

## **Graduate Programs in STRUCTURAL ENGINEERING**

[www.ou.edu/coe/fears](http://www.ou.edu/coe/fears)

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### **PROGRAM FOCUS**

Graduate programs in the School of Civil Engineering and Environmental Science (CEES) at the University of Oklahoma provide advanced engineering education through classroom learning and participation in research. CEES faculty are recognized nationally and internationally for their teaching and research expertise.

The graduate program in structural engineering emphasizes the practical aspects of design, while providing students with fundamental backgrounds in both experimental and analytical research methods. Coursework covers steel structures, structural design with wood or masonry, reinforced and prestressed concrete structures, concrete materials, concrete pavements, static and dynamic behavior of structures, earthquake engineering, advanced mechanics, and numerical methods. Advanced topics that are also covered include structural reliability, computational statistics for engineers, and natural hazard mitigation strategies. Structural engineering also requires a basic understanding of various areas of mathematics such as linear algebra, ordinary differential equations, partial differential equations and statistics.

Experimental structural engineering research, in which the physical response of structural materials and components is studied, plays an important role in our graduate program. A fundamental understanding of mechanical and structural systems is developed through a combination of experimentation, data analysis, and numerical modeling. Analytical methods are used to formulate accurate and efficient mathematical representations of mechanical behavior that can be used in both research and design of structural systems. A second program in the field of structural health monitoring is also available. Research in this program includes laboratory and field investigations, supported by data analysis and inverse modeling.

The critical state of our nation's complex and aging infrastructure challenges, in conjunction with climate change, compels us to find solutions through cross-disciplinary research that may include geotechnical engineering, materials science, computer science, mathematics, electrical engineering, chemistry and chemical engineering, and mechanical engineering. The CEES structural engineering faculty with expertise in concrete materials, concrete and steel structures, numerical modeling, structural dynamics, system identification, structural health monitoring, control, computational statistics, and related technical areas are positioned to lead these research efforts. Collaborations across our departments allow our students to work on complex engineering problems, facing and solving unique challenges related to the performance of infrastructure under a variety of natural and man-made disasters.

### **RESEARCH FACILITIES**

The bulk of the experimental research program in structural engineering is located at the Donald G. Fears Structural Engineering Laboratory, one of the largest, dedicated structural engineering laboratories in the United States. Located on OU's Research Campus South in Norman, Fears Lab contains over 30,000 square feet of laboratory space, including 1,800 square feet of strong floor capable of reacting 320,000 pounds at any one location. An adjacent office building houses faculty and student offices, a conference room, library, and computing facilities.

Experimental research at Fears Structural Engineering Laboratory is supported by the following testing equipment:

- 200,000-pound capacity universal testing machine
- 600,000- and 450,000-pound capacity concrete compression machines
- axial compression and tension capacity of 6,000,000 pounds
- internal pressure loading capability of 6000 psi
- state-of-the-art high efficiency concrete mixer for concrete materials research
- 60-foot-long prestressing bed for fabricating test specimens
- two freeze-thaw testing cabinets for evaluating concrete durability
- 55,000- and 22,000-pound capacity actuators with six-inch stroke integrated into closed loop hydraulic systems for dynamic and cyclic testing
- 55,000-pound capacity test frame with compatible controller
- large-scale rotating bending fatigue apparatus
- two seismic simulators (shake tables)—one 4-foot by 6-foot uniaxial simulator and one 6-foot by 7-foot six-degree-of-freedom simulator—for testing structural response to earthquakes
- two large environmental chambers with temperature and humidity controls
- laminar flow fume hood for clean space
- several multi-channel, microcomputer-based, data acquisition systems with up to 100 channels of input, two with a 100,000 Hz synchronized testing rate
- 15-foot by 60-foot vacuum chamber for testing roofing systems
- full array of miscellaneous hydraulic, electronic and data acquisition equipment
- a large complement of machine tools and manufacturing capability

Numerous computer systems at OU and within the Gallogly College of Engineering support numerical and analytical research. Acknowledging the importance of computational resources in this research field, the state-of-the-art [OU Supercomputing Center for Education and Research \(OSCER\)](#) can further train and support students' needs with its High-Performance Computing infrastructure.

