comer Hall

The department offers programs leading to the master of science in civil engineering, master of science in engineering (environmental engineering), and doctor of philosophy degrees in civil engineering. Research programs in the department include urban environmental quality and water resources; management and safety of transportation systems; infrastructure development, assessment, renewal, and protection; and construction engineering and management. Laboratory facilities are provided for graduate research and instruction in these and other areas.

Admission Requirements

The requirements for admission to the Graduate School are detailed in section 4.4 of this catalog. The Department of Civil, Construction and Environmental Engineering also embraces the requirements of the College of Engineering, summarized as follows:

1. An applicant must have earned a baccalaureate degree from an institution accredited by the Engineering Accreditation Council (EAC) of ABET, Inc. and have a grade point average of at least 3.0 on a 4.0 scale, or at least 3.0 for the last 60 hours completed.

2. Applicants who are not graduates of EAC/ABET-accredited programs must have Graduate Record Examination general test scores of 1000 or higher and grade point averages of 3.0 or higher on a 4.0 scale.

Degree Requirements

Doctor of Philosophy Degree Requirements

A total of 72 hours is required for the degree, including a minimum of 48 hours of coursework beyond the baccalaureate and 24 hours of dissertation research. A maximum of 24 hours of approved transfer credit is allowed, with approval of the Graduate School on the form for Request for Transfer of Graduate Credit.

The student’s advisor and supervisory committee will work with the student to define an appropriate plan of study that meets all degree requirements, including any prerequisite or preparatory work and a core set of courses as required and specified by each specialty area. After approval by the department the PhD Plan of Study is submitted to the Graduate School for final approval. All doctoral students must have a completed Plan of Study approved by the Graduate School no later than the semester during which the student will complete 30 semester hours of UA and/or transfer credit for the doctoral degree. Otherwise, a "hold" may be placed on future registration.

Students are required to pass a preliminary examination that includes both written and oral components, a proposal defense, and a final dissertation defense administered by the student’s supervisory committee.

After passing the comprehensive (preliminary) examination, the student should complete and submit an Admission to Candidacy for the Doctoral Degree to the department for approval. A department-approved candidacy form will be forwarded to the Graduate School.
for final approval.

For additional information about the Graduate School's general requirements for advanced degrees see the online Graduate Catalog (Sec. 4.11.3) for details.

4.11.3 DOCTORAL DEGREES

The University offers several types of doctorates, each of which is described below.

The doctor of philosophy (PhD) degree is regarded as the researcher's degree. Program requirements include the acquisition of special skills for conducting independent, scholarly research of publishable quality. Requirements traditionally include a working knowledge of one or more foreign languages, but currently a number of foreign-language alternatives have been approved by departments. Through acquisition of these skills, PhD candidates demonstrate their potential for careers as independent, publishing scholars. Refer to departmental sections of this Catalog for details on foreign-language requirements or alternatives.

The minimum period in which a doctoral degree can be earned is 3 full academic years of graduate study after completion of a baccalaureate degree, although in most disciplines the period is longer. Graduate teaching assistants (GTA) or graduate research assistants (GRA) whose work assignments are 10 hours per week (i.e. the equivalent of 3 semester hours) or more should expect to take more than the minimum period of 3 academic years to earn a doctoral degree. The only exception to the 3-year minimum is the practice-focused DNP.

Doctor of Philosophy Degree

The doctor of philosophy degree is granted on the basis of scholarly proficiency, distinctive achievement in a special field, and capacity for independent, original investigation. The first two criteria are tested in coursework and a comprehensive examination, the last in a dissertation in which the student must present clearly and effectively the results of substantial research. A combination of these accomplishments, rather than the mere accumulation of residence and course credits, is the essential consideration in awarding the PhD degree. The PhD differs from the EdD in a number of ways, including the fact that the PhD Plan of Study and comprehensive examination demonstrate a higher-level research focus, and there is a greater number of dissertation hours and higher level of complexity and independent thought in a PhD-level dissertation.

Field of specialization

A defined field of specialization is required of all candidates for the doctor of philosophy degree. A minimum of 48 semester hours of non-dissertation course credit is required. Candidates should consult their departments or the appropriate section of this Catalog for additional requirements. The doctoral course as a whole must be unified, and all its parts must contribute to an organized program of study and research. In addition, a student must
complete a minimum of **24 hours of dissertation research**.

**Research skill/language requirements**

There is no University-wide foreign language/research skill requirement for doctoral students; each college or department offering the PhD degree may set its own requirements. This policy reaffirms the importance of research skills and foreign languages in the highest academic degree granted by American universities, but it also recognizes that the departments offering the degrees are in the best position to determine the number and nature of such requirements in the interests of their students. For further information about PhD foreign language/research skill requirements, students may contact their departments or the Graduate School office (205-348-5921).

