MYERS-LAWSON SCHOOL OF CONSTRUCTION (CONSTRUCTION ENGINEERING AND MANAGEMENT PROGRAM)

Our Website (http://cem.mlsoc.vt.edu/)

Overview

The Myers-Lawson School of Construction offers students in the College of Engineering a Bachelor of Science Degree in Construction Engineering and Management. The curriculum emphasizes the development of critical technical, managerial and professional knowledge and skills required for careers in construction engineering or for graduate studies. This program covers engineering theory and resource-management methods to integrate and manage the resources essential to construction operations, supporting the development of safe, ethical, socially responsible, and sustainable solutions for the built environment.

Throughout their studies, students plan, direct, and coordinate construction projects, from buildings to heavy-highway and infrastructure projects. Core courses include construction materials, structural and geotechnical fundamentals, cost estimating, scheduling, project delivery methods, and safety management. Integrative elements of leadership, professional communication, entrepreneurship, and best-practice management principles prepare graduates to excel as construction engineers and managers. A capstone course provides a culminating experience in which students apply their technical and managerial skills to a real-world construction engineering project. The program offers a degree in Construction Engineering and Management and a Major in Construction Safety Leadership.

Accreditation

The Bachelor of Science in Construction Engineering and Management (BSCEM) degree program is accredited by the Engineering Accreditation Commission of ABET (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Construction and Similarly Named Engineering Programs and is also accredited by the Applied and Natural Science Accreditation Commission of ABET (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Construction Management and Similarly Named Programs.

Program Educational Objectives

The Program Educational Objectives of the Construction Engineering and Management program are that, within a few years of program completion, graduates should be effectively serving society as construction engineering and management professionals by:

- Identifying, designing, analyzing, integrating, and managing the technical, material, financial, legal, and personnel administration aspects that support construction operations, projects and organizations throughout the project lifecycle, i.e., from programming to decommissioning.
- Incorporate safety, efficiency, cost effectiveness, environmental sensitivity and social awareness into the development, planning and implementation of construction operations and processes.
- Apply skills of effective communication, entrepreneurship, teamwork, values-based leadership, professional and ethical behaviors that are the necessary complement to technical competence.
- Continue their professional development and learning which may include professional licensure or certification, graduate level education, continuing education courses, self-directed study and active involvement in the construction community.

Student Outcomes

Upon completion of the undergraduate program curriculum in Construction Engineering and Management, students will attain the following outcomes:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Curriculum

The Construction Engineering and Management (CEM) curriculum is built upon a structured integration of engineering analysis and construction management principles. Developed in collaboration with the Via Department of Civil and Environmental Engineering, and the Building Construction programs, it combines targeted coursework with safety-centric, small-cohort learning environment that promotes direct faculty mentorship and rigorous peer collaboration.

Building on these foundations, students complete core engineering courses to learn the fundamentals of structural, geotechnical, and materials engineering concepts, alongside specialized CEM coursework in planning and developing technical solutions for construction and shared building construction courses on building systems fundamentals. Hand-on laboratories, field investigations, and case studies reinforce analytical techniques in estimating, scheduling, safety, risk management, design of temporary works for construction, and construction means and methods. A year-long, team-based capstone challenges students to engineer technical solutions to real-world projects. Students have the opportunity to participate in a summer internship program during which they apply classroom concepts in industry settings. This program

encourages all students to engage in professional work experience prior to graduation and to pursue FE and PE licensure preparation.

Program Contact

The contact person for the undergraduate Construction Engineering and Management program is the CEM Program Chair, Lindsay Lally. Lindsay can be reached at **lbackus@vt.edu**.

- Construction Engineering and Management Major (https://catalog.vt.edu/undergraduate/college-engineering/construction-engineering-management/construction-engineering-management-bs/)
- Construction Safety Leadership Major (https://catalog.vt.edu/undergraduate/college-engineering/construction-engineering-management/construction-safety-leadership-bs/)

Director: Brian Kleiner[1]
Chair: L. Lally

Graduate Program Director: J. Iorio

Professors: A. Akanmu[2]

Associate Professors: K. Afsari[3] and X. Gao

Assistant Professors: A. Ashtarout and R. Zhang

Associate Professor of Practice: A. Johnson and L. Lally

Adjunct Faculty: S. Darr, C. Porterfield, and K. Bocock

Academic Affairs Coordinator: S. Norwood[4]

Footnotes:

[1]Construction Industry Institute Distinguished Professor; National Academic of Construction member; Director, Center for Innovation in Safety, Health and Well-being

[2]Director, Smart Systems Lab

[3]Managing Director, ARCADE Lab

[4]Provost's Award for Excellence in Advising

Undergraduate Course Descriptions (BC)

BC 1014 - Building A Strong Foundation for Success (2 credits)
Exploration of career options within the built environment and construction industry. Professional development, digital literacy, which will include creation of media and “personal brand” identity. Exploration of ideas from multiple viewpoints and perspectives. Oral, written, and visual presentation of ideas such as resume development. Introduction to ethical considerations. Reflection on “Self-as-Learner.” Critical-Thinking skills as they apply to construction projects. Development of group roles as they apply to construction projects. Identification of universities resources, policies, procedures, academic and social engagement opportunities.
Instructional Contact Hours: (2 Lec, 2 Crd)

BC 1114 - Introduction to Building Construction (3 credits)
Introduction to construction with understanding of different market sectors, specializations, career path opportunities, industry stakeholders, and processes. Comprehension of quality assurance, control, project delivery systems, basic estimating, and scheduling. Application of communication skills to professional settings and use of basic calculations to solve construction math problems.
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 1124 - Construction Documents and Safety (2 credits)
Role of construction drawings and specifications. Interpretation of construction documents and creation of basic project documentation. Health, safety, and environmental hazards encountered in the construction industry. Design Lab Studio (1H, 2L, 2C)
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

