Civil Engineering (CVEG)

W. Micah Hale
Department Head
4190 Bell Engineering Center
479-575-4954
Email: micah@uark.edu

Julian Fairey
Graduate Coordinator
4190 Bell Engineering Center
479-575-4023
Email: julianf@uark.edu

Civil Engineering website (http://cveg.uark.edu)

Degrees Conferred:
M.S.C.E. in Civil Engineering (CVEG)
M.S. in Construction Management (CSMG) (Go to Construction Management (http://catalog.uark.edu/graduatecatalog/programsofstudy/constructionmanagement/))
M.S.En.E. in Environmental Engineering (ENEG) (Go to Environmental Engineering (https://civil-engineering.uark.edu/research/environmental-engineering.php))
Ph.D. in Engineering (CVEG)

Program Description: The Master of Science in Civil Engineering program is intended primarily for students possessing the Bachelor of Science in Civil Engineering degree. Students with degrees from other engineering disciplines may be admitted to the program but will be required to complete some undergraduate civil engineering courses as preparation for their graduate studies. The specific courses required will depend on the emphasis of their graduate studies. The objectives of the M.S.C.E. program are to provide a greater depth of understanding of civil engineering topics for the practice of engineering and to serve as preparation for doctoral studies. Students are allowed a great deal of flexibility in designing their course of study. Students desiring to develop a deeper understanding of one sub-discipline area may select courses solely concentrated in that area while those desiring a broader-based education may select courses from several sub-disciplines including courses from other disciplines.

Primary Areas of Faculty Research: The Department of Civil Engineering has ongoing research programs in the environmental/water resources, geotechnical, structural, and transportation areas. The following is a more detailed listing of topics currently being studied in each of these areas:

- **Environmental/Water Resources Area:** Water and wastewater treatment; decentralized collection and treatment systems; soil and groundwater remediation; surface and ground water quality; storm water pollution prevention; environmental and hydrologic modeling; water quality studies.
- **Geotechnical Area:** Aggregates and base materials; geosynthetic reinforcement; embankment and slope stability; field instrumentation and measurement of soil properties; soil and groundwater remediation using geosynthetics; GIS application to geotechnical engineering; foundation design.
- **Structural Area:** High performance concrete; structural materials; bridge deck rehabilitation; computational mechanics; computational wind engineering and tornado modeling; structural earthquake analysis and modeling; structural steel design and analysis.
- **Transportation Area:**Facility design; roadway geometrics; traffic operations and safety; pavement design and rehabilitation; asphalt concrete mixture design; construction materials characterization; construction quality control; geosynthetic reinforced flexible pavements; transportation management systems; high-speed pavement condition data acquisition; and transportation and land development.

In addition to these core areas, the Department of Civil Engineering is also actively pursuing research in the areas of alternative energy sources, infrastructure security, nanotechnology, and sustainability.

M.S.C.E. in Civil Engineering

Applicants for the Master of Science in Civil Engineering degree program who do not possess an engineering degree accredited by the Engineering Accreditation Commission (EAC) of ABET, Inc. must present results from the Graduate Record Examination (GRE) as part of the application process.

Requirements for the Master of Science in Civil Engineering Degree: Minimum 30 semester hours of graduate-level credit for thesis option; or 30 semester hours of graduate-level non thesis or research credit for course work only option.

1. Candidates for the degree who present a thesis are required to complete a minimum of 24 semester hours of course work and a minimum of six semester hours of thesis.
2. Candidates for the degree who do not present a thesis are required to complete a minimum of 30 semester hours of graduate-level course work.
3. Candidates for the degree must present a cumulative grade point average of 3.00 on all graduate courses. The minimum acceptable grade for any course is “C.”
4. Upon admission to the Graduate School and acceptance in a program of study, candidates pursuing a thesis-based program will be assigned to a major adviser, who in consultation with the department head, will select a graduate committee. With guidance from the committee, the candidate will develop a plan of study and a research project to be completed by the candidate. The committee will serve as the examination committee for the final oral and/or written examination and for the thesis. Candidates pursuing a coursework-based program will be assigned to a major adviser, who will assist the candidate in developing a plan of study; the major adviser will coordinate the final and/or written examination.
5. All graduate students enrolled in the M.S.C.E. program in the Department of Civil Engineering must successfully complete one semester of CVEG 50000 Graduate Seminar in Civil Engineering.