**Interdisciplinary Studies**

There is a PhD degree program in interdisciplinary studies, and it is administered by the Graduate School. In addition to the general requirements for the PhD degree, the program of study and the supervisory committee for the prospective interdisciplinary studies degree candidate must be approved by the dean of the Graduate School before the student is admitted to the program. See **Interdisciplinary Studies (IDS)** at the Graduate School's website for information on prerequisites, admission procedures, course of study and other aspects of IDS programs.

**Admission to Doctoral Degree Programs**

Admission to any doctoral program is limited to students whose scholastic records show distinct promise of success in doctoral study. Admission to the Graduate School and the earning of a master's degree from The University of Alabama do not guarantee acceptance into a doctoral program. A student obtaining the master's degree at the University must submit to the dean of the Graduate School written permission from the department head or division dean to be eligible to work toward the doctoral degree. Students in doubt about their acceptance into doctoral programs should consult with departmental advisors and the Graduate School, which makes the final decision about admission. A department may terminate a student's doctoral admission if there is documented unsatisfactory academic or other progress toward completion of the degree.

**Residency Requirements**

The intent of the residency requirement is to ensure that doctoral students contribute to and benefit from the complete spectrum of educational, professional, and enrichment opportunities provided at The University of Alabama. Though not all-inclusive, the list below shows some of the primary reasons why best practices in U.S. graduate education and the graduate faculty on the UA Graduate Council have determined that a substantial residency experience must be included in a doctoral program:

- provide significant interaction between the student and the various UA graduate
faculty in the student's discipline;
- provide ample opportunities for student exposure to and engagement with cognate disciplines and research scholars working in those disciplines;
- provide significant opportunities for face-to-face peer interaction between and among graduate students in the student's discipline and in other disciplines; and
- provide the opportunity for a mentor-apprentice relationship between the student and graduate faculty, as well as adequate time for in-depth and direct faculty evaluation of the student.

There are two possible methods for meeting doctoral residency. The traditional method is the method of choice by the majority of UA departments. There also is an alternative method available, but only for doctoral students in specific departments or programs that have submitted a proposal for an alternative and had the faculty of the Graduate Council evaluate and approve the alternative. (Those departments and programs are in a bulleted list in the last paragraph of this section of the Catalog).

**Traditional Doctoral Residency**

The residency requirement is that the student must spend an academic year in continuous residence on the campus of The University of Alabama as a full-time student in the Graduate School. Any one of the following 4 methods can be used to meet traditional residency:

- a full-time fall semester plus full-time enrollment the next spring;
- a full-time summer (consisting of 9 or more graduate hours in the 13 weeks from Interim through the end of Summer II) plus the following full-time fall semester;
- a full-time spring semester plus the next full-time summer semester as defined above; or
- a full-time spring semester plus the following full-time fall semester.

To meet this requirement, only graduate-level, non-dissertation coursework can be applied. Dissertation or thesis research cannot be used. The Graduate Council, consisting of representatives of the UA graduate faculty, has established a policy that distance learning courses delivered online or by any other distance learning format may not be used to satisfy the traditional doctoral residency requirement.

As mentioned earlier, the majority of UA departments follow traditional residency as described above and do not permit any distance learning hours to be used to meet residency.

**Alternative Doctoral Residency**

For many years there has been an alternative for EdD students at the Gadsden Center. See the College of Education section of this Catalog for details.

For other doctoral students, in 2008 the Graduate School worked closely with the Graduate Council so that a department could apply for approval of an **Alternative Doctoral Residency (ADR)** option for its doctoral students. There is a brief format (available from the Graduate School) for departments to follow in proposing an ADR option. It includes such
things as demonstrating that the proposed ADR will assure that ADR doctoral students meet 5 "value constructs" that underpin doctoral education.

When a department or program receives Graduate Council approval to offer an ADR, the ADR provides a second possible way for students in that department or program to meet the residency requirement. The approved ADR does not replace the traditional residency option, which is still available to students who choose it. Whether the student meets doctoral residency through the traditional method or an approved ADR method, dissertation (699) hours may not be used; only non-dissertation graduate hours may be used.

In the specific departments or programs that have received Graduate Council approval to offer an ADR, students choosing the ADR option may be able to include up to a certain number of distance learning hours. The specific number is what was approved in the ADR proposal for that particular department. Contact the department for details. The following have been approved to offer an ADR:

- PhD in Counselor Education
- PhD in Aerospace Engineering and Mechanics
- PhD in Curriculum and Instruction
- PhD in Human Performance
- PhD in Instructional Leadership
- Instructional Technology Concentration in the PhD Program in Instructional Leadership

**Graduate Credit**
A student must be admitted to the Graduate School and must register as a graduate student in order to receive graduate credit. Approval for graduate registration must be obtained from program advisors prior to registration.

