Bachelor of Science in Environmental Engingeering

The Department of Civil and Environmental Engineering (CEE) offers design-oriented and student-centered undergraduate programs in Civil Engineering, Construction Engineering and Environmental Engineering. The degrees build upon fundamental engineering principles and provide specialization within Civil, Construction and Environmental Engineering. Graduates are positioned for a broad range of professional opportunities and are well prepared for an engineering career in a world of rapid technological change.

Program Description

The Environmental Engineering degree introduces students to the fundamentals of environmental engineering including the scientific and regulatory basis of public health and environmental protection. Topics covered include water reclamation and reuse, hazardous waste management, contaminated site remediation, environmental science, water and wastewater treatment, and regulatory processes. Graduates are equipped to investigate and analyse environmental systems and assess risks to public health and ecosystems as well as evaluate and design natural and engineered solutions to mitigate risks and enable beneficial outcomes.

The degree was designed to meet ABET accreditation requirements and to build on faculty strengths. Beyond the campus common core, students take core environmental engineering courses (EV fundamentals, EV lab, EV field session, hydrology, hydrology lab, water treatment, fate & transport) and must take four EV electives from a menu of options that include life cycle assessment, environmental chemistry, microbiology, air pollution, and site remediation.

Program Educational Objectives

The Environmental Engineering program contributes to the educational objectives described in the CSM Graduate Profile and the ABET accreditation criteria. Program Educational Objectives (PEOs) are as follows:

1. Graduates will uphold the standards of Mines as critical and creative innovators, motivators, collaborators, communicators, and leaders.
2. Graduates will be successfully employed in engineering, science, or other impactful careers.
3. Graduates will engage in continual learning by pursuing additional educational opportunities such as advanced degrees, professional licensure, conferences, training, networking, and society membership.
4. Graduates will be ambassadors of their field, contributing to collective knowledge in industry, research, and society.
5. Graduates will demonstrate ethical and responsible behavior in their professional endeavors, adhering to established codes of conduct and promoting the well-being of society and the environment.
6. Graduates will address emerging world challenges by adapting to rapidly evolving technology and industry trends and remaining current and relevant in their respective fields.

Student Learning 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 and inclusive 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.

ABET Accreditation Status if applicable

The Bachelor of Science in Environmental Engineering is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org/, under the commission's General Criteria and Program Criteria for Environmental Engineering and Similarly Named Engineering Programs.

Primary Contact

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Bachelor of Science in Environmental Engineering Degree Requirements:

First Year

		lec	lab	sem.hrs
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
GEGN101	EARTH AND ENVIRONMENTAL SYSTEMS			4.0
HASS100	NATURE AND HUMAN VALUES			3.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
PHGN100	PHYSICS I - MECHANICS			4.0
EDNS151	CORNERSTONE - DESIGN I			3.0
S&W	SUCCESS AND WELLNESS			1.0
				32.0

Sophomore

Fall		lec	lab	sem.hrs
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
CEEN241	STATICS			3.0
EDNS251	CORNERSTONE DESIGN II or CEEN 267			3.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
CHGN209	INTRODUCTION TO CHEMICAL THERMODYNAMICS, CBEN 210, or MEGN 261			3.0
FREE	Free Elective			3.0
				17.0

Spring		lec	lab	sem.hrs
MATH225	DIFFERENTIAL EQUATIONS			3.0
CEEN310	FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING			3.0
HASS215	FUTURES			3.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
FREE	Free Elective			3.0
				15.0

Junior

Fall		lec	lab	sem.hrs
CEEN381	HYDROLOGY AND WATER RESOURCES ENGINEERING			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
MATH201	INTRODUCTION TO STATISTICS			3.0
CEEN301	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: WATER			3.0
EBGN321	ENGINEERING ECONOMICS			3.0
				15.0

Spring		lec	lab	sem.hrs
CEEN302	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: AIR AND WASTE MANAGEMENT			3.0
CEEN303	ENVIRONMENTAL ENGINEERING LABORATORY			3.0
BIOSCI ELECT	Bio-Science Elective*			3.0
EVE ELECT	Environmental Engineering Elective**			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
				15.0