Students should also be aware of Graduate School requirements with regard to master's degrees (http://catalog.uark.edu/graduatecatalog/degreerequirements/#mastersdegreestext).

Ph.D. in Civil Engineering

Applicants for the Doctor of Philosophy with emphasis in Civil Engineering degree program who do not possess an engineering degree accredited by the Engineering Accreditation Commission (EAC) of ABET, Inc. must

present results from the Graduate Record Examination (GRE) as part of the application process.

Requirements for the Doctor of Philosophy (Ph.D.) degree with emphasis in Civil Engineering: Minimum 72 semester hours of graduate-level credit beyond the baccalaureate degree; minimum 42 semester hours of graduate-level credit beyond the master's degree.

1. Candidates for the degree are required to complete a minimum of 36 semester hours of graduate-level course work and a minimum of 18 semester hours of dissertation. Graduate-level course work comprising an earned master's degree may be included in the minimum course work credit hours for the Ph.D. degree.
2. Candidates for the degree must present a cumulative grade point average of 3.00 on all graduate courses. The minimum acceptable grade for any course is "C."
3. All graduate students enrolled in the Ph.D. program in the Department of Civil Engineering must successfully complete two semesters of CVEG 50000 Graduate Seminar in Civil Engineering.

Students should also be aware of Graduate School requirements with regard to doctoral degrees (http://catalog.uark.edu/graduatecatalog/degreerequirements/#phdandedddegreestext).

Graduate Faculty

Bernhardt-Barry, Michelle, Ph.D., M.S.C.E., B.S.C.E. (Texas A&M University), Associate Professor, 2013, 2019.
Braham, Andrew F., Ph.D. (University of Illinois-Urbana-Champaign), M.S., B.S. (University of Wisconsin-Madison), Associate Professor, 2010, 2018.
Clark, Suzanne G., J.D. (University of Arkansas), B.S. (University of Connecticut), B.A. (Fairfield University), Instructor, 2023.
Coffman, Rick, Ph.D. (University of Missouri-Columbia), M.S. (University of Texas at Austin), B.S. (University of Wyoming), Professor, 2009, 2021.
Fairey, Julian, Ph.D., M.S.C.E. (University of Texas at Austin), B.S.C.E. (University of Alberta, Canada), Associate Professor, 2008, 2014.
Fernstrom, Eric, Ph.D. (University of Arkansas), Teaching Assistant Professor, 2014, 2021.
Guo, Lei, Ph.D. (University of California, Berkeley), B.S. (Lanzhou University, China), Assistant Professor, 2022.
Hale, Micah, Ph.D., M.S.C.E., B.S.C.E. (University of Oklahoma), Professor, 21st Century Leadership Chair in Civil Engineering, 2002, 2013.
Hall, Kevin D., Ph.D. (University of Illinois-Urbana-Champaign), M.S.C.E., B.S.C.E. (University of Arkansas), Professor, Walter E. Hicks and Blossom Russel Hicks Professorship for Infrastructure Engineering, 1993, 2002.
Hernandez, Sarah, Ph.D., M.S. (University of California, Irvine), B.S. (University of Florida), Associate Professor, 2015, 2021.
Heymsfield, Ernie, Ph.D. (City University of New York), M.S.C.E. (Polytechnic University), Associate Professor, 2001, 2007.
Mitra, Suman, Ph.D. (University of California, Irvine), M.S., B.S. (Bangladesh University of Engineering and Technology), Assistant Professor, 2019.
Morrow, Tommy K., Ph.D. (University of Texas at Austin), Instructor, 2019.
Murray, Cameron, Ph.D. (University of Oklahoma), M.S.C.E, B.S.C.E. (University of Arkansas), Associate Professor, 2017.
Power, Daniel, B.S.M.E., (University of Arkansas), Instructor, 2022.
Prinz, Gary S., Ph.D, M.S., B.S. (Brigham Young University), Associate Professor, 2014, 2019.
Sasidharan, Lekshmi, Ph.D. (Pennsylvania State University), M.S. (National Institute of Technology), B.S. (University of Kerala), Teaching Assistant Professor, 2022.
Selvam, R. Panneer, Ph.D. (Texas Tech University), M.S.C.E. (South Dakota School of Mines and Technology), M.E., B.E. (University of Madras, India), University Professor, James T. Womble Professor of Computational Mechanics and Nanotechnology Modeling, 1986, 2010.
Tayeh, Ralph, Ph.D., M.S. (University of Florida), B.S. (Lebanese American University, Byblos, Lebanon), Instructor, 2021.
Thompson, Rick, Ph.D., M.S., (Catholic University of America), M.B.A. (Cornell University), M.Arch (New School of Architecture & Design), Instructor, 2021.
Welcher, Richard, M.S.C.E., B.S.C.E. (University of Arkansas), Instructor, 2011.
Williams, Rodney D., Ph.D., M.S., B.S.C.E. (University of Arkansas), Instructor, 1998.
Williams, Stacy Goad, Ph.D., M.S.C.E., B.S.C.E. (University of Arkansas), Associate Professor, 1997.
Wood, Clinton M., Ph.D. (University of Texas at Austin), M.S.C.E., B.S.C.E. (University of Arkansas), Associate Professor, 2013, 2019.
Zhang, Wen, Ph.D. (Purdue University), M.S. (University of Kansas), Associate Professor, 2011, 2018.