**Graduate Credit for Noncredit Experiences**
All course credit used toward a UA graduate degree must be taught at the graduate level. No graduate credit may be earned by correspondence study or for experiential learning not conducted under the direct supervision of graduate faculty of The University of Alabama. The UA does not offer graduate credit for noncredit workshops, seminars, continuing education experiences, professional development, internships, work/life experience, and so forth.

**Transfer of Credit**
Acceptable graduate credit that was earned in a **regionally accredited institution** in which the student was enrolled in that institution's graduate school may be considered for transfer and application to the requirements for a doctoral degree if approved by the department and the Graduate School. Only credit that was earned during the six-year period (18 fall, spring, and summer semesters) preceding admission to the doctoral program may be considered for transfer.

Revalidation (recertification) of credits more than 18 semesters old at the time of admission to a doctoral program is not an option.
Consideration of credit does not guarantee its transfer. Evaluation of credit for transfer will not be made until after the student has enrolled in the Graduate School of The University of Alabama. Credit will not be accepted from any institution at which the student failed to achieve an overall "B" average on all graduate work attempted. Only courses in which a student earned a "B" grade or better may be transferred.

A student completes a Request for Transfer of Graduate Credit and submits it to the Graduate School. The student also must ensure that the Graduate School has an official (not faxed or copied) transcript of the credit involved. Students should be aware that planning to transfer a course in the final semester typically will delay commencement by a semester if the UA graduate registrar does not receive official notice of completion of the course by at least 3-4 weeks prior to commencement. It is best to apply for official transfer of credit in the student's first semester of doctoral enrollment; otherwise, the student and advisor will be unsure about the number of course hours needed when submitting the required Plan of Study.

With the approval of the student's department and the dean of the Graduate School, up to one-half of the required coursework (exclusive of dissertation research hours) for a doctoral degree may be transferred from another institution if approved by the department and the graduate school. Please note that some departments allow fewer than 24 hours of transfer credit, so be sure to check with your department's graduate coordinator regarding your department's transfer policy.

In some cases, foreign educational credentials may not meet the Graduate School's criteria for transfer of credit. It may be necessary for students in this situation to secure an evaluation of their credentials from World Education Services Inc. (WES), an external foreign credential evaluation service.

Time Limits

All requirements for the doctoral degree must be completed within seven years (21 fall, spring, and summer semesters) following admission to the doctoral program, with the following specific exceptions approved by the Graduate Council: psychology, modern languages and classics, English and political science (eight years if entering the doctoral program with a baccalaureate, not master's, degree), and eight years from the time of first registration in PhD courses for students dually enrolled in the PhD program in political science and the JD program.

Previous graduate credit may be applied to the doctoral degree if the credit was earned during the six-year period (not seven years) prior to admission to the doctoral program. Such credit must be identified clearly on the Outline of PhD Program (Plan of Study) and requires Graduate School approval. Only those students graduating within the time limit for their doctoral program may apply previous graduate credit to the doctoral degree if the credit was earned during the six-year period prior to admission to the doctoral program. Revalidation (recertification) of credits more than 18 semesters old at the time of admission to a doctoral program is not an option.
Time Limits Extension Request

Only under compelling circumstances beyond the student’s control a student may petition for a one-semester extension to the seven-year time limit (or eight-year time limit for the selected programs noted above). The Graduate Council approved the following steps to request an extension:

- To begin the process, the student petitions the department head. In the petition the student (a) describes the compelling circumstances, (b) briefly describes the current status of the dissertation, then (c) includes a timeline showing each important remaining step in the completion of the dissertation. The last step and date in the timeline are submission of the successfully defended dissertation on or before the published final date for submission of dissertations for the requested extension semester.
- If the department head supports the petition, it is forwarded to the college dean.
- If the college dean supports the petition, it is sent to the graduate dean.
- If the graduate dean or his designee approves the extension, it will not require the student to validate any out-of-date UA or transfer courses previously approved for the plan of study.

If a student fails to complete all degree requirements within the time limit for the student’s doctoral program or within a one-semester extension approved as noted above, the student will be dropped (suspended) from the doctoral program. To complete a doctoral degree, the student would have to reapply for admission and be admitted by the department and Graduate School. Graduate Council policies do not provide the option to revalidate (recertify) either UA or transfer courses completed more than six years prior to the date of admission. Thus, a readmitted student would be able to apply to the new admission only those courses approved by the department and Graduate School and completed within the 6 years (18 fall, spring, and summer semesters) prior to the new admission.

Repeating Courses When Given an Extension

When requests are made for extensions of the doctoral time limits, and it is deemed that an out-of-date course is integral to the degree program, the college dean may request permission of the Graduate School for such a course to be repeated. In this case, both grades are used in calculation of the GPA.

Plan of Study

Early in the graduate program, each student must confer with the appropriate departmental adviser or major professor to select courses, discuss when and by which method the doctoral residency requirement will be completed, discuss research interests, and so forth. Then a Plan of Study must be prepared and submitted to the Graduate School.