Summer		lec	lab	sem.hrs
CEEN330	ENGINEERING FIELD SESSION, ENVIRONMENTAL			3.0
				3.0

Senior

Fall		lec	lab	sem.hrs
EDNS491	CAPSTONE DESIGN I			3.0
CEEN470	WATER AND WASTEWATER TREATMENT PROCESSES			3.0
CEEN482	HYDROLOGY AND WATER RESOURCES LABORATORY			3.0
EVE ELECT	Environmental Engineering Elective**			3.0
EVE ELECT	Environmental Engineering Elective**			3.0
				15.0

Spring		lec	lab	sem.hrs
EDNS492	CAPSTONE DESIGN II			3.0
CEEN480	CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT			3.0
EVE ELECT	Environmental Engineering Elective**			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective			3.0
FREE	Free Elective			3.0
				15.0

Total Semester Hrs: 127.0

**** Bio-science Elective Courses -*** Students must take a minimum of one course from this list. If this requirement is met with BIOL110, then CEEN460, CEEN461 and CHGN462 may count as Environmental Engineering Electives or Free Electives. BIOL110 cannot count as an Environmental Engineering Elective.

CBEN110	FUNDAMENTALS OF BIOLOGY I
CEEN460	MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT
CEEN461	FUNDAMENTALS OF ECOLOGY
CHGN462	MICROBIOLOGY

***** Environmental Engineering Elective Courses -*** Students must take a minimum of four courses from this list. These courses may count as Free Electives if not used to meet this requirement.

CEEN311	MECHANICS OF MATERIALS
CEEN312	SOIL MECHANICS
CEEN405	NUMERICAL METHODS FOR ENGINEERS
CEEN401	LIFE CYCLE ASSESSMENT
CEEN402	PROJECT ENGINEERING
CEEN410	ADVANCED SOIL MECHANICS

CEEN425	CEMENTITIOUS MATERIALS FOR CONSTRUCTION
CEEN426	DURABILITY OF CONCRETE
CEEN460	MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT
CEEN461	FUNDAMENTALS OF ECOLOGY
CEEN472	ONSITE WATER RECLAMATION AND REUSE
CEEN473	HYDRAULIC PROBLEMS
CEEN475	HAZARDOUS SITE REMEDIATION ENGINEERING
CEEN478	WATER TREATMENT DESIGN AND ANALYSIS
CEEN479	AIR POLLUTION
CEEN492	ENVIRONMENTAL LAW
CEEN493	SUSTAINABLE ENGINEERING DESIGN
CEEN555	LIMNOLOGY
CEEN581	WATERSHED SYSTEMS MODELING
CHGN403	INTRODUCTION TO ENVIRONMENTAL CHEMISTRY
CHGN462	MICROBIOLOGY
ENGY320	INTRO TO RENEWABLE ENERGY
GEGN466	GROUNDWATER ENGINEERING
GEGN468	ENGINEERING GEOLOGY AND GEOTECHNICS
GEGN473	GEOLOGICAL ENGINEERING SITE INVESTIGATION
GEGN475	APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS
MEGN467	PRINCIPLES OF BUILDING SCIENCE
PEGN430	ENVIRONMENTAL LAW AND SUSTAINABILITY

Major GPA

During the 2016-2017 Academic Year, the Undergraduate Council considered the policy concerning required major GPAs and which courses are included in each degree's GPA. While the GPA policy has not been officially updated, in order to provide transparency, council members agreed that publishing the courses included in each degree's GPA is beneficial to students.

The following list details the courses that are included in the GPA for this degree:

CEEN300 through CEEN499 inclusive

COURSES

CEEN198. SPECIAL TOPICS. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

CEEN199. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: Independent Study form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

CEEN210. INTRODUCTION TO CIVIL INFRASTRUCTURE. 2.0 Semester Hrs.
An introduction to civil infrastructure systems, including the analysis, design and management of infrastructure that supports human activity, including transportation (road, rail, aviation), water and wastewater, communications and power.