Courses

CVEG 50000. Graduate Seminar in Civil Engineering. 0 Hours.
A weekly seminar devoted to civil engineering research topics. Appropriate grade to be "S". (Typically offered: Fall and Spring)

CVEG 51003. Geosynthetic Applications in Civil Engineering. 3 Hours.
Geosynthetic Applications in Civil Engineering: The functional properties of various geosynthetic materials are defined as they relate to; reinforcement, separation, filtration, and drainage applications. Design procedures are developed for the use of geosynthetics in transportation, environmental and geotechnical applications. Prerequisite: CVEG 31302 and CVEG 31301 or equivalent. (Typically offered: Irregular)

CVEG 51103. Soil Dynamics. 3 Hours.
This course covers propagation of stress waves in elastic and inelastic materials, dynamic loading of soils, and stiffness and damping properties of soils. Use of field and laboratory techniques to determine shear wave velocity of soils. Also includes applications of dynamic soil properties in site stiffness characterization, geotechnical earthquake engineering, evaluation of ground improvement, and design of machine foundations. Prerequisite: CVEG 41403 or graduate standing. (Typically offered: Irregular)

CVEG 51203. Measurement of Soil Properties. 3 Hours.
Consideration of basic principles involved in measuring properties of soils. Detailed analysis of standard and specialized soil testing procedures and equipment. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: CVEG 41403 or graduate standing. (Typically offered: Irregular)

CVEG 51303. Geotechnical Site Characterization. 3 Hours.
One of primary tasks of geotechnical engineers is to perform in-situ site characterization for engineering design of foundations, retaining structures, roads, bridges and other infrastructure. This course will focus on in-situ investigations performed for the purpose of collecting detailed site characterization data for direct and/or indirect use in geotechnical design. Specifically, we will study various static (e.g., SPT, CPT, VST, DMT, PMT) and dynamic (e.g., CHT, DHT, SW, GPR) in-situ tests used to obtain estimates of stratigraphy, density, strength, stress history, modulus, and permeability of geotechnical materials. We will predominantly focus on site characterization of soil sites, but will mention rock testing and design methods when appropriate. Prerequisite: Graduate standing. (Typically offered: Irregular)

CVEG 51403. Transportation Soils Engineering. 3 Hours.
Advanced study of the properties of surficial soils; soil classification systems; pedology; soil occurrence and variability; subgrade evaluation procedures; repeated load behavior of soils; soil compaction and field control; soil stabilization; soil trafficability and subgrade stability for transportation facilities. Prerequisite: CVEG 31302. (Typically offered: Irregular)

CVEG 51503. Earth Retaining Structures. 3 Hours.
This course will focus on the analysis and design of earth retaining structures. Specifically, we will discuss soil and rock property design parameter selection, lateral earth pressures for wall system design, and load and resistance factor design (LRFD) for retaining walls. Wall types discussed include gravity and semi-gravity walls, modular gravity walls, MSE walls, nongravity cantilever walls and anchored walls, and in-situ reinforced walls. Information on wall system feasibility and selection, construction materials and methods, cost information, and design and performance information will be discussed. Prerequisite: Graduate standing. (Typically offered: Irregular)