## **DEGREE PROGRAMS**

The structural engineering program is individually tailored to meet the needs and interests of each student. Two advanced degrees are offered: Master of Science and Doctor of Philosophy.

### **Master of Science Degree (MS)**

MSCE programs are open to students with undergraduate degrees in civil engineering or related engineering or science disciplines who have completed certain minimum undergraduate coursework. Both thesis and coursework only options are available for obtaining the master's degree. The coursework only option requires completion of 32 semester credit hours, of which 9 hours are structural core courses and are listed on page 8 of this document. The thesis option requires completion of 30 semester credit hours, with the same core course options, five hours devoted to thesis research, and one hour to a course on technical communications. The thesis option also requires a final defense.

## Doctor of Philosophy Degree (PhD)

A master's degree in a related discipline is typically required for admission to all CEES PhD degree programs, although students who have outstanding academic credentials and a documented record of research experience at the undergraduate level may occasionally be admitted to the doctoral program without a master's degree.

The doctoral program requires completion of research that expands the student's professional knowledge in the fundamental concepts of structural engineering. The student is expected to produce a research dissertation of professional significance that could be the basis of two or more papers published in refereed journals. The doctoral degree requires a minimum of 48 hours of post-bachelor's coursework, a minimum of 4 and a maximum of 41 hours of dissertation research, and one hour of technical communications, all totaling at least 90 post bachelor's hours. Twenty-four hours of CEES courses or equivalent and at least 6 hours of courses outside CEES are required. The coursework required for the doctoral program is determined by each student with the approval of their advisor and a faculty committee and is based on the student's educational background and chosen research program.

## RESEARCH AREAS

Faculty research interests cover a broad spectrum of structural engineering. Current and recent research projects involving members of the structural engineering faculty include:

- structural steel and cold form steel structures; reinforced, prestressed, and post-tensioned concrete structures; and steel-concrete composite structures
- determination of tendon stresses and secondary effects in post-tensioned structures
- bond performance of prestressing strands
- repair and rehabilitation of bridge structures using innovative concrete materials
- development of high-performance and ultra-high-performance concrete for transportation structures
- use of blast furnace slag and other pozzolans to improve performance of concrete
- rapid setting and shrinkage compensating concrete using calcium sulfoaluminate cement
- rehabilitation and life cycle analysis of infrastructures and existing structures using fiber-reinforced polymers (FRPs) and FRP composites
- use of nanomodification techniques for mechanical improvements in structural materials
- machine learning tools for optimized material behavior
- study of 3D-printed composites for civil engineering
- hybrid carbon-glass FRP strengthening
- seismic testing of structural components and ductility of slab-column connections
- static and dynamic modeling of tall building systems, structural dynamics, and earthquake engineering
- code analyses and model development
- infrastructure resiliency
- accelerated ways to enhance risk assessment
- machine learning in structural engineering applications
- natural hazard mitigation strategies
- numerical analysis and Monte Carlo simulation
- neural networks, Hilbert transform, and Hilbert-Huang-transform
- field programmable gate array (FPGA)-based smart wireless sensing
- structural health monitoring and damage detection

## ADMISSION REQUIREMENTS

Enrollment as a graduate student in CEES requires:

- an undergraduate degree in civil engineering **or** an undergraduate degree in an associated area plus approved additional coursework
- a 3.0 GPA or above from an accredited university or college
- completed Statement of Goals or Purpose (500 words or less)
- two letters of reference (master's degree) and three letters of reference (doctoral degree) that address applicant's knowledge of engineering and scientific principles, analytical abilities, experimental abilities, initiative and communication skills, plus additional comments that would be beneficial in evaluating applicant's skills
- official GRE scores are optional and not required for admission but may be required by some potential faculty sponsors to be considered for a Qualifying Graduate Assistantship.
- TOEFL (iBT) score of at least 79 or IELTS score of at least 6.5 for students whose native language is not English

In addition, for admission to the doctoral program, applicants are encouraged to submit a sample of written research work, such as a refereed publication or abstract of a master's thesis.