CEEN241. STATICS. 3.0 Semester Hrs.
Forces, moments, couples, equilibrium, centroids and second moments of areas, volumes and masses, hydrostatics, and friction. Applications of vector algebra to structures. 3 hours lecture; 3 semester hours. Prerequisite: PHGN100 and credit or concurrent enrollment in MATH112.
Course Learning Outcomes

- Develop two- and three-dimensional particle free body diagrams and use scalar approaches in two-dimensions and vector approaches in three-dimensions to solve for unknown forces for systems with pulleys and springs.
- Calculate the moment of a force in two-dimensional scalar and three-dimensional vector notation and correlate force couples to couple moments.
- Resolve forces, distributed loads, and couple moments into an equivalent resultant system as either a concentrated force at a calculated location or as a concentrated force and a couple moment at a specified location.
- Identify translational and rotational support reactions and construct free body diagrams for two- and three-dimensional statically determinant rigid body systems and use equations of equilibrium to solve associated support reactions.
- Use the equations of force and moment equilibrium to solve for unknowns in statically determinate beams, trusses, frames, machines, sliding friction, friction on flat belts, discrete loaded cables, cables subject to distributed loads, and systems with hydrostatic fluid pressure on flat, vertical, sloping, and curving surfaces.
- Solve for the internal shear force, normal force, and bending moment in a structural or mechanical member; express these concepts in the form of an equation; and graphically construct shear and moment diagrams.
- Determine centroids with the composite area method and the integration method and determine moments of inertia via the parallel axis theorem to develop Mohr's circle and interpret values for the principle moments of inertia and moments of inertia for any inclined axes.

CEEN267. DESIGN II: CIVIL ENGINEERING. 3.0 Semester Hrs.
Equivalent with EPIC267,
Design II builds on the design processes introduced in Design I, focusing on open-ended problem solving in which students integrate teamwork and communication with the use of computer software, AutoCAD and Civil3D, as tools to solve engineering problems. Projects often include planning, due diligence, construction document preparation, and site certification processes in the context of land development projects. Prerequisites: EDNS151 or EDNS155 or HNRS115 or Grandey First-Year Honors Experience (HNRS198A and HNRS198B).
Course Learning Outcomes

- Analyze the diverse roles and responsibilities within the civil engineering profession, identifying key areas of specialization and career opportunities.
- Evaluate ethical challenges in engineering practice and apply engineering ethics resources to real-world scenarios.

- Investigate the site engineering planning process, including permitting, construction, and record preparation, and synthesize the various stages of the engineering workflow.
- Develop proficiency in AutoCAD and Civil3D software tools to create and communicate engineering designs effectively through technical drawings and visual representations.
- Apply critical thinking skills to solve open-ended engineering problems, justifying the selection of multiple viable solutions based on technical criteria and constraints.
- Collaborate effectively within multidisciplinary teams, demonstrating strong communication skills and presenting technical information to both technical and non-technical audiences.

CEEN298. SPECIAL TOPICS. 0-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

CEEN299. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: Independent Study form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

CEEN301. FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: WATER. 3.0 Semester Hrs.
This course introduces fundamentals of environmental science & engineering as applied to water resource management and environmental problem solving. Topics include environmental regulation, toxicology, material balance, applications in environmental chemistry, hydrology, water quality management, water supply and treatment, and wastewater treatment and reuse. Topical discussions will address major sources and concerns in measurement, practice and underlying theory in the field of environmental engineering. The course also includes field trips to local water and wastewater treatment facilities to integrate theory with practice. 3 hours lecture; 3 semester hours. Prerequisite: CHGN122, PHGN100.
Course Learning Outcomes

- Qualitatively and quantitatively describe environmental water quality parameters.
- Predict changes in water quality and quantity by using engineering, hydrologic, and chemistry concepts.
- Articulate how interconnected themes such as toxicology, hydrology, treatment, cost, and regulations influence ethical engineering and management solutions that protect ecosystems and public health.
- Apply physical, chemical, biological and engineering tools toward water and wastewater treatment.