CVEG 51603. Seepage and Consolidation. 3 Hours.
Investigation of the flow of water through soils and the time rate of compression of soils. Characterization of the hydraulic conductivity of soils in the field, seepage through earth dams, excavation cut-off walls, and other seepage control systems. Analytical and experimental investigations of soil volume change under hydraulic and mechanical loading. Design of earth and rock dams, well pumping, and vertical and radial consolidation in embankments. Prerequisite: CVEG 41403 or graduate standing. (Typically offered: Irregular)

CVEG 51703. Advanced Foundations. 3 Hours.
Study of soil-supported structures. Topics include drilled piers, slope stability, pile groups, negative skin friction, foundation design from the standard penetration test and Dutch cone, and other specialized foundation design topics. Prerequisite: CVEG 41403 or graduate standing. (Typically offered: Irregular)

CVEG 51803. Geo-Environmental Engineering. 3 Hours.
Study of the geotechnical aspects of waste containment systems and contaminant remediation applications. Analysis and measurement of flow of water and contaminants through saturated and unsaturated soils, clay mineralogy and soil-chemical compatibility, and mechanical and hydraulic behavior of geomembranes, geotextiles, and geosynthetic clay liners. Design and construction aspects of compacted clay and composite landfill liners, drainage systems, and landfill covers. Prerequisite: CVEG 31302 or graduate standing. (Typically offered: Irregular)

CVEG 51903. Geotechnical Earthquake Engineering. 3 Hours.
This course covers stress wave propagation in soil and rock; influence of soil conditions on seismic ground motion characteristics; evaluation of site response using wave propagation techniques; liquefaction of soils; seismic response of earth structures and slopes. Prerequisite: Graduate standing. (Typically offered: Irregular)

CVEG 52003. Water Chemistry. 3 Hours.
This course provides a basis for applying principles of physical chemistry to understanding the composition of natural waters and to the engineering of water and wastewater treatment processes. Topics covered include chemical equilibrium (algebraic, graphical, and computer-aided solution techniques); acid-base equilibria and buffering; oxidation and reduction reactions; and solid precipitation and dissolution. Prerequisite: Graduate standing or CVEG 32403 and instructor approval. (Typically offered: Spring)

CVEG 52103. Advanced Water Treatment Design. 3 Hours.
Design of industrial and municipal water treatment plants. Discussion of raw and treated water requirements for several uses. Prerequisite: CVEG 32403. (Typically offered: Spring)

CVEG 52303. Microbiology for Environmental Engineers. 3 Hours.
Fundamental and applied aspects of microbiology and biochemistry relating to water quality control, wastewater treatment, and stream pollution. Prerequisite: CVEG 32403. (Typically offered: Irregular)

CVEG 52403. Groundwater Hydrology. 3 Hours.
Detailed analysis of groundwater movement, well hydraulics, groundwater pollution and artificial recharge. Surface and subsurface investigations of groundwater and groundwater management, saline intrusion and groundwater modeling will be addressed. Prerequisite: CVEG 32203. (Typically offered: Irregular)

CVEG 52503. Physical-Chemical Processes for Water and Wastewater Treatment. 3 Hours.
This course provides a fundamental understanding of physical and chemical processes used in the treatment of drinking water and wastewater. Principals of mass balance are applied to understand the impact of reactor hydraulics (ideal and non-ideal flow) and reaction kinetics on process performance and identify important process variables. Chemical processes covered include disinfection, gas transfer, adsorption, and ion exchange; physical processes covered include coagulation, flocculation, sedimentation, filtration, and membranes. Prerequisite: Graduate standing and instructor consent. (Typically offered: Fall Odd Years)

CVEG 52903. Water Reuse. 3 Hours.
CVEG 52903 is a graduate-level course that discusses topics related to water reclamation and reuse. Topics include past and current practices of water reuse, health and environmental issues related to water reuse, water technologies and systems for water reuse, and water reuse applications. Prerequisite: CVEG 32403 or equivalent course. (Typically offered: Spring Even Years)

CVEG 53003. Theory of Stability. 3 Hours.
Study of structural members subjected to compression. Analysis of compression members considering support conditions and within frame configurations. Analysis of beams considering lateral torsional bucking. AISC Steel Manual strength equations related to columns and beams are derived and discussed. Prerequisite: Graduate standing. (Typically offered: Irregular)