The PhD Plan of Study and DMA Plan of Study are available at the Graduate School
website. The Plan of Study for other doctoral programs (EdD, DNP) are available from the student’s department, college or school. All doctoral students must have a completed Plan of Study approved by the Graduate School no later than the semester during which the student will complete 30 semester hours of UA and/or transfer credit toward the doctoral degree. Otherwise, a “hold” may be placed on future registrations.

An amended Plan of Study (if needed) must be submitted to the Graduate School when the student submits the form for Admission to Candidacy for Doctoral Degree.

**Preliminary or Comprehensive Examination**

A preliminary or comprehensive qualifying examination is required of all doctoral candidates. This examination is given after

- any foreign language/research skill requirements are met (PhD students only);
- two full years of graduate study are completed; and
- the supervisory committee deems the student to have adequate preparation in the major and minor fields of study.

The examination is conducted by the student’s supervisory committee or other committee established in the program area. Whereas one of the purposes of the preliminary examination is to determine the student’s research competence to begin work on a dissertation, the examination should be completed at least nine months before the degree is to be awarded. A student may take the final oral or written examination only twice. Failing the examination twice results in dismissal from the degree program and the Graduate School.

**Admission to Candidacy**

The requirements for advancing to candidacy include passing the qualifying (major or preliminary) examination; completion of all coursework as listed on the approved program of study; receiving departmental approval of the dissertation subject (although some departments require the defense of a dissertation proposal and/or writing one or more preliminary sections of the dissertation as well); and having the committee recommend the student for Admission to Candidacy for the Doctoral Degree. The completed candidacy form is submitted to the Graduate School well in advance of the final semester.

**Continuous Dissertation or Document Registration**

Once a student has met the requirements for admission to candidacy, received approval for the dissertation research proposal, or initiated enrollment in 699 (dissertation research for a doctoral degree), the student must pursue completion of the dissertation without interruption by enrolling each fall and spring semester of the academic year for at least 3 hours of dissertation research. Summer enrollment for 699 Dissertation Research is expected if the student is working on the dissertation and using any University facilities or resources, including faculty time, but the only time summer registration is required for dissertation
research (3 hours minimum) is when a doctoral student is graduating in August or defending the dissertation during the summer semester. This is true whether or not the student has formally submitted an Application for Admission to Candidacy.

Each PhD student must have completed a minimum of 24 hours of such dissertation work upon completion of the degree. The amount of dissertation research for which a student enrolls in any given semester should be commensurate with the progress a student is expected to make on the dissertation, as well as reflective of the extent to which University facilities and faculty time are invested in the proposed activities.

**Dissertation Proposal**

The dissertation proposal aims to show the appropriateness, manageability and significance of the projected research. The student formally presents the written proposal to the dissertation committee and defends it in a meeting with the committee. The proposal normally includes an introduction giving an overview and stating the significance of the proposed research, review of the literature, and methodology. Departments determine the details of the dissertation proposal’s format with respect to such things as the length of the introduction and detail of the review of the literature.

Once the student and dissertation chair have developed a proposal, and the graduate dean has approved the dissertation committee, the student schedules the dissertation proposal meeting that includes all committee members. The student cannot propose a dissertation and have its final defense in the same semester.

**Dissertation**

A dissertation showing the ability to conduct independent research and skill in organization, writing and presentation must be prepared on a topic in the major field. It must constitute an original contribution to knowledge. Early in the process, the subject of the dissertation must be approved by the dissertation committee of the major department or division and by the dean of the Graduate School.

A dissertation committee, with the director of the dissertation as its chairperson, supervises the preparation of the dissertation. The committee shall have not fewer than five members, all of whom are appointed by the dean of the Graduate School. The graduate dean’s approval of the proposed dissertation committee is expected to be obtained before significant progress is made on the dissertation--typically just before or just after the dissertation proposal meeting. For this purpose, the student submits the form for Appointment/Change of a Doctoral Dissertation Committee.

All members of a dissertation committee must be members of the UA Graduate Faculty. The committee chair must be a full member of the Graduate Faculty, as described in the Catalog’s section on Qualifications of the Graduate Faculty. One member must be from outside the student’s major department. If the outside member is not a full or associate member of the UA Graduate Faculty (e.g., a highly qualified person from another university, a business or
industry), the graduate dean needs to appoint that member by approving Temporary Graduate Faculty status for the specific purpose of serving on the student’s dissertation committee.

The final oral dissertation defense is the culminating experience in the doctoral program. As such, all members of the dissertation committee are expected to attend and participate in real time. Virtual attendance via interactive video or teleconference is permitted for off-campus external committee members, but Tuscaloosa campus faculty should attend in person unless extraordinary circumstances dictate the need for virtual attendance.