CEEN302. FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: AIR AND WASTE MANAGEMENT. 3.0 Semester Hrs.
Introductory level fundamentals in atmospheric systems, air pollution control, solid waste management, hazardous waste management, waste minimization, pollution prevention, role and responsibilities of public institutions and private organizations in environmental management (relative to air, solid and hazardous waste). 3 hours lecture; 3 semester hours. Prerequisite: CHGN122, PHGN100 and MATH213 or consent of instructor.

CEEN303. ENVIRONMENTAL ENGINEERING LABORATORY. 3.0 Semester Hrs.
Equivalent with ESGN355,
This course introduces the laboratory and experimental techniques used for generating and interpreting data in environmental science and engineering related to water, land, and environmental health. An emphasis is placed on quantitative chemical and microbiological analysis of water and soil samples relevant to water supply and wastewater discharge. Topics include basic water quality measurements (pH, conductivity, etc.) and quantitative analysis of chemicals by chromatographic and mass spectrometric techniques. Advanced topics include quantitative and qualitative analysis of bioreactor performance, bench testing for water treatment, and measurement and control of disinfection by-products. Prerequisite: (CEEN301 or CEEN302) and MATH201.
Course Learning Outcomes

- Design and conduct basic environmental science and engineering laboratory experiments to answer well-defined scientific and engineering questions.
- Select appropriate physical, chemical, and/or biological assays necessary to conduct the experiments.
- Differentiate between qualitative and quantitative sources of data.
- Critically analyze and interpret data in more than one major environmental engineering focus area (e.g., air, water, land, environmental health).
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

CEEN310. FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING. 3.0 Semester Hrs.
The study and application of principles of incompressible fluid mechanics. Topics include: hydrostatic forces on submerged surfaces, buoyancy, control volume analysis, conservation of mass, fluid motion, Bernoulli's equation and conservation of energy, momentum, dimensional analysis, internal flow (pipe systems), external flow (drag and lift), flow in open channels, and hydraulic jumps. The course will also introduce concepts about municipal water supply networks and storm water drainage and wastewater collection and treatment systems. May not also receive credit for PEGN251 or MEGN351. Prerequisites: PHGN100, CEEN241. 3 lecture hours, 3 semester hours.
Course Learning Outcomes

- Identify correct values and units (in U.S. and S.I. unit systems) for the following fluid properties for a variety of fluids: density, specific weight, specific gravity, and viscosity (kinematic and dynamic). Apply values in problem solving.
- Apply the fluid mechanics concepts of Pascal's Law, pressure-elevation relationship, and Archimedes' Principle to in compressible fluid statics or buoyancy problems in a variety of contexts.
- Compute the magnitude, direction, and location of static fluid forces on submerged horizontal plane, vertical plane, inclined plane, and curved surfaces.
- Apply the Momentum Equation, Continuity Equation, Bernoulli's Equation, and the General Energy Equation to incompressible fluid dynamics problems in a variety of contexts.
- Compute energy lost due to friction, added by a pump, or removed by a motor in incompressible fluid flow in pipe systems. Compute the power and mechanical efficiency of pumps and motors.

- Identify and solve series and parallel pipe system problems including a variety of minor energy losses.
- Solve open channel flow and introductory hydrology problems regarding Manning's Equation, hydraulic jumps, and weirs and flumes.

CEEN311. MECHANICS OF MATERIALS. 3.0 Semester Hrs.
Fundamentals of stress, strain, deformation, and material properties. Mechanics of members subjected to axial, torsional, bending, and combined loads; beam deflection; static indeterminacy; Euler buckling; stress transformation and principal stresses; thermal stress, strain, and deformation; thin-walled pressure vessels; Allowable Stress Design; and stress concentrations. May not also receive credit for MEGN212. Prerequisites: CEEN241 or MNGN318.
Course Learning Outcomes

- Proficiency in mechanics of materials analysis methods including unit conversion, sign conventions, and free-body diagrams.
- Ability to solve classical mechanics of material problems, including deformation of members, stress-strain analysis, use of Mohr's Circles and elastic buckling.
- Ability to implement compatibility and deformation concepts to solve indeterminate structures.
- Ability to implement failure criteria in allowable stress design methodologies.