CVEG 53103. Matrix Analysis of Structures. 3 Hours.
Energy and digital computer techniques of structural analysis as applied to conventional forms, space trusses, and frames. Prerequisite: CVEG 33003 or graduate standing. (Typically offered: Irregular)

CVEG 53143. Mass Timber Design. 3 Hours.
Mass timber is a structural material that is gaining great popularity for usage in the United States. However, few graduating civil engineering students have design knowledge of the material. This course gives an overview of two mass timber products, glued-laminated timber (glulam) and cross-laminated timber (CLT). Students attending the class will design and analyze mass timber structural components using the Load and Resistance Factor Design (LRFD) method. Additionally, students will design and analyze glulam and CLT connections using readily available proprietary connections that are typically used in the design engineering community. Prerequisite: Graduate standing. (Typically offered: Irregular)

CVEG 53203. Structural Dynamics. 3 Hours.
Dynamics response of single and multidegree of freedom systems. Modal analysis. Response spectra. Computer programs for dynamic analysis. Design considerations for structures subjected to time-varying forces including earthquake, wind, and blast loads. Prerequisite: CVEG 33003. (Typically offered: Irregular)

CVEG 53303. Concrete Materials. 3 Hours.
Topics include portland cement production, supplementary cementing materials, fresh and hardened concrete properties, mixture proportioning, chemical admixtures, curing, and specialty concretes. Corequisite: Lab component. Prerequisite: CVEG 43003. (Typically offered: Irregular)

CVEG 53403. Highway Bridges. 3 Hours.
Economics of spans, current design and construction specifications, comparative designs. Possible refinements in design techniques and improved utilization of materials. Prerequisite: CVEG 43103 and CVEG 43003. (Typically offered: Irregular)

CVEG 53503. Prestressed Concrete Design. 3 Hours.
Analysis and design of prestressed concrete beams. Topics include flexural analysis, prestress bond, draping and debonding, allowable stresses, shear analysis and design, camber prediction, and prestress losses. Prerequisite: CVEG 43003. (Typically offered: Irregular)

CVEG 53603. Advanced Topics in Reinforced Concrete. 3 Hours.
Analysis and design of reinforced concrete members. Topics include slender columns, one-way and two-way slab design, strut and tie design, and torsion. Prerequisite: CVEG 43003 or graduate standing. (Typically offered: Irregular)

CVEG 53703. Advanced Structural Steel Design. 3 Hours.
Design of structural steel components using the Load and Resistance Factor Design method. Intensive treatment of simple and eccentric connections, composite construction, plate girders, and plastic analysis and design. Prerequisite: CVEG 43103 or graduate standing. (Typically offered: Irregular)

CVEG 53803. Finite Element Methods in Civil Engineering. 3 Hours.
An understanding of the fundamentals of the finite element method and its application to structural configurations too complicated to be analyzed without computer applications. Application to other areas of civil engineering analysis and design such as soil mechanics, foundations, fluid flow, and flow through porous media. Prerequisite: Graduate standing. (Typically offered: Irregular)

CVEG 53903. Advanced Strength of Materials. 3 Hours.
The course will continue from the basic material addressed in the undergraduate course and investigate in more detail stress analysis as it pertains to civil engineering type problems. Topics addressed in the course will include stress analysis (two-dimensional), constitutive relationships, solutions for two-dimensional problems, flexure, torsion, beams on elastic foundations, and energy methods. Prerequisite: CVEG 20203 or MEEG 30103. (Typically offered: Irregular)

CVEG 54103. Transportation and Land Development. 3 Hours.
Study of interaction between land development and the transportation network. Application of planning, design, and operational techniques to manage land development impacts upon the transportation system, and to integrate land layout with transportation network layout. Prerequisite: Graduate standing. (Typically offered: Irregular)

CVEG 54203. Structural Design of Pavement Systems. 3 Hours.
An introduction to the structural design of pavement systems including: survey of current design procedures; study of rigid pavement jointing and reinforcement practices; examination of the behavioral characteristics of pavement materials and of rigid and flexible pavement systems; introduction to structural analysis theories and to pavement management concepts. Prerequisite: CVEG 44303. (Typically offered: Irregular)