The dissertation must comply with the regulations in *A Student Guide to Preparing Electronic Theses and Dissertations*. Graduate School deadlines, including each semester's dissertation deadline, are available at the Graduate School’s homepage.

Consult the ETD website for details of ETD submission, including information on what needs to be submitted to the Graduate School. The graduate dean must approve the dissertation before the student can be cleared for graduation.

The Catalog section on Continuous Dissertation Registration for Doctoral Students states that once a student qualifies for doctoral candidacy, the student must enroll each semester for at least 3 hours of dissertation (699) research. If certain conditions are met for the student’s final semester, the student may qualify to enroll for fewer than 3 hours of 699 dissertation research, but only in that final semester (see table below). A zero-hour or one-hour 699 registration is not permitted in any but the final semester, and only under the conditions described in the table below.

### Final-Semester Dissertation (699) Minimum Registration Hours

<table>
<thead>
<tr>
<th>When was the *completed electronic dissertation submitted to ProQuest/the Graduate School?</th>
<th>Minimum hours of 699 registration required in the final semester</th>
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</thead>
<tbody>
<tr>
<td>By 4:45 p.m. on the last-possible day for instructors to post grades for the semester before the student’s final semester (date published in the **University Academic Calendar)</td>
<td>0</td>
</tr>
<tr>
<td>After 4:45 p.m. on the last-possible day for instructors to post grades for the semester before the student’s final semester, but before 4:45 p.m. on the last-possible day to register or add a course for the student’s final semester (both dates published in the University Academic Calendar)</td>
<td>1</td>
</tr>
<tr>
<td>After 4:45 p.m. on the last-possible day to register or add a course for the student’s final semester (date published in the University Academic Calendar)</td>
<td>3</td>
</tr>
</tbody>
</table>

* "Completed” means submitted at ProQuest after being successfully defended; being
carefully edited following the defense meeting; and having the Committee Acceptance Form (CAF) signed by all committee members, department chairperson and graduate dean. At the time of ProQuest submission, the student also must submit the Survey of Earned Doctorates through the NORC website.

**The University Calendar is available at the Academics tab of the website of the University Registrar.**

**Article-Style Dissertations**

This approach is intended for doctoral students whose dissertation will consist of a number of related manuscripts or articles that represent independent research or creative activity. It is an option available only to students in certain fields in which the faculty have received Graduate Council approval from the Graduate Council. A complete list of these fields is below:

- Accountancy
- Aerospace Engineering and Mechanics
- Applied Statistics
- Biological Sciences
- Chemical Engineering
- Chemistry
- Civil Engineering
- Computer Science
- Economics
- Education (all departments)
- Electrical and Computer Engineering
- Finance
- Geological Sciences
- Health Education and Promotion
- Management
- Management Science
- Marketing
- Mechanical Engineering
- Metallurgical and Materials Engineering
- Physics
- Psychology
- Engineering

Article-style dissertations must be based upon research completed while the student is enrolled at The University of Alabama. For each article used, the student must be the first author, or equivalent, as defined by the discipline.

As with traditional dissertations, the article-style dissertation must be the student's original idea. It must be a unified work and include a sequence of articles of publishable quality around a cohesive theme, with a comprehensive review of literature demonstrating an in-depth understanding of the unifying framework.

- In article-style dissertations there will be introductory material to describe the studies, show how they are related, and explain their significance;
- connecting language to bridge each study to the next; and
- a summary making clear the importance of the studies, integrating the major findings, and discussing the implications for the overall topic.
These components do not have to be separate sections or chapters. They may be parts of the manuscripts or may be accomplished in an abstract.

All parts of both traditional and article-style dissertations must conform to the provisions set forth in *A Student Guide to Preparing Electronic Theses and Dissertations*, except when the circumstances of a specific project or discipline's style manual require deviation. Students considering the article-style approach should contact the Graduate School before beginning their work if they have questions concerning specific problems or deviations from traditional procedure.

All doctoral candidates must give members of the dissertation committee a minimum of two weeks to read the dissertation before the date of the required final oral examination.

**Electronic submission of dissertations:** August 15, 2009, is the date when electronic submission began to be required and paper submission no longer was accepted. Consult the [ETD website](#) for details of ETD submission, including information on what needs to be submitted to the Graduate School. The graduate dean must approve the dissertation before the student can be cleared for graduation.

**Protection of Human Subjects for Research**

Scientific research involving human subjects has produced substantial benefits for society, but it also has significant ethical questions. The mission of the University's Institutional Review Board (IRB) for Protection of Human Subjects is to ensure that research involving human subjects is conducted ethically. University and federal policies require that review and approval to use human subjects in research precede the research, no matter how great or small the involvement of the human subjects. In the case of dissertation research that involves the use of human subjects, the principal investigator is responsible for contacting the college Human Research Review Committee to obtain approval for the planned research. The University's IRB approval form is available at the [IRB website](#).