CEEN312. SOIL MECHANICS. 3.0 Semester Hrs.
An introductory course covering the engineering properties of soil, soil phase relationships and classification. Principle of effective stress. Seepage through soils and flow nets. Soil compressibility, consolidation and settlement prediction. Shear strength of soils. 3 hours lecture; 3 semester hours. Prerequisite: CEEN311.
Course Learning Outcomes

- Explain soils origins and their unique role in infrastructure.
- Classify soils according to AASHTO and the Unified Soil Classification System.
- Calculate fundamental soil properties using weight-volume relationships.
- Perform typical earthwork calculations related to the compaction of soils.
- Apply concepts of hydraulic head and Darcy's law to analyze one-dimensional flow.
- Construct and use flow nets to quantify two-dimensional seepage, uplift pressures, and exit gradients.
- Calculate pore water pressures, total, and effective stresses in different field and laboratory conditions.
- Explain the mechanisms of one-dimensional consolidation and quantify the corresponding settlement.
- Calculate the shear strength of soils and explain basic experimental procedures.
- Have a basic knowledge of contemporary geotechnical issues.
- Recognize the need for lifelong learning and be able to do so.

CEEN312L. SOIL MECHANICS LABORATORY. 1.0 Semester Hr.
Introduction to laboratory testing methods in soil mechanics. Classification, permeability, compressibility, shear strength. 3 hours lab; 1 semester hour. Co-requisite: CEEN312.
Course Learning Outcomes

- Perform standard soil tests such as particle size analysis, Atterberg limits, standard Proctor test, constant and falling head tests, 1_D consolidation, unconfined compression, direct shear, and triaxial tests.
- Describe the fundamentals of each soil property, the factors that affect each soil property, typical values of each property for different soil types, and the application of each soil property in engineering practice.
- Perform experiments following proper conduct that includes quantifying error, assessment of repeatability, reporting data to appropriate levels of accuracy, and understanding what factors influence results.
- Effectively communicate experimental methods, relevant data collected, analysis and interpretation of data and error, and significance and application of soil properties.
- Work effectively on a team whose members together provide leadership and a positive work environment, establish goals, plan tasks, and meet objectives.

CEEN314. STRUCTURAL ANALYSIS. 3.0 Semester Hrs.
Analysis of determinate and indeterminate structures for both forces and deflections. Influence lines, work and energy methods, moment distribution, matrix operations, computer methods. 3 hours lecture; 3 semester hours. Prerequisite: CEEN311.
Course Learning Outcomes

- Determine structural stability, determinate structure, indeterminate structure.
- Analysis of typical structural systems including cable, arch, truss, beam, and frame.
- Structural analysis method including virtual work, force method, displacement method, and moment distribution method.
- Influence line analysis.
- Internal forces and deformation of determinate systems.
- Internal forces and deformation of indeterminate systems.

CEEN315. CIVIL AND ENVIRONMENTAL ENGINEERING TOOLS. 1.0 Semester Hr.
Students in this project-based course will be introduced to and implement useful, industry standard tools from Civil and Environmental Engineering fields. Although unlimited, subjects presented may include: introduction to industry software, data analysis, materials testing, design preparation/ presentation, or hands-on exercises illustrating concepts presented in lecture. Content will be presented in modules that occur over three to five-week periods. Modules indicative of the breadth of the profession will be offered. Credit hours will be awarded based on the completion of least three modules encompassing 15 weeks. Co-requisite: CEEN310 or CEEN311.
Course Learning Outcomes

- Synthesize theoretical concepts and industry practices across disciplines such as fluid mechanics, mechanics of materials, data acquisition systems, and related subjects, to generate holistic engineering solutions that are grounded in both theory and real-world applications.
- Develop advanced problem-solving skills to analyze, manipulate, and solve complex problems with spatial dimensions, ensuring a deep understanding of geometric and structural relationships.