CVEG 54303. Traffic Engineering. 3 Hours.
A study of both the underlying theory and the use of traffic control devices (signs, traffic signals, pavement markings), and relationships to improved traffic flow and safety, driver and vehicle characteristics, geometric design, and societal concerns. Also includes methods to collect, analyze, and use traffic data. Prerequisite: CVEG 34103 or graduate standing. (Typically offered: Irregular)

CVEG 54403. Data Analysis and Machine Learning. 3 Hours.
The purpose of this course is to provide students with a solid background in the application of common statistical/econometric analysis techniques and related statistical modeling. This course emphasizes the empirical application of statistical techniques, but underlying theories and their limitations will also be discussed and simple derivations will be performed in class. The class will focus on applications of modeling techniques through the use of technical computing software including Matlab and KNIME. Students from all areas of engineering and other broad disciplines are welcome. Prerequisite: Graduate Standing. (Typically offered: Spring)

CVEG 54503. Production and Construction of Pavement. 3 Hours.
The life cycle of a pavement can be seen in five stages: 1) material selection, 2) structural design, 3) production and construction, 4) the life of the pavement, and 5) the end of the pavement's life. This course will focus on the production and construction of pavement, but will provide a brief overview of the first, second, fourth, and fifth stages as well. Three different types of pavements will be explored: 1) unbound granular material, 2) flexible pavement (asphalt concrete), and 3) rigid pavement (Portland cement concrete). Prerequisite: Graduate Standing. (Typically offered: Irregular)

CVEG 54603. Transportation Modeling. 3 Hours.
The use of mathematical techniques and/or computer software to model significant transportation system attributes. May compare model results with actual measured traffic attributes, using existing data sources and/or collecting and analyzing field data. Pre- or Corequisite: Lab component. Prerequisite: Graduate standing. (Typically offered: Irregular)

CVEG 54703. Transportation System Characteristics. 3 Hours.
Introduction to the fundamentals of traffic engineering and transportation networks. In the first part, students will become familiar with traffic engineering studies, traffic flow theory, traffic control devices, traffic signals, capacity, and level of service analysis of freeways and urban streets. The second part of this course will introduce the basic concepts of transportation network analysis and explore some applications. Prerequisite: CVEG 34103 or graduate standing. (Typically offered: Irregular)

CVEG 54903. Pavement Maintenance and Rehabilitation. 3 Hours.
The life cycle of a pavement can be seen in five stages: 1) material selection, 2) structural design, 3) production and construction, 4) the life of the pavement, and 5) the end of the pavement's life. This course will focus on the life of roadway pavements and the end of the pavement's life, but will provide a brief overview of the first, second, and third stages as well. Three different types of pavements will be explored:1) unbound granular material, 2) flexible pavement (asphalt concrete), and 3) rigid pavement (Portland cement concrete). Prerequisite: Graduate Standing. (Typically offered: Irregular)

CVEG 55003. Construction Safety. 3 Hours.
Construction industry safety management systems, practices, and research to prevent injuries on work sites. Roles, responsibilities, and interaction of construction industry participants in safety management. OSHA organization, regulation framework, and resources. Safety program procedures and practices associated with positive safety performance outcomes. Total cost of injuries to include personal, direct/indirect costs, and workers compensation insurance. Prerequisite: Graduate Standing. (Typically offered: Fall, Spring and Summer)

CVEG 55103. Construction Scheduling. 3 Hours.
Develop an understanding of modern scheduling techniques used for the management of construction projects. Learn the underlying logical principles, calculation methods, and presentation formats for PDM, the most prevalent technique. Load schedules with resources and costs to enable leveling, smoothing, and earned value analysis. Learn to update schedules for actual progress, identify problems, and compress or crash activities. Prerequisite: Graduate Standing. (Typically offered: Fall, Spring and Summer)

CVEG 55203. Construction Productivity. 3 Hours.
This course introduces the student to construction industry productivity measurement, management practices, planning processes, and work methods to improve labor productivity on project sites. Factors that influence labor productivity such as resource supply chain, rework, changes, craft labor motivation, and the workface environment are included. Roles, responsibilities, and interaction of construction industry participants in productivity management will be examined. Participants will learn construction productivity improvement program tools associated with improved productivity performance including work sampling and activity analysis. Prerequisite: Graduate Standing. (Typically offered: Fall, Spring and Summer)