BC 1214 - Introduction to Building Construction I (3 credits)
Introduction to construction with an overview of construction drawings and specifications, construction terminology, building codes and building systems, cost estimating and bidding, construction management processes, construction documents, load paths and foundations, construction health and safety, and hands-on experiential learning through lab exercises. Strategic career success factors and introduction to ethical decisions in construction management.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 1224 - Introduction to Building Construction II (3 credits)
Overview of the important areas of contracting and the workings of the construction industry. Application of construction management theory, processes, and terminology including, definable building systems, building code interpretations, the reading and preparing of basic construction drawings and integrating construction details and project specifications to derive safe construction means and methods, equipment section, cost estimates and time schedules.
Prerequisite(s): BC 1214 or BC 1114
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2004 - Construction Surveying (1 credit)
Surveying in context of the construction process, basic surveying methods, equipment, emerging technologies, topographic surveying, and application to construction layout.
Prerequisite(s): BC 1124
Instructional Contact Hours: (1 Lec, 1 Crd)

BC 2014 - Construction Principles I (3 credits)
Fundamentals of the construction technology and process emphasizing project management/operations, materials and methods. Utilization of industry-specific technology/software applications, techniques and sequences/project loading for the construction of buildings in compliance with Construction Specifications Institute (CSI) Divisions 00-05, 31, 32, 33. Planning, scheduling, materials cost analysis, job-appropriate equipment and labor requirements, masonry applications, concrete and formwork. Site preparation and utilization, use of construction industry-specific software, interpretation of project drawing documents. Integration of project safety and health issues. Quantity surveying for the management of construction resources, according to current principles and industry standards.
Prerequisite(s): BC 1224 or BC 1124
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2024 - Construction Principles II (3 credits)
Continuation of the fundamentals of construction technology and process emphasizing materials, methods, techniques and sequences for the construction of buildings using Construction Specifications Institute (CSI) Divisions 01, 06-14, 21. Interpretation of construction details relevant to a construction project. Cost impact of building codes and inspections. Development of presentation skills using project-based learning. Planning, scheduling, labor needs, and quantity surveying for the management of construction resources. Development of safety and quality assurance plans, including building systems for fire suppression.
Prerequisite(s): BC 2014
Corequisite(s): BC 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2044 - Construction Materials (3 credits)
Introduction to the life cycle, properties, behaviors, and sustainability impacts of common construction materials including wood, insulation, asphalt, ferrous and nonferrous metals, aggregate, concrete, masonry, glass, and plastics. Theory of materials including material properties; behavior under physical, thermal, and environmental loads; and interfaces between dissimilar materials. Methods and criteria for material comparison and selection for sustainable construction. Preparation of professional written reports as a team and individually; Project management for materials selection/application.
Corequisite(s): BC 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2064 - Integrated Construction I (3 credits)
Application of construction means, materials and methods related to quantity take-off, cost management, scheduling, resource management, document drawing, building information modeling in support of a selected project. Project cost impact of building code requirements. Emphasis on structural components of selected project.
Prerequisite(s): BC 2014 and BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2104 - Building Effective Construction Teams (3 credits)
Introduction to leadership behavior styles and their impact on construction management team performance, including analysis of how ethical behavior and individual strengths support positive relationship-building. Development of management strategies to maximize positive conflict outcomes through trust-building between construction project stakeholders. Identification of the role that implicit bias plays in decision-making within diverse project teams. Development of presentation skills for a construction audience.
Prerequisite(s): BC 1224 or BC 1124
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2114 - Information Technology in Design and Construction (3 credits)
Building delivery and project management improvements through the use of information technology (IT) are explored, including scheduling software, building information modeling (BIM) tools, and virtual design and construction (VDC) simulation software and their corresponding theories and concepts that integrate design and construction. Use BIM/VDC tools for graphical presentations, databases, and spreadsheets.
Prerequisite(s): BC 1224 or CEM 2104 or BC 1124
Corequisite(s): BC 2014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2134 - Construction Data Analysis (2 credits)
Identification and use of various types and sources of construction market data and the tools for analyzing construction data to support managerial decision making. Different forms of applying mathematics to the construction market for better productivity and processes across the construction industry. Develop insights to inform management and investment decisions. Use of cost-benefit analysis as applied to construction management in determining feasibility of projects.
Prerequisite(s): MATH 1025 or MATH 1225
Instructional Contact Hours: (2 Lec, 2 Crd)

BC 2214 - Why Buildings Stand Up (3 credits)
Overview of fundamental principles explaining why structures remain stable under various loading conditions. Explores different types of structures and applied loads and analyzes both determinate and indeterminately supported structures. Calculation of shear, bending moments, deflections in beams, and buckling. Discussion of ethical impacts on user safety and hazard avoidance, in project design and construction methods, materials, etc. Explores different types of soil composition and their strength properties.
Prerequisite(s): (BC 1224 or BC 1124) and (MATH 1025 or MATH 1225)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2354 - Residential Construction Technologies (3 credits)
Identify and evaluate conventional construction materials, methods, building systems, and products to less-familiar, innovative technological alternatives for a specific residential construction project. Compare innovative technological alternatives with material and cost estimates. Overview of conventional materials, equipment, designs, and processes in residential construction. Investigate recent literature on emerging technologies to determine best practices. Strengthen understanding of the primary building systems in residential construction applications.
Prerequisite(s): BC 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 3014 - Building Physics and Environmental Systems (3 credits)
Theory and analysis methods relative to performance of envelope systems and the design and integration of mechanical and electrical building systems. Topics covered include: envelope systems and performance metrics, conceptual and technical design theory, operational principles, and maintenance issues, all necessary for determining the selection of passive and active environmental control systems within a building including: envelope system, heating, ventilation, air conditioning, lighting, and acoustical systems.
Prerequisite(s): PHYS 2205 and PHYS 2215 or PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 3064 - Integrated Construction II (3 credits)
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on building systems components of selected project.
Prerequisite(s): (BC 2064 or CEM 2104) and (PHYS 2205 and PHYS 2215 or PHYS 2305)
Corequisite(s): BC 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 3114 - Building Systems Technology (3 credits)
Emphasis is placed on the integration and physical installation of passive and active environmental control systems including: heating, ventilation, air conditioning, lighting, acoustics, plumbing, and fundamentals of thermal loads.
Prerequisite(s): BC 2024 and (PHYS 2305 or PHYS 2205 and PHYS 2215) or (CEM 2104 and PHYS 2305)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 3134 - Temporary Structures in Construction (3 credits)
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts.
Prerequisite(s): (BC 2044 and BC 2024 and BC 2214) or CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEM 3134