- Cultivate proficiency in the rigorous analysis and experimentation process, applying scientific methods to ensure accuracy and reliability in the collection and interpretation of engineering data.
- Predict experimental outcomes based on theoretical frameworks, and interpret results to assess their alignment with anticipated models, contributing to continuous refinement in the design and testing process.
- Analyze probabilities and statistical data, leveraging techniques to draw meaningful insights from large data sets, and apply these insights to evaluate the behavior and performance of engineering systems.
- Apply principles of uncertainty in measurements, and evaluate the propagation of errors to understand their impact on engineering designs and experiments, ensuring robust and reliable outcomes.
- Investigate complex engineering systems by integrating interdisciplinary knowledge to draw actionable, data-driven conclusions that inform practical decision-making in real-world engineering contexts.

CEEN317. EXPLORING ENGINEERING DYNAMICS. 1.0 Semester Hr.
Exploring Engineering Dynamics introduces students to the application of motion and forces imparted by and on moving objects in civil engineering. Students will review kinematics and kinetics of rigid bodies learned in physics, and will learn to apply dynamics principles to civil infrastructure such as bridges, buildings, tunnels, dams, and earth retaining structures. Example topics and applications include relating centrifugal force to superelevation on roads and railway; estimating the force a vehicle imparts on guardrail; characterizing the vibration behavior of a building, tunnel, bridge or dam subjected to earthquake shaking; translating dynamic loads like wind, wave, earthquakes and even wrecking balls into force estimates applied to infrastructure. Prerequisites: CEEN241. Corequisites: None.
Course Learning Outcomes

- Apply mathematical, scientific, and engineering principles.
- Identify, formulate, and solve engineering problems.
- Explain concepts of position, displacement, velocity, acceleration, and forces.
- Examine particle motion along a straight line and represent it graphically.
- Analyze particle motion along a curved path using various coordinate systems.
- Apply the equations of motion to analyze accelerated particle motion in different coordinate systems and determine forces.
- Describe the work-energy principle and apply it to problems involving force, velocity, and displacement.
- Explain linear impulse-momentum and apply it to solve problems involving force, velocity, and time.
- Apply conservation of linear momentum to engineering systems.
- Communicate engineering concepts and calculations clearly and logically.

CEEN320. INTRODUCTION TO CONSTRUCTION ENGINEERING. 3.0 Semester Hrs.
Overview of the construction process for civil construction (spanning the building, transportation, and infrastructure sectors), including procurement methods and project delivery methods, codes, regulations, tests, standards, and Risk estimation and management. Construction methods and materials. Construction contracts, including drawings and specifications. Construction administration, including submittals, requests for information, change orders, special instructions, claims, disputes, arbitration, litigation, and project close-out. Project scheduling using the Critical Path Method. Construction project management. Construction safety and OSHA. Quantity takeoff s and construction estimating. Application of engineering analysis and design to construction projects. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- Explain the various project delivery methods and roles and responsibilities of the members of the design and construction team, including the construction engineer.
- Apply construction management aspects communication, requests for information, cost and schedule control, submittals, and resource control.
- Discuss safety, quality, constructability, and sustainability criteria as applied to construction and design.
- Calculate factors associated with the design of temporary operations to account for jobsite conditions, standards, and codes.
- Categorize a project into a scope of work from plans and specifications.
- Calculate material quantities using manual methods.
- Develop a construction project schedule using the Critical Path Method.