CVEG 55303. Legal Aspects of Construction. 3 Hours.
Students will identify legal issues in the course of a construction project and learn to determine when and where they or their employers or clients need legal advice. The course covers the most common legal considerations and disputes that arise in the construction and design industries from the perspectives of different industry participants, and it explores the most important contractual terms commonly used in construction industry agreements. The individual lessons address basic aspects of the legal system, liability for negligence and professional malpractice, and a full range of legal risk allocation and risk management strategies, relating to: bidding and proposal practices; project delivery systems; contracting practices; insurance; surety bonds; pricing, scheduling, and payment disputes; contract administration; legal remedies; and alternative dispute resolution methods. Prerequisite: Graduate Standing. (Typically offered: Fall, Spring and Summer)

CVEG 55403. Sustainability in Construction Management. 3 Hours.
Sustainability in Construction Management will explore traditional concepts of construction management through the lens of sustainability. Topics covered will include elements of sustainable design and construction, sustainable project requirements and management, choosing materials and production, sustainability design and construction economics, understanding specifications, community participation, waste management, regulatory agencies, and worker safety and roles. These topics will be viewed through the lens of the three pillars of sustainability: economics, environmental, and social. Prerequisite: Graduate Standing. (Typically offered: Fall, Spring and Summer)

CVEG 55503. Risk and Financial Management in Construction. 3 Hours.
This course prepares students to understand the differences between financial management in a construction company versus financial management in other industries. The course will also teach students how to account for a construction company's financial resources. The students will then learn how to quantitatively analyze financial decisions. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer)

CVEG 55603. Building Information Modeling (BIM) for Design and Construction. 3 Hours.
This course provides students with a comprehensive overview of building information modeling (BIM) within the context of multiple project delivery methods and from the different perspectives of owners, architects/engineers and contractors/subcontractors. The course includes "hands-on" experiences using BIM software (Autodesk Revit) and will provide students with a basic working knowledge of the software. The curriculum also covers a systems perspective of how BIM works in different contractual relationships and workflows. Finally, the course will provide students with an understanding of how to implement BIM for companies that have not already done so. The course culminates with a student-modeled project in BIM, in conjunction with a real-world example in how your company can implement BIM. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer)

CVEG 55703. Construction Project Management. 3 Hours.
Construction project management introduces students to the full life cycle of construction projects from feasibility through completion and commissioning. Students are given an overview of the diverse construction industry, general project management concepts, and the specific application of those principles to complete construction projects. Standard construction industry processes and procedures such as cash flow and payment scheduling, change orders, project acceleration, coordination and communication, record keeping are depicted. Prerequisite: Graduate Standing. (Typically offered: Spring)

CVEG 55803. Heavy Construction Equipment Management. 3 Hours.
The course covers estimating equipment ownership, operating cost, and how to determine economic life and replacement policy as well as how to schedule a production-driven, equipment-intensive project that achieves target production rates and meets target equipment-related unit costs and profits. The course will cover material selection based on productivity and OSHA safety regulations. While this class is in the heavy civil track within the department, both horizontal and vertical construction equipment will be discussed. Prerequisite: Graduate Standing. (Typically offered: Summer)

CVEG 55903. Cost Management: Ownership. 3 Hours.
Study of cost management procedures applicable to the building process from the conceptual phase through owner operations, including conceptual estimating, converting estimates to budgets, progress measurement, project cost analysis and control, value engineering, and life-cycle costing. Prerequisite: Graduate standing. (Typically offered: Fall and Spring)

CVEG 56003. Advanced Building Information Modeling (BIM) for Design and Construction. 3 Hours.
This course will cover the fundamental principles and practices of using building information models for model management, including quantification, scheduling, and coordination. The course will also present the use of advanced information systems in the construction context, such as parametric modeling, creating infrastructure models, and reality capture. The goal of this course is to develop the students' understanding of how cloud-connected tools, collaboration tools, and advanced construction technologies can transform and improve the construction management process to aid in project success. Prerequisite: Must be a student in the CSMG masters degree program. (Typically offered: Fall and Summer)

CVEG 56103. Construction Supply Chain Management. 3 Hours.
This course introduces the concepts of construction supply chain management and its implementation in construction projects. Through lectures regarding theories, case studies, and discussion, students will learn about improvement opportunities in recent construction projects from a supply chain lens. The lectures will cover lean principles, materials management, and digital threads to achieve these. Then, students will work on a hypothetical project to solve critical issues by using supply chain management concepts. Prerequisite: Graduate standing. (Typically offered: Fall and Spring)

CVEG 5620V. Independent Study. 1-6 Hour.
Fundamental and applied research. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer)

CVEG 5630V. Special Problems. 1-6 Hour.
Special problems in CVEG. Prerequisite: Graduate standing. (Typically offered: Irregular) May be repeated for up to 12 hours of degree credit.