BC 3954 - Study Abroad (1-19 credits)
Study abroad in Spain.
Instructional Contact Hours: Variable credit course

BC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4024 - Estimating, Production, and Cost Engineering (3 credits)
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEE 4014

BC 4064 - Integrated Construction III (3 credits)
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on administrative/general contractor functions (such as project safety, budget development, and permitting) of the selected project.
Prerequisite(s): BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4114 - Building Information Modeling in Design and Construction (3 credits)
Introduction to means and methods to enrich the geometric information of a building model with semantic data such as, material, structural and performance values. Concept of interoperability in architecture, engineering and construction industry. Overview of approaches to information modeling such as Standard for the Exchange of Product model data (STEP), Industry Foundation Classes (ifc), Construction Operations Building Information Exchange (COBie) and Green Building XML (gbXML). Key concepts of object-oriented modeling and programming.
Prerequisite(s): BC 2114 or (ENGE 1215 and ENGE 1216)
Corequisite(s): CS 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4124 - Digital Construction & Manufacturing (3 credits)
Explore working principles, design projects, & experiment with construction digital information modeling, computer numerical control (CNC), and computer aided manufacturing (CAM) processes. Fundamentals of digital prototyping. Analysis of the industry tools such as 3D scanners, 3D printers, CNC manufacturing techniques, and others, used to provide familiarity with technologies & provide understanding of their benefits & limitations.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4164 - Production Planning and Process Design for Construction (3 credits)
The course deals with the planning and design of construction processes. Course topics include production systems, behavior of construction systems and workers, the relationships between subsystems in the construction process, queuing systems, process modeling and simulation. The major emphasis is on production and productivity. Production problems that typically occur in construction systems are discussed. The course also explores recent innovations in construction system design such as lean construction and agile construction.
Prerequisite(s): BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4174 - Decision Making and Risk Management (3 credits)
Explores the theories, methodologies, and tools used in decision making and risk management, with a focus on applications in the construction industry. Students will gain insights into the complexities of making decisions in uncertain project environments and learn strategies to identify, assess, and mitigate risks effectively throughout the project lifecycle. Pre: Junior/Senior Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4264 - Fundamentals of Construction Management (6 credits)
Practical construction management methods within the built environment. Construction materials, document drawings, management activities, fundamentals of construction scheduling and planning. Quality, quantity, and cost of materials necessary to complete a construction project. Construction information technology tools. Partially duplicates BC 2014 and 2114. Pre: Junior Standing.
Instructional Contact Hours: (6 Lec, 6 Crd)

BC 4314 - Building Performance and Energy Management (3 credits)
Fundamentals of building performance mandates for the built environment. Practical means and methods for evaluating building performance metrics within integrated design including acoustic performance, visual performance, and indoor air quality and management. Specific focus on energy resources consumed by thermal, hygrothermal, lighting, and other environmental building systems. Assessment of building energy consumption and analysis of retrofit scenarios through performance evaluation over the entire building life cycle.
Prerequisite(s): BC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4324 - Innovation in Residential Construction (3 credits)
Mechanisms of historical and current innovations in the residential construction industry. Theory and application within the realms of innovation, diffusion, technology, adoption, new product development, housing innovation literature, supply chain management, sustainability, information technology, commercialization, and housing policy. Innovation theories and applications to residential construction through the analysis and utilization of data-driven hypotheses typical to the industry.
Prerequisite(s): BC 2354 and BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4334 - Sustainable Building Performance Management (3 credits)
Introduction to means and methods for managing the sustainability of buildings and their performance over the life cycle. Best practices for sustainable projects in the areas of planning/development, site design, project management, energy and water conservation and green building assessment tools and methods; Leadership in Energy and Environmental Design (LEED) rating system; economic analysis of green building alternatives; and implementation planning.
Prerequisite(s): BC 3064 and BC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4364 - Lifecycle BIM for Facility Management (3 credits)
BIM (Building Information Modeling) concepts and tools that are critical for facility operation and maintenance. Identifying, capturing, analyzing, exporting and exchanging facility lifecycle data. Spreadsheet-based and BIM based facility management platforms. Case studies and real-life application for understanding mechanical, electrical, and plumbing systems from an owner or facility manager perspective. Workflow processes for data exchange.
Prerequisite(s): BC 2114 and BC 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4374 - Residential Housing and Land Development (3 credits)
Application of means, methods, and strategies for delivering single and multi-family residential housing in urban and suburban contexts. Project planning, including market analysis to determine highest and best use of an identified property, marketing and sales strategies, site and product design and procurement, infrastructure requirements, zoning and government agency regulations, financial analysis and feasibility study, financing strategies, and delivery control systems. Roles of developer and project team in preparing formal proposals for a housing development to be submitted for financing. Identification and application of interfaces with project stakeholders. Overview of contemporary topics such as green development and affordable housing.
Prerequisite(s): BC 2354 and BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4434 - Construction Practice I (3 credits)
Explores advanced business and management practices and applications to vertical construction projects. Topics include scope, planning and scheduling, assemblies estimating, cash flow controls. Creation of work breakdown structure, application of concepts of assemblies estimating and general conditions to interpret insurance and contract requires along with digital construction practices.
Prerequisite(s): BC 3064 and BC 3114 and BC 3134
Corequisite(s): BC 4064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4444 - Construction Practice II (4 credits)
This course explores and applies the business and construction practices related to operation of a construction company to a capstone experience. Construction operation is examined as it relates to construction, financial and personnel management. Project management topics studied in this course are applied in the corequisite lab. This course is formally designated as a writing intensive course. Formal written and edited and oral presentations are presented and critiqued by the BC faculty team, the writing resource center, students and industry professionals.
Prerequisite(s): BC 4434
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BC 4754 - Internship (1-3 credits)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