**Final Examinations**

When the dissertation has been completed, the candidate will be given a final oral examination by a committee of not fewer than five members, one of whom must be from outside the student's major department or, for students in the College of Education, outside the student's area (not program), and appointed by the dean of the Graduate School. This examination will focus primarily on the candidate's research work, as embodied in the dissertation, and the field in which the dissertation lies, but it may encompass the complete program for the degree. The results of the examination must be reported to the Office of the Graduate School at least six weeks before the commencement at which the degree is to be conferred.

**Application for Graduation**

Each candidate for a doctoral degree must apply for the degree through the Office of the
Graduate School no later than the "last day to register or add a course" of the semester or the first term of the summer session in which requirements for the degree are to be completed. That day is published for each semester at the website of the University Registrar. To apply for graduation, the student submits an Application for Degree to the Graduate School.

Clearing the Academic Record for Commencement

At least one week before commencement, the candidate's record must have been cleared for graduation.

Attendance at Commencement

A candidate for a doctoral degree must be present at a scheduled commencement to receive the diploma and hood, unless excused by the graduate dean.

Withholding or Withdrawing an Advanced Degree

The University of Alabama reserves the right to withhold or withdraw an advanced degree on the recommendation of the graduate faculty.

Course Descriptions

Master's students may, with permission of the department and approval by the Graduate School, receive credit for six hours of 400-level credit. No 400-level courses can be approved for application to a PhD degree, other than the maximum of 6 hours already completed as part of a master's degree. A master's student may, with approval of a petition, meet prerequisites with a combination of related coursework and experience.

CE 511 Advanced Rock Mechanics. Three hours.
Prerequisite: AEM 250.
Advanced levels of theories of rock failure, ground movement, stability analysis, and the design of underground openings; rock testing methods.

CE 515 Advanced Engineering Economics. Three hours.
Prerequisite: IE 203 or CE 366; and GES 255 or GES 400 or 500
Not open to students with credit for CE 415. Capital budgeting decision making under risk and uncertainty, utility theory, cost estimation, and design of financial control through management simulation.

CE 516 Advanced Information Systems Design. Three hours.
Prerequisite: CE 414 or equivalent.
Not open to students with credit for CE 416. Current concepts in information systems architecture and applications, including decision support systems and expert systems. Emphasis placed on expanded use of systems design methodology.

CE 517 Advanced Project Management. Three hours.
Prerequisites: IE 203 or CE 366; and GES 255
Not open to students who have credit for CE 417. This is an engineering management course
designed to introduce students to the functions of project engineers and managers. It details the processes of planning and controlling project scope, time, and cost.

**CE 518 Engineering Management.** Three hours.
Prerequisite: CE 366
Not open to students who have credit for CE 418. An introduction to management principles, and the management functions of planning, organizing, motivating, and controlling. Management of engineers in research, design, manufacturing/construction, and quality will be studied.

**CE 522 Solid and Hazardous Waste Management.** Three hours.
Prerequisite: CE 320 or B.S. degree in a compatible field.
Engineering design and regulatory requirements for the collection, storage, recycling, treatment, and disposal of solid wastes.

**CE 523 Effects and Fates of Hazardous Chemicals Released to the Environment.** Three Hours.
Prerequisites: CE 520; CE 378; & CE 425 or permission of instructor.
Chemical fate and transport in the environment. Frequency and magnitude of accidents involving hazardous material. Effects of these releases on the community.

**CE 525 Air Pollution.** (3-0) Three hours.
Prerequisite: AEM 311 or CHE 304.
Introduction to the source, characteristics, and effects of air pollution and to air pollution control technology and design.

**CE 526 Physical/Chemical Processes in Water and Wastewater Treatment.** Three hours.
Prerequisites: Graduate standing and course in differential equations; or permission of the instructor.
Discussion of fundamentals of physical/chemical processes, as they relate to environmental quality and water and wastewater treatment. Reactor principle, chemical processes, and particle removal process will be discussed from fundamental theory.

**CE 527 Storm Water Management.** Three hours.
Prerequisites: CE 378 and CE 475 or permission of instructor.
Quality and quantity of urban storm water. Receiving water problems and sources of pollutants. Runoff quality and quantity characteristics. Selection and design of controls; regulations.

**CE 529 Environmental Systems Analysis** Three hours.
Prerequisites: CE 320 and CE 424.
Advanced examination of tertiary, physical, and chemical unit operations used in water and wastewater systems.

**CE 532 Advanced Structural Analysis.** Three hours.
Prerequisite: CE 331.
Introduction to the matrix-displacement method of analysis for framed structures, including computer implementation of analysis. An introduction to finite-element analysis is also included.

**CE 534 Advanced Structural Mechanics.** Three hours.
Prerequisite: CE 331 or graduate standing
Introduction to advances structural mechanics topics, including elementary elasticity, elementary beam theories, beams on elastic foundations, energy methods, buckling and free vibration of beams, and elementary thin-plate theory.