CVEG 57003. Environmental Regulations and Permits. 3 Hours.
The purpose of this course is to introduce students to selected environmental regulations, Federal and State Agencies and to present an overview of the Permitting Process. The course primarily addresses NPDES wastewater and storm water rules and requirements but will also touch on Air Quality, Environmental Impact and impact statements as well as OSHA regulations. This course covers compliance and how you attain compliance. Prerequisite: Graduate standing and Department consent. (Typically offered: Fall and Spring)

CVEG 57103. Low Impact Development. 3 Hours.
To understand the purposes and aspects of low impact design and to apply LID principles to storm water management and site development. Prerequisite: Graduate Standing. (Typically offered: Fall, Spring and Summer)

CVEG 58603. Fundamentals of Sustainability in Civil Engineering. 3 Hours.
Qualify and quantify the economic, environmental, societal and engineering drivers behind sustainability in Civil Engineering. Justification of the feasibility and benefits of sustainability in environmental, geotechnical, structural and transportation through verbal and written communications. Students cannot receive credit for both CVEG 48603 and CVEG 58603. Prerequisite: Graduate standing or instructor consent. (Typically offered: Irregular)

CVEG 59003. Seismic Steel Building Design. 3 Hours.
The aim of this course is to give students the ability to analyze and design steel systems and components for extreme lateral loads induced by earthquakes. Focus will be placed on: basic theory of dynamic response and application of seismic design provisions; understanding of lateral load paths in structural steel systems; and the analysis and design of common steel seismic systems and components. Prerequisite: Graduate standing and Department consent. (Typically offered: Irregular)

CVEG 59103. CFD for Wind Engineering. 3 Hours.
The goal of this course is to apply the Computational Fluid Dynamics (CFD) method to wind engineering problems. This is a unique class which needs an understanding of basic fluid mechanics, numerical techniques, wind engineering, turbulence, structural dynamics, fluid structure interaction (FSI) effect etc. Only an introduction to CFD is made using 1D, 2D and 3D problems. The course concludes with a brief discussion on advanced topics. Prerequisite: Graduate Standing. (Typically offered: Irregular)

CVEG 59203. Timber Design. 3 Hours.
Selection of timber beams, columns, and beam-columns. Physical properties of wood, analysis and design of timber connections. Truss design, glulam members, timber bridge design, treatment for decay, and fire protection. Prerequisite: CVEG 33003 with a C or better. (Typically offered: Irregular)

CVEG 59303. Advanced Timber Design. 3 Hours.
Expanding upon learning objectives from Timber Design I, this course will focus more in-depth on the topics of whole building design. Design loads will be developed per ASCE 7-22 procedures with emphasis on complete lateral design for wind and seismic loading. Design, selection, and detailing for both gravity and lateral loading connections will be completed. Fire rating code compliance and detailing will also be covered. Prerequisite: CVEG 59203. (Typically offered: Irregular)

CVEG 59503. Fundamentals of Fracture and Fatigue in Structures. 3 Hours.
The course will cover the concepts of linear-elastic, elastic-plastic and time-dependent Fracture Mechanics as applied to fracture in a variety of materials, structures, and operating conditions. The examples will include fracture in large components such as aircraft, bridges and pressure vessels and also in bones and in soft materials and human tissue. Prerequisite: Graduate standing in Civil, Mechanical or Biomedical Engineering or consent of the instructor. (Typically offered: Fall)
This course is cross-listed with BMEG 59503, MEEG 59503.

CVEG 6000V. Master's Thesis. 1-6 Hour.
Master's Thesis. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

CVEG 7000V. Doctoral Dissertation. 1-18 Hour.
Doctoral Dissertation. Prerequisite: Candidacy. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.