BC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (CEE)

CEE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2804 - Introduction to Civil and Environmental Engineering (3 credits)
Overview of the specialty areas within the civil engineering profession, professional engineer licensing, and engineering ethics. Includes recognizing contemporary issues in civil engineering, civil engineering work in the surrounding community, and the impact of civil engineering solutions on society. Emphasizes successful personal business practices for civil engineering professionals, to include the fundamentals of effective oral, written, and visual communication skills for the Civil Engineer. Introduction to engineering library resources. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 2814 - Geomatics (4 credits)
Introduction to data measurement issues in the civil and environmental engineering sub disciplines. Collection techniques, analysis, errors, statistical description and visualization. Spatial measurements such as leveling, distance and angles, mapping and topographic surveys, the Global Positioning System, LiDAR, terrain models, earthwork methods, construction surveying, coordinate systems, and Geographic Information Systems. Non-CEE students are exempt from the CEE 2834 corerequisite.
Prerequisite(s): ENGE 1216 or ENGE 1414
Corequisite(s): CEE 2834
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

CEE 2834 - Civil Engineering Drawings and Virtual Modeling (3 credits)
Introduction to the use of Computer-Aided Drafting, Building Information Modeling and Geographic Information Systems software. Interpretation of civil engineering drawings. Creation of civil engineering plans and two- and three- dimensional visualizations. Professional collaboration tools. Basemap creation. Basic analysis tools utilizing Geographic Information Systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 3014 - Construction Management (3 credits)
Introduction to the fundamental elements involved in managing construction projects. Project lifecycle, delivery methods and contracts, equipment and labor productivity, scheduling, and cost estimating and control. Pre: Junior standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3104 - Introduction to Environmental Engineering (3 credits)
Overall view of environmental engineering with emphasis on hazardous waste management, water treatment, wastewater treatment, air pollution and its control, solid waste management, groundwater pollution and environmental regulations.
Prerequisite(s): CHEM 1035 and CHEM 1045 and (MATH 1026 or MATH 1206 or MATH 1206H or MATH 1226 or MATH 2016 or MATH 2024) and (PHYS 2305 or PHYS 2205)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3274 - Introduction to Land Development Design (3 credits)
An introduction to the land development design process including site selection and feasibility, environmental considerations, utility layout, grading, stormwater management and integrating planning with the design of infrastructure to support residential and commercial development.
Prerequisite(s): CEE 2814 and (CEE 2824 or CEE 2834)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3304 - Fluid Mechanics for Civil and Environmental Engineering (4 credits)
Introductory course in fluid mechanics. Includes concepts and measurements of fluid properties; computing hydrostatic and hydrodynamic forces on hydraulic structures; computing fluid pressures, discharges, and velocities; and determining energy losses in pipe flows. Course includes conducting hydraulic laboratory experiments and demonstrations, analyzing and interpreting collected data, and preparing technical laboratory reports. Emphasizes the fundamentals of effective interpersonal, written, and visual communication skills for technical civil engineering reports. Design Lab/Studio. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Prerequisite(s): ESM 2104 and CEE 2804
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3314 - Water Resources Engineering (4 credits)
Open channel flow; hydrology; hydraulic modeling; hydraulic machinery and structures; laboratory experiments and demonstrations. Design Lab/Studio.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3404 - Introduction to Structural Engineering (3 credits)
Introduction to structural engineering as an art and science and its fundamental tenets; description of structural systems, structural loads, and load paths; structural models, case studies of successful and unsuccessful structural designs; calculations of forces and deformation for simple determinate structures (trusses, beams and simple frames) and indeterminate structures using virtual work, use of stiffness methods in computer programs.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3424 - Reinforced Concrete Structures I (3 credits)
Behavior and design of reinforced concrete members based on ultimate strength. Uncertainty, load and resistance factors. Load paths in framing systems. Beams, columns and slabs in flexure and shear. Deflections and crack control. Design of reinforced concrete members. Columns under axial forces, shear and flexure.
Prerequisite(s): (CEE 3404 or BC 2214) and (CEE 3684 or BC 2044)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3434 - Design of Steel Structures I (4 credits)
Properties and behavior of structural steel. Design of steel members and connections using American Institute of Steel Construction specifications. Consideration of loads, structural safety, and serviceability. Design of members to resist tension, compression, and bending. Design of basic steel connections including tension connections, bearing plates, and base plates. Team-based design project to design a simple steel framed building. Design Lab/Studio.
Prerequisite(s): (CEE 3404 or BC 2214) and (CEE 3684 or ESM 3054 or BC 2044)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3514 - Introduction to Geotechnical Engineering (4 credits)
Introduction to soil as an engineering material for construction and infrastructure support. Geological processes, soil classification, phase relations, geostatic and applied stresses, permeability, seepage effects, settlement, and strength. Laboratory testing, interpretation, and presentation of results. Application of geotechnical principles to civil and environmental engineering problems. Design Lab/Studio.
Prerequisite(s): ESM 2204 and GEOS 2104
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3604 - Introduction to Transportation Engineering (3 credits)
Planning, design and operation of transportation systems with emphasis in multimodal transportation techniques and unified system engineering theories to analyze large scale transportation problems. Discussion of Intelligent Vehicle Highway Systems (IVHS) and hands on experience in computer models in transportation operations and planning. Interactions between transportation infrastructure and environmental engineering planning. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3684 - Civil Engineering Materials (4 credits)
Fundamental nature and performance of civil infrastructure materials, including metals, portland cement concrete, asphalt concrete, polymers, and wood. Material properties, microstructure, and mechanical behavior. Laboratory experimental procedures and standardized testing, property variability, durability, sustainability and resilience. Design of cementitious and asphalt mixtures, experimental design, non-destructive testing. Design lab/studio.
Prerequisite(s): CHEM 1045 and CHEM 1035 and ESM 2204 and GEOS 2104 and (CEE 2814 or CEM 2824)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3804 - Computer Applications for Civil and Environmental Engineers (3 credits)
Introduction to computer applications in civil and environmental engineering. Integration of quantitative analysis for design, data management, computer programming and problem solving skills with computer tools and techniques. Topics include systems analysis, numerical methods, optimization, data mining, computer programming and data queries. Analysis and interpretation of a global data set. Pre: Junior Standing.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3814 - Analytical Tools in Civil and Environmental Engineering (3 credits)
Computer programming and data analysis for civil and environmental engineering projects. Acquiring, cleaning and pre-processing data sets. Probability distributions, hypothesis testing, and regression modeling. Time series and frequency analysis. Data visualization.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