CEEN321. CONSTRUCTION METHODS. 3.0 Semester Hrs.
This course will introduce students with a deep understanding of the properties, applications, and impacts of major construction methods, including the implementations of construction machines, earthwork and excavation, construction material control and handling, foundation and support systems, as well as the construction methods and logistics needed for concrete, steel, asphalt, and temporal traffic control. Discussions will explore the intricate relationship between material properties, behavior, structural form, and how the use of methods will impact construction project logistics, cost, overall design, and structural integrity of construction projects. The construction methods are connected to standards, codes, and regulations to ensure the quality and safety of the construction projects. Students will have the opportunity to engage with industry members and discuss the practical applications of the materials and methods discussed in the class. The students who complete this course will be well-equipped to make informed decisions and contribute to the successful execution of design and construction projects.
Course Learning Outcomes

- Identify, formulate, and solve real-world construction problems using engineering principles.
- Explain concepts of various construction methods.
- Develop construction plans that integrate machine capabilities, productivity, material properties, and logistical constraints for efficient construction project execution.
- Evaluate the impact of different construction methods on construction project scheduling, cost, and overall design, using case studies to propose alternative solutions that address potential challenges.
- Describe the relationship between material behavior, structural form, and construction logistics, and assess design and operation impacts on project outcomes.
- Communicate construction concepts, technical solutions, and design justifications clearly and logically in written and oral formats.

CEEN322. CONSTRUCTION ESTIMATING, PLANNING & SCHEDULING. 3.0 Semester Hrs.

This course introduces the fundamentals of construction estimating, planning, and scheduling, with emphasis on work breakdown structures, critical path method, earned value management, and risk analysis. Students will gain hands-on experience with scheduling and estimating software to develop project plans that integrate resources, productivity, and logistical constraints. Case studies highlight the impact of planning and estimating decisions on cost, schedule, and project performance. The course emphasizes professional standards, safety, and ethical responsibility, preparing students for effective project management in construction practice. Prerequisite: CEEN320.

Course Learning Outcomes

- Identify, formulate, and solve project management challenges in construction by applying engineering and scheduling principles.
- Explain core concepts of construction estimating, planning, and scheduling, including work breakdown structures, critical path method, earned value management, and risk analysis.
- Develop comprehensive project schedules and cost estimates that integrate productivity data, resource availability, material requirements, and logistical constraints.
- Evaluate the impacts of uncertainty, change management, and alternative planning approaches on project outcomes, using case studies to propose effective and efficient solutions.
- Describe the interactions between planning decisions, resource allocation, and cost control, and assess how these factors influence overall project performance, safety, and sustainability.
- Communicate scheduling strategies, cost analyses, and project management decisions clearly and professionally in both written and oral formats.

CEEN324. CONSTRUCTION PROJECT ADMINISTRATION & CONTROLS. 3.0 Semester Hrs.

Effective management requires control of key project aspects to ensure construction projects are completed on time, within budget, and to the highest standards of quality. Through lectures, case studies, and real-world simulations, students will be guided by industry experts to understand construction risk identification, assessment and mitigation, effective management of project changes, project communication and documentation, cash flow management, and schedule management and reporting. This course presents a crucial educational opportunity for individuals seeking to excel in the construction industry to practice the essential skills and knowledge with relevant tools and skills required for successful project delivery; come and build a successful career in Construction Project Administration and Control. Prerequisite: CEEN320.

Course Learning Outcomes

- Explain construction project delivery systems, methods of contracting and procurement, and distinguish the impacts of each on the administration aspects of construction projects.
- Explore methods to identify and assess sources of risk in construction and mitigate project risks using decision analysis tools.
- Understand the role of communication and critical communication documentation relative to construction project administration.
- Manage a construction budget and project cash flow using invoices and pay applications and other tools to control project finances.
- Monitor project progress, track, revise, and crash schedules, and learn skills to implement corrective project actions when necessary.
- Develop strategies for monitoring and controlling construction projects, including tracking progress, managing changes, document control, and monitoring safety and quality.

CEEN330. ENGINEERING FIELD SESSION, ENVIRONMENTAL. 3.0 Semester Hrs.