## TRANSFER CREDITS

No more than 8 hours of eligible graduate coursework may be transferred from another institution for the master's degree. No more than 30 hours of eligible graduate coursework, including a maximum of 5 hours of master's thesis research, may be transferred from another institution for the doctoral degree.

## FINANCIAL ASSISTANCE

The University of Oklahoma provides research and teaching assistantships to qualified graduate students. These assistantships include a stipend, tuition waiver, and health benefits. Students with assistantships can enroll for a maximum of 9 credit hours per semester and are not subjected to tuition fees. OU fellowships may be available for highly qualified students pursuing the doctoral degree.

All applicants are considered for funding during admission review, and you may hear back from a faculty member once they begin to review applications. You may also contact a faculty member in your area of interest to see if financial assistance is available.

Research assistants typically write their thesis or dissertation on the subject for which financial support is received. Teaching assistants typically supervise laboratory sections, hold office hours, and grade assignments. Instructor positions are occasionally available for doctoral students, particularly those interested in an academic career. Graduate students whose native language is not English must first pass an English proficiency exam before being appointed as a teaching assistant or instructor with student contact.

Master's students receiving financial assistance are almost always those who pursue the thesis option. Because students with assistantships typically spend 10-20 hours per week on their teaching or research responsibilities, such students may take up to an additional year to complete their master's degree.

## THE UNIVERSITY OF OKLAHOMA

Created by the Oklahoma Territorial Legislature in 1890, the University of Oklahoma is a doctoral degree-granting research university serving the educational, cultural, economic, and healthcare needs of the state, region, and nation. The Norman campus serves as home to all the university's academic programs except health-related fields. The OU Health Sciences Center, which is in Oklahoma City, is one of only four comprehensive academic health centers in the nation with seven professional colleges. Both the Norman and Health Sciences Center colleges offer programs at the Schusterman Center, the site of OU-Tulsa. OU enrolls approximately 30,000 students, has nearly 3,000 faculty members and has 20 colleges offering 152 majors at the baccalaureate level, 160 majors at the master's level, 75 majors at the doctoral level, and 20 majors at the professional level. The university's annual operating budget is approximately \$2.4 billion and is an equal opportunity institution.

## THE COMMUNITY

Norman, Oklahoma is a community of about 124,000 located 18 miles south of Oklahoma City and 190 miles north of Dallas. A variety of recreational, cultural, and social activities are available in Norman and surrounding areas. Lake Thunderbird, 10 miles east of Norman, provides an excellent setting for numerous water activities. Norman was recognized as one of the most progressive cities in the state and the Norman Public School system has been acknowledged as one of the top school systems in Oklahoma.

Oklahoma City, with a metropolitan population of approximately 1.4 million, is the state's capital and largest city, and boasts a minor league ballpark and a canal that flows beside choice restaurants, shops, and quaint cafes in the historic Bricktown entertainment district. In the downtown Oklahoma City area, you'll also find the Myriad Botanical Gardens, the Oklahoma City National Memorial, and the Oklahoma City Museum of Art. There's never a shortage of fun in the metro. With more than 50 attractions, you can catch a movie in the OmniDome large-format theater at the Science Museum Oklahoma (formerly called the Omniplex) or tour one of the nation's top zoos right next door. Don't miss a stroll through the National Cowboy and Western Heritage Museum, where galleries are full of priceless Western art and treasures.

## APPLICATIONS

To apply, visit our application website at <https://www.ou.edu/coe/cees/apply> and then the university's Graduate College application website at <https://gograd.ou.edu/apply/>.