CEE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4014 - Estimating, Production, and Cost Engineering (3 credits)
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BC 4024

CEE 4024 - Construction Control Techniques (3 credits)
Techniques used to plan, schedule, and control the Construction Process. Emphasizes manual and computer-based approaches. Focuses on an analytical approach towards the construction process whereby good technical methodologies and solutions are converted to reality through construction practices.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4034 - Smart Sustainable Infrastructure (3 credits)
Challenges and barriers to sustainable infrastructure. Effects of a changing planet and society on current infrastructure systems. Technology and data use for engineering. Infrastructure data interpretation. Data-driven engineering solutions.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4074 - Construction Engineering: Means and Methods (3 credits)
Construction means, methods, and equipment used to transform a particular design concept into a completed usable structure or facility. Selection and optimization of individual units as well as the systems needed to produce the required work to the required quality on time and on budget.
Prerequisite(s): CEE 3014 or CEM 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4104 - Water and Wastewater Treatment Design (3 credits)
Design of municipal water and wastewater treatment plants. Emphasis on characterization of water and wastewater and physical, chemical, and biological treatment methods. Sludge processing advanced treatment methods and treatment plant hydraulics are considered. A grade of C- or better required in prerequisites.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4114 - Fundamentals of Public Health Engineering (3 credits)
Public health engineering principles for protection against biological and chemical health hazards. Emphasis on major communicable diseases that plague mankind, organisms that cause them, routes of transmission, and engineering methods of control. Appropriate control methods for rural areas and developing countries.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4134 - Environmental Sustainability - A Systems Approach (3 credits)
Quantitative methods to evaluate environmental sustainability using a sytems approach. Sustainability assessment frameworks, oreintors and indicators, indicators of sustainable development, green-house gas emissions, renewable energy systems, whole-system design, economic systems and input-outpur techniques, system dynamics models, emergence and agent-based models. Class project requiring integration of environmental, economic and social systems using system dynamics and agent-based models. Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4144 - Air Resources Engineering (3 credits)
Effects, regulation, sources, and control of air pollution. Application of engineering calculations and models to estimate emissions, predict pollutant concentrations, and design pollution control equipment. Senior standing required. A grade of C- or better required in prerequisites.
Prerequisite(s): CEE 3104 or ENGR 3124 or GEOS 3114 or ENSC 3634
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4254 - Municipal Engineering (3 credits)
An introduction to the field of municipal engineering. Infrastructure, capital projects, financing, sustainability, disaster planning and response, and plan review for development projects. Senior standing required.
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4264 - Sustainable Land Development (3 credits)
An introduction to the modern techniques for developing land while maintaining a focus on long-term sustainability. Topics include site layout, stormwater impact, air quality and microclimate, living resources, LEED and EarthCraft development standards. Pre-requisite: Senior Standing required
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4274 - Land Development Design (3 credits)
Overview of land development projects including construction practices, legal issues, and government policies. Feasibility study, engineering evaluation. Grading and roadway design, layout design of lots, buildings, streets, sewers, and stormwater control. Interactive graphics and automated drafting.
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4284 - Advanced Land Development Design (3 credits)
Advanced course in land development design focusing on site grading and parking, stormwater management, and erosion control. Reviews project design criteria and applicable municipal and state guidelines. Uses CAD software for design and deliverables. Senior/Graduate standing required.
Prerequisite(s): CEE 3274
Corequisite(s): CEE 4274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4304 - Hydrology (3 credits)
Precipitation, evaporation, consumptive use, infiltration; stream flow, flood routing; statistical analysis of hydrologic data, flood and drought forecasting, risk analysis, subsurface flow, well hydraulics, introduction to urban drainage design. A grade of C- or better required in pre-requisite.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4314 - Groundwater Resources (3 credits)
Fundamentals of groundwater hydrology; flow through porous media, both saturated and unsaturated; flow to wells in both confined and unconfined aquifers; seepage of groundwater to canals and field drains; analysis of aquifer test data to quantify flow and storage parameters; contaminants in groundwater, basic introduction to groundwater modeling. A grade of C- or better required in pre-requisite 3304.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4324 - Open Channel Flow (3 credits)
Mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow.
Prerequisite(s): CEE 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4334 - Hydraulic Structures (3 credits)
