

## **STRUCTURAL ENGINEERING PROGRAM INFORMATION FOR GRADUATE STUDENTS**

The Structural Engineering graduate program at Clemson University offers Master of Science and Doctor of Philosophy degrees in Civil Engineering. The objective of the program is to provide a well-balanced education in structural analysis and design, and in theoretical and practical aspects of Civil Engineering. Through the graduate level courses offered within the Civil Engineering department, students learn classical structural mechanics and behavior of engineering materials, explore modern computational techniques, recognize the uncertainties and errors in calculations and gain hands-on experiences through laboratory/field testing to prepare for a consulting or research career path. Students are also encouraged to explore supporting and complimentary courses offered in other Civil Engineering disciplines and other departments at Clemson University.

### **Structural Engineering Degree Requirements**

The plan of study should include at least 80% of required classes from the following list: CE 6010, CE 6040, CE 6070, CE 608, CE 8010 (or ME 8180), CE 8020, CE 8030, CE 8040, CE 8050 (or ME 6320), CE 8070, CE 8080, and CE 8090,. The plan must also include a mixture of graduate-level structural design courses such as concrete, steel, masonry, or wood design. It is required that all masters students have taken at least two undergraduate level structural design classes (CE 4020 and CE 4060 or equivalents). For those students that are accepted for admission without having taken these two classes, they should be taken before the end of the second semester of graduate study. These classes do not count towards the hour requirements for the MSCE degree. Requirements for the degree programs are as follows:

Master of Science Thesis Option: A minimum of 24 course credits (not including research and thesis credits) is required. Students may take a maximum of 12 credits of 6000 level courses, must take a minimum of 12 credits of courses at the 8000 level, and must take at least 6 credits of CEE 8910 (Research and Thesis). The thesis option is required for students with research or teaching assistantships. Upon completing the research and documenting it in a M.S. thesis, students will be required to pass a public oral defense. The student's graduate advisory committee is selected by the student after consultation with the student's research advisor.

Master of Science Non-thesis Option: Students may take a maximum of 15 credits of 6000 level courses and must take a minimum of 15 credits of courses at the 8000 level, with a minimum of 30 total credits. All MS non-thesis option students will have committee chairs and committee members assigned by the Structures coordinator for the MS non-thesis option degree.

Special Consideration for Graduate Students with Non-Engineering Bachelor's degrees: For students with non-engineering Bachelor's degrees (i.e., degrees in Physics, Math, etc.) additional coursework beyond what is required for an MSCE degree may be required in order to qualify for licensure. Our MSCE program is not accredited and very few are. It is incumbent on individual students to coordinate their course plan with state examining boards to insure eligibility for licensure at a later date. In order to provide some guidance to graduate students with this concern the following summary of NCEES (National Council of Examiners for Engineering and Surveying) regulations is provided. Each state board determines their own

requirements on education, but most use the education standards given below. Please note that the combination of undergraduate and graduate coursework should be evaluated against these regulations.

*Applicants having engineering degrees from programs that are not accredited by the Engineering Accreditation Commission (EAC) of ABET must demonstrate the following:*

*A. 32 college semester credit hours of higher mathematics and basic sciences*

- 1. Credits in mathematics must be beyond algebra and trigonometry and must emphasize mathematical concepts and principles rather than computation. Courses in differential and integral calculus are required. Additional courses may include differential equations, linear algebra, numerical analysis, probability and statistics, and advanced calculus.*
- 2. Credits in basic sciences must include at least two courses. These courses must be in general chemistry, general calculus-based physics, or general biological sciences; the two courses may not be in the same area. Additional basic sciences courses may include earth sciences (geology, ecology), advanced biology, advanced chemistry, and advanced physics. Computer skills and/or programming courses may not be used to satisfy mathematics or basic science requirements. Basic engineering science courses or sequence of courses in this area are acceptable for credit but may not be counted twice.*

*B. 16 college semester credit hours in general education that complements the technical content of the curriculum*

- 1. Examples of traditional humanities/social sciences courses in this area are philosophy, religion, history, literature, fine arts, sociology, psychology, political science, anthropology, economics (micro and macro), professional ethics, and social responsibility. Examples of other general education courses deemed acceptable include management (such as organizational behavior), accounting, written and oral communications, business, and law.*
- 2. No more than 6 credit hours may come from courses in management, accounting, business, or law. Courses in engineering economics, engineering management, systems engineering/analysis, production, and industrial engineering/management will not be counted. Language courses in the applicant's native language are not acceptable for credit; no more than 6 credit hours of foreign language courses are acceptable for credit. Native language courses in literature and civilization may be considered in this area. Courses that instill cultural values are acceptable, while routine exercises of personal craft are not.*