The University of Oklahoma in compliance with all applicable federal and state laws and regulations does not discriminate on the basis of race, color, national origin, sexual orientation, genetic information, sex, age, religion, disability, political beliefs, or status as a veteran in any of its policies, practices or procedures. This includes but is not limited to admissions, employment, financial aid, and educational services. For questions regarding discrimination, sexual assault, sexual misconduct, or sexual harassment, please contact the Office(s) of Institutional Equity as may be applicable – Norman campus at (405) 325-3546/3549, the Health Sciences Center at (405) 271-2110 or the OU-Tulsa Title IX Office at (918) 660-3107. Please see [www.ou.edu/eoo](http://www.ou.edu/eoo).

Accommodations are available by contacting (405) 325-2344 or [ceesgradstudies@ou.edu](mailto:ceesgradstudies@ou.edu).

## CEES FACULTY

Websites of individual faculty members can be accessed through [www.ou.edu/coe/cees/people](http://www.ou.edu/coe/cees/people).

## COURSE OFFERINGS

For developing a graduate program, courses are divided into four categories: structural engineering, geotechnical engineering, mathematics, and other related courses. Students should have a minimum of six hours of undergraduate analysis courses (approved by CEES) as a prerequisite to graduate study. The student, working with his/her advisor and advisory committee, develops a comprehensive course of study from the courses listed below.

<b>Structural Engineering Courses (3 credit hours each)</b>	
CEES 4663G	Introduction to Matrix Methods in Structural Analysis
CEES 4753G	Structural Design – Wood
CEES 5020	Structural Design – Composites
CEES 5020	Masonry Design
CEES 5020	Structural Reliability
CEES 5020	Bridge Engineering
CEES 5383	Earthquake Engineering
CEES 5653	Advanced Mechanics of Materials
CEES 5663	Structural Analysis II
CEES 5683	Dynamics of Structures
CEES 5743	Design of Concrete Mixtures and Materials
CEES 5763	Introduction to Finite Element Method
CEES 5773	Structural Design – Steel II
CEES 5783	Structural Design – Concrete II
CEES 5793	Design of Prestressed Concrete Structures
CEES 6663	Advanced Finite Element Methods
<b>Related Geotechnical Engineering Courses (3 credit hours each)</b>	
CEES 4333G	Foundation Engineering
CEES 5343	Advanced Soil Mechanics
CEES 5353	Introduction to Soil Dynamics
CEES 5413	Soil-Structure Interaction
CEES 5693	Structural Design of Pavements

<b>Suggested Mathematics (MATH) Courses (3 credit hours each)</b>	
MATH 4073G	Numerical Analysis I
MATH 4093G	Applied Numerical Methods
MATH 4103G	Introduction to Functions of a Complex Variable
MATH 4163G	Introduction to Partial Differential Equations
MATH 4753G	Applied Statistical Methods
MATH 5093	Applied Numerical Methods
MATH 5773	Applied Regression Analysis
MATH 5113	Topics in Applied Mathematics
MATH 5173	Advanced Numerical Analysis I
MATH 5183	Advanced Numerical Analysis II
MATH 5403	Calculus of Variations
MATH 5423	Complex Analysis I
<b>Related Aerospace and Mechanical Engineering (AME) Courses (3 credit hours each)</b>	
AME 4383G	Control Systems
AME 5003	Introduction to Structural Health Monitoring
AME 5023	Elastic Stress Analysis
AME 5503	Nonlinear Dynamical Systems and Control
AME 5063	Composite Materials
AME 5573	Advanced Engineering Analysis I
AME 6033	Fracture Mechanics

If agreeable to the advisor and the advisory committee, other courses related to the major or minor field of study may also be selected from the above and other departments.

## Core Course Requirements for MS in Structural Engineering

The structures group have the following core course requirements for students pursuing an MS degree in structural engineering.

Students are required to take one course from each of the following three groups:

### Group A

CEES 5653 Advanced Mechanics of Materials

CEES 5663 Structural Analysis II

### Group B

CEES 5773 Structural Design – Steel II

CEES 5783 Structural Design – Concrete II

CEES 5793 Design of Prestressed Concrete Structures

### Group C

CEES 4663G Introduction to Matrix Methods in Structural Analysis

CEES 5683 Dynamics of Structures

CEES/AME 5763 Introduction to Finite Element Method