Hydraulic analysis and design of engineering structures for water control, including reservoirs, dams, spillways, spilling basins, drainage structures, and hydraulic models.
Prerequisite(s): CEE 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4344 - Water Resources Planning (3 credits)
Analysis of the water resources planning process and the institutional framework for water resources management. Criteria and procedures for evaluating management alternatives are examined, with emphasis on assessment of economic and environmental impacts. Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4364 - Geospatial Analysis and Hydrologic Design (3 credits)
Application of geospatial analysis and hydrologic modeling to problems of design using industry standard GIS tools and processes. Introduction to geospatial analysis, terrain analysis, flood frequency analysis, and hydraulic design for solving water resources engineering problems in practice. Evaluation of urbanization and climate change on watersheds and their impacts on populated areas. Design of flood risk maps. Team-based design project with report and presentation.
Prerequisite(s): CEE 3314 or BSE 4344
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4384 - Coastal Engineering (3 credits)
Basic wave mechanics principles, surf-zone processes, littoral and sediment processes, shoreline features, astronomical tides, coastal hazards, and functional design of coastal structures. Field trips.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4394 - Urban Water Sustainability (3 credits)
Coupled socio-hydrologic feedback loops and implications for water systems resilience. Urban water transitions theory and the evolution of water systems through time. Water productivity and the soft path for water. Ecosystem services. Urban water system challenges, including climate change, urbanization, equity and environmental justice, and water security. Centralized and distributed drinking water, stormwater, and wastewater treatment systems. Statistical analysis of urban water systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4404 - Intermediate Structural Analysis (3 credits)
Analysis of statically indeterminate 2D and 3D beam, truss and frame structures by the force and displacement methods. Computer implementation of force method. Influence lines and approximate methods of analysis.
Prerequisite(s): CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4454 - Masonry Structural Design (3 credits)
Masonry materials, material testing, material specifications. Structural behavior and design of masonry elements (walls, beams, and columns) and systems used in structures. Construction techniques and the details of masonry construction. Building codes relating to analysis and design of masonry structures.
Prerequisite(s): CEE 3684 and CEE 3424
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4514 - Methods in Geotechnical Engineering (3 credits)
Principles and techniques for characterizing earth materials (soil and rock) for civil engineering projects in various regional environments; with emphasis on the interdisciplinary approach to field exploration and site description through soil mechanics theory, geologic correlations, geophysical methods, in site testing and sampling. A grade of C- or better required in pre-requisite 3514.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4534 - Earth Pressures and Foundation Structures (3 credits)
Earth pressure theories and their applications to the design of retaining structures, anchors, and excavation bracing. Bearing capacity and settlement of shallow foundations. Types and capacity of deep foundations.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4544 - Design of Earth Structures (3 credits)
Application of geotechnical engineering principles in the design and construction of earth structures. Subsurface models, shear strength of soil, slope stability, earth fills, earth retention, ground improvement, sustainability considerations, geotechnical reporting. Team-based design project.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4554 - Natural Disaster Mitigation and Recovery (3 credits)
Causes, mechanics, classifications, and forces associated with tornadoes, hurricanes, floods, earthquakes, and landslides. Resistance evaluation for existing ground, facilities and structures. Hazard-resistant design of new facilities. Risk and reliability assessment and decision analysis. Strategies and designs for natural disaster risk mitigation. Emergency response for protection of life and property and restoration of lifelines. Includes an interdisciplinary team project. Prerequisite: Senior Standing Required
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4564 - Introduction to Coastal and Marine Geotechnics (3 credits)
Geotechnical aspects of coastal and marine engineering. Introduction to the coastal zone as a working environment. In-situ geotechnical methods and complementary techniques for investigation. Survey strategies. Local field trips for demonstrating methods, practice and design. A grade of C- or better is required in prerequisite 3514.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4604 - Traffic Engineering (3 credits)
Study of traffic and parking characteristics; application of traffic control devices; principles and techniques used to improve the efficiency and safety of traffic flow systems. A grade of C- or better required in pre-requisite 3604.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4610 - Mechanics of Composite Materials (3 credits)
Introduction to the deformation, stress, and strength analysis of continuous-fiber-polymer-matrix laminated composites. Fabrication, micromechanics of stiffness and expansional coefficients, classical lamination theory (CLT). Environmentally induced stresses. Computerized implementation and design
Prerequisite(s): ESM 2204 or AOE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4044