**CE 536 Wood Structural Design.** Three hours.
Prerequisite: CE 331.
Modern timber engineering: design of beams, columns, trusses, and floor systems.

**CE 537 Reinforced Concrete Structures II.** Three hours.
Prerequisite: CE 433.
Design of reinforced concrete building components including two-way slabs, slender columns, prestressed beams, slap-on-grade, and retaining walls.

**CE 538 Structural Steel Design II.** Three hours.
Prerequisite: CE 434.
Basic and elementary design procedures for steel structures such as plate girders, mill buildings, multistory buildings, highway bridges, and light-gauge steel structures.

**CE 539 Design of Masonry Structures.** Three hours.
Prerequisite: CE 539
Design of un-reinforced and reinforced masonry walls, columns, pilasters, beams and lintels.

**CE 542 Waste Containment Facilities.** Three hours.
Prerequisite: CE 340 or permission of instructor.
Introduction to the fundamentals of soil behavior as they relate to environmental engineering. Topics include soil behavior, soil compaction, conduction phenomena, geosynthetics, and aspects of landfill design.

**CE 544 Foundation Engineering.** Three hours.
Prerequisite: CE 340.
Analysis and design of soil foundation systems.

**CE 551 Geometric Design of Roadways.** Three hours.
Prerequisite: CE 350.
Application of the principles of geometric design: alignment, vertical control, drainage, traffic control, interchanges, and intersections. Design projects will be prepared to illustrate standard techniques.

**CE 552 Traffic Safety and Security.** Three hours.
Prerequisite: CE 350.
Introduction to transportation safety and security issues. Site/situation identification techniques, risk assessment, countermeasure analysis, cost effectiveness, construction, and evaluation.

**CE 553 Intelligent Transportation Systems--ITS.** Three hours.
Prerequisite: CE 350.
Introduction to intelligent transportation systems including traffic management, institutional and planning issues; system architecture, and system design/construction/operation.

**CE 554 Urban Transportation Planning.** Three hours.
Prerequisite: CE 350.
An introduction to the planning process, software associated with transportation modeling, and conducting transportation planning and traffic impact studies.
CE 556 Transportation Systems Analysis. Three hours.  
Prerequisite: CE 350 or Graduate Status.  
Basic concepts and tools of systems analysis, including those from microeconomics, optimization, project evaluation and decision making, are integrated into the context of transportation planning and management.

CE 560 Front End Planning. Three hours.  
Prerequisite: CE 366  
Principles and applications for effective early planning of capital facilities, including: finance, economics decision making, risk management, team alignment, and front end planning processes and tools.

Prerequisite: CE 366  
Addresses the estimating and cost control function from conceptual planning through project execution. Topics include productivity analysis, organization of estimates, cost forecasting, estimating tools and techniques, contingency planning and relationship to contract types and project execution strategies.

CE 557 Pavement Design and Construction. Three hours.  
Prerequisite: CE 340.  
The thickness design of base, subbase, asphalt, and concrete layers for highway pavements, including both design and construction aspects.

CE 558 Traffic Engineering. Three hours.  
Prerequisite: CE 350.  
Vehicle operating characteristics, traffic flow, geometric design of road and intersections, and methods of traffic control.

CE 559 Pavement Rehabilitation. Three hours.  
Prerequisite: CE 350.  
This course covers two areas concerning care of existing highway asphalt and concrete pavements. Major maintenance includes overlay design, additional drainage, recycling, and slab repair. Routine maintenance includes distress surveys, pothole repair, and crack and joint sealing.

CE 561 Horizontal Construction Methods. Three hours.  
Prerequisite: CE 366  
Introduction to horizontal construction engineering equipment and methods. Design of horizontal construction systems, and construction operation analyses and simulation.

CE 562 Vertical Construction Methods. Three hours.  
Prerequisite: CE 366  
Construction of buildings, including mechanical, electrical plumbing and controls systems, design of temporary structures, and planning and design of lifts.

CE 564 Safety Engineering. Three hours.  
Prerequisite: GES 255 or equivalent.  
Not open to students with credit for CE 464. An exposure to safety engineering and accident prevention including state and federal laws related to general and construction projects. Topics include accident theories, safety regulations, Construction Safety Act, hazards and their control, human behavior and safety, and safety management.
CE 565 Advanced Blasting Engineering. Three hours.  
Prerequisite: CE 340 or CE 411 or AEM 250.  
Behavior of rock under dynamic loads intended to fragment or penetrate; theories of drilling, 
blasting, and communication; and application of theory.

CE 569 Construction Internship. Three hours.  
Prerequisite: CE 366, CE464 or Graduate Standing  
Practical field experience working with management of construction.