*C. 48 college semester credit hours of engineering science and/or engineering design courses*

- 1. Courses in engineering science must be taught within the college/faculty of engineering and must have their roots in mathematics and basic sciences but carry knowledge further toward creative application of engineering principles. Examples of approved engineering science courses are mechanics, thermodynamics, heat transfer, electrical and electronic circuits, materials science, transport phenomena, engineering economics, and computer science (other than computer programming skills).*
- 2. Courses in engineering design must stress the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation. Graduate-level engineering courses may be included to fulfill curricular requirements in this area.*

PhD Program: There are two options for entering the PhD program: directly after completing BS degree and after completing an MS degree. Following are course and reporting requirements for each:

- Direct from BS Program – 60 credits beyond the BS degree with a minimum of 30 credit hours of coursework. Also, at least 18 research credits are required.
- Post MS Program - 30 credits beyond the MS degree with a minimum of 12 credits of coursework. Also, at least 18 research credits are required.
- For both programs GS2A (Committee make-up) and GS2B (Plan of Study) forms should be completed by the end of the first year of study.

Each PhD student is required to pass the following exams during their program of study: a Preliminary examination, a Comprehensive examination (also referred to as the “proposal defense”), and a Dissertation Defense examination.

The Qualifying exam is a written exam that must be passed by the end of the third semester of study and is required for all PhD students. The exception to this is direct PhD admits, who are required to pass the qualifying exam by the end of the fifth semester of study. The exam is given as needed. The exam content and format are as follows:

- The exam is 4 hours long and is closed book and notes and appropriate design codes will be provided.
- The exam will contain nine questions: three about structural analysis, three about structural mechanics, and three focused on the student’s area of PhD research.
- The Qualifying exam may be taken at the end of the second or third semesters of study, and if the first attempt is failed then a second attempt is allowed. However, a student may elect to wait and take the exam only once, at the end of the third semester of study. Students who do not pass the preliminary exam by the end of the third semester (whether having one or two attempts) will not be allowed to continue in the PhD program.

The Comprehensive Exam consists of an oral defense of the student’s proposed research plan, and written questions provided by the graduate committee members. Two weeks prior to the comprehensive exam the student must submit a written research proposal to the graduate committee. Graduate School rules should be followed for the timing of this exam. After successfully completing the Comprehensive exam the student is admitted to PhD candidacy.

The Dissertation Defense exam consists of an oral defense of the PhD Dissertation. Two weeks prior to the exam the student must submit their dissertation to the graduate committee. Graduate School rules should be followed for the timing of Defense of Dissertation exam. In the rare circumstance that a student fails the exam, a second opportunity to pass the exam will be given no later than two academic semesters after the first attempt. Students that do not pass on the second attempt will not be allowed to continue in the PhD program.

Other General Information:

If a student fails to make satisfactory progress toward their degree (MS or PhD) then permission may be denied to continue the program. Students whose cumulative GPA falls below 3.0 are placed on probation and become ineligible for assistantships.

Duties of students receiving assistantships are described in the letter giving the offer of aid and in the contract signed by the student and by the supervising faculty member.

Master's theses and PhD dissertations are submitted to the university electronically. Instructions are given on the Electronic Thesis and Dissertation (ETD) homepage located at <http://scholar.lib.vt.edu/theses>. Workshops on ETD are given by the Graduate School.

During the academic year, students who have a fellowship, scholarship, or graduate assistantship (GA), including teaching and research assistantships, must take a minimum of 9 credits hours per semester. International students must maintain full-time student status (i.e., 9 credits) except for summer and their last semester. Unfunded domestic students have no minimum credit hour requirement. Audited courses are not counted toward the minimum. Graduate students are not required to enroll during summer sessions unless they are taking courses (e.g., students working on research during the summer are not required to sign up for CEE 5994 or 7994). Students working as teaching or grading assistants during the summer must register for a minimum of 3 credit hours; these hours can be coursework or research.

Students registered for 12 or more credits may audit one course; students registered for 9-11 credits may audit two courses. Students wishing to audit courses must receive permission from the course instructor.