CEE 4614 - Concrete Materials (3 credits)
Fundamental properties of portland cement concretes. Concrete mixture design procedures. Testing of fresh and hardened properties of concrete. Durability and degradation mechanisms. Condition assessments, forensic materials engineering, and repair strategies.
Prerequisite(s): CEE 3684 or BC 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4624 - Planning Transportation Facilities (3 credits)
Transportation planning process; urban and regional studies, surveys, data analysis, model development and testing; transportation management, administration, finance, system evaluation, implementation, and integration.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4634 - Infrastructure Condition Assessment (3 credits)
Infrastructure components and assessment needs; physical and chemical properties of construction materials; deterioration causes, assessment methods, nondestructive evaluation techniques, infrastructure management systems, performance models, service-life-cycle estimates.
Prerequisite(s): CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4654 - Geometric Design of Highways (3 credits)
Functional design of highways; curves, intersections, interchanges, drainage, and other features involved in highway safety and traffic efficiency.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4664 - Pavement Design (3 credits)
Principles underlying methods for the design of various elements of flexible and rigid pavements for highways and airports; climate and traffic effects; pavement management systems. A grade of C- or better required in pre-requisite 3684.
Prerequisite(s): CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4674 - Airport Planning and Design (3 credits)
Airport planning and economic justification, site selection, configuration, development and design of terminal areas, demand forecasting, access, traffic control.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4684 - Transportation Safety (3 credits)
Basic principles associated with transportation safety related to humans, vehicles and infrastructure as well as principles of design for safety and practices of empirical evaluation of safety. Principles and practices of accident investigation and injury epidemiology as well as safeguards and control practices.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4694 - Freight Operations (3 credits)
Introduction to the operation of modal and intermodal freight facilities. Impact of goods movement on the multi-modal transportation system. Role of privately owned and operated goods movement on public sector transportation operations, management, and decision making. Communication of impacts.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4804 - Professional and Legal Issues in Civil Engineering (3 credits)
An overview of civil engineering professional practice, including business etiquette, professional development, leadership, and lifelong learning. Emphasizes the importance of registration for civil engineers. Compares and contrasts common project delivery methods, processes, key players, and management topics for the design and construction industry. Incorporates analyses of legal and ethical aspects of civil engineering practice. Analyzes contemporary issues and public policies that impact the civil engineering profession, and the impacts of civil engineering solutions on society. Emphasizes effective written, oral, and visual professional communication for the civil engineering professional. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Prerequisite(s): CEE 2804
Corequisite(s): CEE 3304
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4814 - Risk and Reliability Analysis in Civil and Environmental Engineering (3 credits)
Risk assessment and reliability analysis as applied to civil engineering applications. Identification and modeling of non-deterministic problems in civil engineering design and decision making. Application of probability and statistics to performance analysis. Development of probabilistic engineering safety assessments.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4824 - Introduction to Forensic Engineering (3 credits)
Basic processes in engineering failure investigations: response, data gathering, testing, modeling, and reporting. Origins of natural and man-made disasters, role of building codes and material specifications, standard of care, ethical standards and legal issues as related to forensic engineering.
Prerequisite(s): CEE 3684 and ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4844 - Building Information Modeling and Integrated Practices (3 credits)
Introduction to Building Information Modeling (BIM). Architectural modeling, custom parametric object creation, virtual structural modeling. Constructability and construction management analysis. Reality capturing technologies. Virtual reality and immersive virtual environments. Contemporary topics and new directions for BIM technologies. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4854 - Machine Learning Applications in Civil and Environmental Engineering (3 credits)
Solution of practical problems in Civil and Environmental Engineering (CEE) using machine learning (ML). Fundamental concepts and challenges to using ML in CEE. Preparation of project data, creation, and training of supervised learning models. Evaluation of model performance. Introduction to unsupervised learning and deep learning.
Prerequisite(s): CEE 3814
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (CEM)

CEM 1974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 2104 - Introduction to Construction Engineering and Management (3 credits)
Overview of the construction engineering and management profession specialty areas. Introduction to the undergraduate program of study. Fundamentals of effective oral, written and visual communication skills. Professionalism, ethics, and legal issues relating to the industry. Contemporary issues facing the industry. Engineering library resources. Project drawings, computer aided design (CAD), and responding to Requests for Proposals (RFPs).
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 2404 - Construction Project Documents (1 credit)
Interpret design documents for construction projects. Analyze project documents to select appropriate construction engineering methods. Quantify materials using appropriate methods and technology. Review and comparison of construction documentation in various industry sectors. Identify information required for construction that is missing or ambiguous in the design documentation. Create and analyze a request for information (RFI) to modify and update the project documentation.
Corequisite(s): CEM 2104
Instructional Contact Hours: (3 Lab, 1 Crd)

CEM 2714 - Construction Safety Systems (3 credits)
Introduction to construction safety and the importance of safety, health, and wellness in the construction industry. Identify systematic safety issues and safety management systems, evaluation of safety systems through MEAD (MacroErgonomic Analysis and Design) methodology to recommend safety management systems to improve safety outcomes on construction operations. Assess health, safety, and wellness initiatives for construction worker safety and well-being. Pre: Sophomore Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 2824 - Construction Site Analysis (3 credits)
Geospatial information, Global Positioning Systems (GPS), surveying, and aerial photography for condition assessment, solving construction engineering problems, and managing construction control processes. Topographic survey methodology for field layout and stakeout processes in construction. Geospatial data collection techniques for construction risk analysis. Document existing site conditions. Use of software, and custom program tools. Individual and team projects and presentations.
Corequisite(s): 2104 or BC 1224 or CEE 2834.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CEM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 3024 - Construction Estimating and Scheduling (3 credits)
Introduction to estimating and scheduling of construction operations using construction documents. Quantity takeoff, resource and crew enumeration, network logic, activity durations, Critical Path Method (CPM) and Location-Based Management System (LBMS). Bid assembly with markups. Construction decisions based on ethical principles. A grade of C- or better is required in prerequisite.
Prerequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3064 - Intro to Lean Construction (3 credits)
Introduction to Lean Construction thinking, principles, and practices, definitions, history, theory, and fundamentals related to project production systems. Operating system, organization practices, commercial terms. Pull planning and Last Planner System, the Big Room concept, and Integrated Form of Agreement (IFOA). Conventional Lean practices A3 problem solving, 5 Whys Root Cause Analysis, and 5S Methodology. Continuous improvement, respect for people, elimination of waste, reducing variability and increasing plan reliability.
Prerequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3074 - Global Design and Construction for Sustainable Development (3 credits)
A collaborative approach for applying engineering systems and design to global issues. Design, engineering, and construction focused on social responsibility in the global village. Multi-disciplinary teamwork requiring identification of client needs and design considerations, development of site layouts, selection of resources, management of schedule, cost, materials, personnel, quality, and jobsite safety. Applied conflict handling skills and self-reflection on social responsibility, service, intercultural global awareness, and evaluating the success of sustainable projects. May be repeated one time with different content for a maximum of six credits. Multi-day field trip required. Pre: Junior Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