CE 570 Open Channel Flow. Three hours.  
Prerequisite: CE 378.  
Basic concepts of fluid flow, energy and momentum principles, flow resistance in nonuniform 
sections, channel controls and transitions, and nonuniform flow computations.

CE 573 Statistical Applications in Civil Engineering. Three hours.  
Prerequisite: MATH 238.  
Applications of statistical and probabilistic methodologies for analysis and solution of practical 
civil engineering problems, including frequency and risk analysis, analyses of experimental 
data, and systems simulation and optimization.

CE 575 Hydrology. Three hours.  
Prerequisite: CE 378. Hydrologic cycle, rainfall-runoff relations, unit hydrograph, statistical 
hydrology, and hydrologic simulation; includes a class project with application to flood control, 
water supply, and multipurpose projects.

CE 580 Forensic Engineering. Three hours.  
Prerequisite: AEM 250  
When failures in the built environment occur, whether during design, construction or in-
service, a thorough examination of the causes is essential to both the evolution sound 
engineering practices and to dispute resolution through the legal system. The role of the 
engineer in this process is examined.

CE 581 Legal Aspects of Engineering and Construction. Three hours.  
Prerequisites: CE 262 and at least one CE 300-level class.  
Legal aspects of engineering and construction contacts and specifications; contract formation, 
interpretations, rights and duties, and changes; legal liabilities and professional ethics of 
architects, engineers, and contractors.

CE 582 Advanced Geological Engineering. Three hours.  
Prerequisite: GEO 101 or permission of instructor.  
Engineering properties of rocks and soils, surface and subsurface exploration, ground water, 
land subsidence, earthquakes, geophysical techniques, and application of geology to civil, 
mining, and environmental engineering.

CE 584 Experimental Design and Field Sampling. Three hours.  
Prerequisites: CE 320 & GES 255 (or equivalent) or permission of instructor  
Experimental design, sensitivity analyses, water sampling and flow monitoring. Receiving 
water chemical reactions. Field investigations.

CE 585 Construction Site Erosion Control. Three hours.  
Prerequisites CE 378, basic engineering hydrology.  
Nature and magnitude of erosion problems, erosion plan development. Rainfall energy and
erosion predictions. Sediment transport in urban areas. Channel and slope stability, and sedimentation and other controls.

**CE 591:592 Special Problems.** One to three hours.
Prerequisite: Written permission of the instructor.
Independent study. Credit is based on the amount of work undertaken.

**CE 598 Research Not Related to Thesis.** Variable credit.

**CE 599 Master's Thesis Research.** One to Twelve hours.

**CE 605 Impacts of Homeland Security on America.** One hour.
Prerequisite: None.
An interdisciplinary seminar that explores the impacts of homeland security on the economy, politics, law, computing infrastructure, transportation, drinking water, the environment, and other fields.

**CE 622 Water Quality Engineering.** Three hours.
Prerequisites: MATH 238 and CE 424.
Introduction to the principles of water-quality engineering and the development and use of water-quality models.

**CE 629 Environmental Regulations.** Three hours.
Prerequisite: CE 424.
Study of environmental laws and the regulations that have resulted from those laws.

**CE 632 Advanced Structural Analysis II.** Three hours
Prerequisite: CE 532.
Finite-element methods, three-dimensional structures.

**CE 633 Structural Stability.** Three hours.
Prerequisite: CE 331.
Static buckling of structural elements, frames, and trusses.

**CE 634 Advanced Structural Mechanics.** Three hours.
Prerequisite: CE 331 or graduate standing.
Introduction to advances structural mechanics topics, including elementary elasticity, elementary beam theories, beams on elastic foundations, energy methods, buckling and free vibration of beams, and elementary thin-plate theory.

**CE 653 Traffic Planning.** Three hours.
Prerequisite: CE 350.
The role of transportation and traffic in urban planning; the relationship of traffic facilities to land use, zoning, and planning studies.

**CE 655 Sustainable Transportation.** Three hours.
Prerequisite: Instructor Permission.
Pre-requisite: Instructor permission. Course will define the concept of sustainable transportation and examine its applications. It will address the travel behavior, land use and policy issues that affect and are affected by the increasing emphasis towards developing more sustainable transportation systems.

**CE 656 Transportation Demand and Network Modeling.** Three hours.
Prerequisite: CE456/556 or equivalent, or permission from instructor.
Co-requisite: CE 573 Statistical Application in Civil Engineering or equivalent, or consent of instructor.
Theory and models of individual choice behavior and their applications in travel demand modeling; mathematical models for transportation network problems and their applications in planning and operations of urban highway and transit systems.

**CE 691:692 Special Problems (Area).** Variable credit. Advanced work in some area of specialization. Credit awarded is based on the amount of work completed.

**CE 698 Research Not Related to Dissertation.** Variable credit.

**CE 699 Doctoral Dissertation Research.** Three to twelve hours.