## STRUCTURAL ENGINEERING PROGRAM Course Offerings

### Tentative Graduate Courses

Fall 2020

|              |                            |         |
|--------------|----------------------------|---------|
| CE 4010/6010 | Matrix Structural Analysis | Redmond |
| CE 8030      | Adv Steel Design           | Naser   |
| CE 8080      | Earthquake Engineering     | Pang    |

Spring 2021

|              |                                      |         |
|--------------|--------------------------------------|---------|
| CE 4040/6040 | Masonry Design                       | Redmond |
| CE 4080/6080 | Structural Loads and Systems         | Ross    |
| CE 8020      | Adv Reinforced Concrete              | Cousins |
| CE 8930      | Structural Fire Engineering & Safety | Naser   |
| CE 8930      | Risk Engineering                     | Pang    |

Fall 2021

|              |                            |         |
|--------------|----------------------------|---------|
| CE 4010/6010 | Matrix Structural Analysis | Redmond |
| CE 4070/6070 | Wood Design                | Pang    |
| CE 8030      | Adv Steel Design           | Naser   |
| CE 8040      | Prestressed Concrete       | Cousins |

Spring 2022

|              |                               |         |
|--------------|-------------------------------|---------|
| CE 4080/6080 | Structural Loads and System   | Ross    |
| CE 8020      | Adv Reinforced Concrete       | Ross    |
| CE 8080      | Earthquake Engineering        | Pang    |
| CE 8050      | Advanced Structural Mechanics | Redmond |

**Various courses that may be of interest to graduate students in structures, but may not be taught by structural engineering faculty**

**Civil Engineering**

|         |   |
|---------|---|
| CE 6570 | Material Testing and Inspection                       |
| CE 8010 | Finite Element Analysis                               |
| CE 8260 | Properties of Portland Cement Concrete                |
| CE 8270 | Special Cements and Concrete                          |
| CE 8280 | Repair and Rehabilitation of Concrete Structures      |
| CE 6210 | Geotechnical Engineering Design                       |
| CE 6240 | Earth Slopes and Retaining Structures                 |
| CE 8220 | Foundation Engineering                                |
| CE 8250 | Soil Dynamics and Geotechnical Earthquake Engineering |
| CE 8510 | Reliability   |

**Mathematics**

|           |                                    |
|-----------|------------------------------------|
| MTHS 6000 | Theory of Probability              |
| MTHS 6030 | Introduction to Statistical Theory |
| MTHS 6050 | Statistical Theory and Methods II  |
| MTHS 6060 | Sampling Theory and Methods        |
| MTHS 8000 | Probability                        |

**Mechanical Engineering**

|         |  |
|---------|--|
| ME 6300 | Mechanics of Composite Materials ME 8180 |
|         | Introduction to Finite Element Analysis  |
| ME 8340 | Principles of Structural Stability       |
| ME 8360 | Fracture Mechanics                       |
| ME 8370 | Theory of Elasticity I                   |
| ME 8380 | Theory of Elasticity II                  |
| ME 8450 | Structural Vibrations                    |
| ME 8510 | Advanced Finite Element Analysis         |

**Statistics**

|           |                                       |
|-----------|---------------------------------------|
| EXST 8010 | Statistical Methods I                 |
| EXST 8020 | Statistical Methods II                |
| EXST 8030 | Regression and Least Squares Analysis |

**Related Course Programs**

Students in the Master's degree program are encouraged to take courses outside of the structures program to broaden their background. Many alternatives are available, especially in the engineering science and mechanics, construction, geotechnical, materials, mathematics, statistics, and computer science areas. At the PhD level it is desirable for the student to develop additional depth in structural mechanics, mathematics, and continuum mechanics.

## **Structural Engineering Faculty**

Tommy Cousins, Professor; P.E., Ph.D., North Carolina State University. Bridge engineering behavior; prestressed and reinforced concrete.

Steve Csernak, Senior Lecturer; P.E., M.S., Clemson University. Structural engineering, wind and seismic design.

Mohannad Naser, Assistant Professor; Ph.D., Michigan State University. Structural engineering, structural fire.

Weichi Pang, Professor, Ph.D. Michigan Tech. Structural reliability, earthquake engineering, wind engineering

Laura Redmond, Assistant Professor, Ph.D. Georgia Tech, Behavior of reinforced concrete and masonry structures, non-linear modeling of structures.

Brandon Ross, Associate Professor, P.E., Ph.D. University of Florida. Building adaptation, experimental evaluation of prestressed and reinforced concrete, and low-cost systems for housing.

## **Emeritus Faculty**

Subhash Anand, Ph.D., Northwestern University, Computational Mechanics, Masonry Structures.

Russell Brown, Ph.D., Rice University, Concrete and Masonry Structures, Experimental Testing.

Jack McCormac, M.S., MIT, Structural Analysis and Design.

Robert Nowac, M.S., University of Pittsburgh, Engineering Mechanics.

Peter Sparks, Ph.D., University of London, Wind Engineering and Structural Performance