CEM 3084 - Construction Economy (3 credits)
Engineering economics, accounting, finance, and entrepreneurship. Construction financial management and financial decision-making. Construction financial risk, estimation, and generation of financial statements. Construction company creation and business plan development. Assessment of construction project delivery methods and impacts of retainage, bonding, and taxation.
Prerequisite(s): CEM 2104 or BC 2024
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3134 - Temporary Structures in Construction (3 credits)
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts.
Prerequisite(s): (BC 2044 and BC 2024 and BC 2214) or CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BC 3134

CEM 3154 - Smart Construction (3 credits)
Introduction to smart construction, definitions, principles and practices. Exploration of inefficiencies associated with the traditional approaches to construction. Intelligence requirements of the building lifecycle. Smart planning and contracting practices, and facilitating technologies. Smart design principles, techniques, technologies, strategies for involving down-stream stakeholders in the design of buildings for constructability and maintainability. Overview of digital infrastructure, types, selection and role in integrating the design and construction phases.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3164 - Construction Health and Safety (3 credits)
Introduction to fundamentals of Occupational Health and Safety (OHS) for the construction industry. History of OHS regulation and specific governmental regulations, standards and laws. Health, safety, and environmental hazards identification. Methods of quantifying exposure and estimating risk. Design and prioritization of control solutions to mitigate hazards. Contemporary issues and theoretical frameworks in the field of OHS management relevant to the industry. Prevention through Design, behavior-based safety, different construction project delivery methods, safety climate and culture, control banding, and systems safety.
Corequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3714 - Controlling Construction Safety Hazards (3 credits)
Perceive, recognize (cognitive recall), and examine/classify (decision making) construction safety hazards and their underlying energy sources. To control hazards, the construction hierarchy of controls guides a safety by design methodology. Accident investigation or forensic processes using design-based arguments to determine root causes of incidents. Pre: Sophomore Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4024 - Construction Law and Contract Administration (3 credits)
Application of contract law, torts, and statutory law in construction. Legal context, parties, interpreting contracts and specifications, contract changes, differing site conditions, delays, disruptions, and acceleration. Dispute avoidance and resolution. Ethics and risk management. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4314 - Design of Wood Structures (3 credits)
Analysis and design of wood structures comprised of solid wood and/or composite wood products. Evaluation of mechanical properties of wood materials. Design of individual tension, compression and bending members, and wood-steel dowel connections. Lateral loading design of diaphragms and shearwalls.
Prerequisite(s): SBIO 3314 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SBIO 4314

CEM 4445 - CEM Capstone (3 credits)
4445: Preliminary design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. 4446: Final design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, ethical, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. The final deliverable includes a comprehensive written proposal and oral presentation. Pre: Senior standing.
Prerequisite(s): CEM 3024
Corequisite(s): CEM 3134
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4446 - CEM Capstone (3 credits)
4445: Preliminary design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. 4446: Final design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, ethical, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. The final deliverable includes a comprehensive written proposal and oral presentation. Pre: Senior standing.
Prerequisite(s): CEM 3084 and CEM 4445 and CEM 3134
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4624 - Construction Robotics and Automation (3 credits)
Automation and its application in construction. Automated problem-solving methodologies in Building Information Modeling (BIM) and data interoperability solutions. Robotics and the application of robotic technologies in construction considering safety and technical operation requirements in construction environments and robot programming and controls. Unmanned Aerial Vehicles (UAVs) or drones in construction projects. Emerging areas of research in the field of construction automation and robotics. No programming background is required.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4634 - Data Analysis and Visualization for Construction and Facilities Management (3 credits)
Introduction to data analysis and visualization theories and techniques applied in the construction and facilities management domain. Data collection, processing, storage, analysis, and visualization methods in the context of construction and building management. Data-driven decision making.
Prerequisite(s): (CEM 2104 or BC 2024 or CEE 3014) and (BC 2114 or CEE 3804)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4644 - Artificial Intelligence for Design, Construction, and Operations (3 credits)
Evaluate the basic concepts and computational tools of artificial intelligence (AI), machine learning, and deep learning in the architecture, engineering, and construction (AEC) industry. Appraise the history and potential to improve automation, digitalization, and diversity and inclusion in the industry. Develop practical expertise in formulating, deploying, and evaluating deep learning models, including convolutional neural networks, pretrained computer vision models, sequential models, and generative AI, through hands-on projects such as infrastructure health monitoring, safety management, and building energy consumption prediction. Foster real-world application of knowledge through project-based learning.
Prerequisite(s): (MATH 2114) and (ENGE 1215 or CS 1014 or ENGE 1414 or CS 1054 or CS 1064 or CS 1114)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4714 - Construction Safety Culture (3 credits)
Examination of construction safety culture and climate and the role of organizational leadership in ethical safety practices. Analyze safety cultures within the construction industry for recommendations of change to shape safety practices.
Prerequisite(s): CEM 2104 or CEM 2714 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4724 - Construction Industry Futures: Safety, Health, and Wellness (3 credits)
Evaluate the future of the construction industry dynamics (trends, drivers, and disruptors) relative to their impacts on safety, health, and wellness. Compare global construction safety performances and practices. Design adaptable safety, health, and well-being management systems of the future based on technology-human interfaces, climate change, and globalization in construction.
Prerequisite(s): CEM 2104 or CEM 2714 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course