The environmental module is intended to introduce students to laboratory and field analytical skills used in the analysis of an environmental engineering problem. Students will receive instruction on the measurement of water quality parameters (chemical, physical, and biological) in the laboratory and field. The student will use these skills to collect field data and analyze a given environmental engineering problem. Three weeks in summer session. 9 hours lab; 3 semester hours. Prerequisite: CEEN301, CEEN303.

Course Learning Outcomes

- Reinforce basic principles of environmental quality analysis and environmental engineering concepts in experimental, hands-on, laboratory, and field settings.
- Gain experience in field assessment, experimental design and data analysis. How to collect useful data. How to design experiments. How to interpret and identify key results.
- Hone technical communication skills. Written reports (short and long). Oral reports. Effective graphics.
- Hone team work sills. Team roles. Group dynamics. Peer pressure.
- Become familiar with standard professional practices.
- Attain an ability to communicate effectively with a range of audiences, ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering to draw conclusions.

CEEN331. ENGINEERING FIELD SESSION, CIVIL. 3.0 Semester Hrs.

The theory and practice of modern surveying. Lectures and hands-on field work teaches horizontal, vertical, and angular measurements and computations using traditional and modern equipment. Subdivision of land and applications to civil engineering practice, GPS and astronomic observations. Three weeks (6 day weeks) in summer field session; 9 hours lab; 3 semester hours. Prerequisite: EDNS251, CEEN267.

Course Learning Outcomes

- Measure distances using various tools such as pacing, chain, and total station.
- Perform a lot survey, including closing the traverse, calculating the area, and using proper drafting standards.
- Measure and calculate differential elevations.
- Measure and calculate direction by bearing and azimuth.
- Adjust a traverse using the compass rule.
- Explain the Legal Aspects and Governmental Land Office in the subdivision of the lands.
- Calculate terrestrial distances using spherical geometry.
- Set real property boundaries and collect topographic data.
- Use AutoCAD and Civil3D as a drafting and design tool.
- Use surveying tools such as compass, chain, hand level, engineer level, total station, GPS.
- Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- Acquire and apply new knowledge as needed, using appropriate learning strategies.

CEEN340. COOPERATIVE EDUCATION. 3.0 Semester Hrs.
(I,II,S) Supervised full-time engineering-related employment in which specific educational objectives are set and achieved. The co-op differs from a typical internship in both the length and scope of responsibilities. Students must meet with the CEE Co-op Advisor prior to enrolling to determine the appropriateness of the engagement, clarify the educational objectives, set expectations, and receive written approval for their specific Co-op program. This prior approval of the CEE Co-op Advisor and completion of paperwork with the Career Center is required prior to beginning the work portion of the program. The co-op occurs during academic fall or spring semester(s) and may overlap with a summer session, with a typical length of six months total. 3.0 credit hours. This course is repeatable. Prerequisite: Second semester sophomore status or above and a cumulative grade-point average of at least 2.00.

CEEN350. CIVIL AND CONSTRUCTION ENGINEERING MATERIALS. 3.0 Semester Hrs.
This course deals with the nature and performance of civil engineering materials and evaluation of their physical and mechanical properties. This course focuses on materials used in construction and maintenance of building and infrastructure such as metals (steel and aluminum), aggregates, Portland cement, concrete, shotcrete, asphalt, wood, recycled materials, and composites. The course covers standards describing materials and tests for determining material properties and includes a lab component where students conduct tests, analyze the resulting data, and prepare technical reports. Laboratory tests include evaluation of behavior of civil engineering materials under a wide range of conditions. 2 hours lecture; 3 hours lab, 3 semester hours. Prerequisite: CEEN311.
Course Learning Outcomes

- Describe the basic properties of a variety of civil engineering materials including metals, concrete, aggregates, asphalt, and wood.
- Identify and explain significant considerations in choosing a material for a specific application including, for example, mechanical properties, durability, and sustainability.
- Follow standards to conduct tests of material properties and perform the calculations necessary to analyze and interpret test results.
- Explain the importance of standards in the context of civil engineering materials.
- Work effectively in teams to perform experimental tasks.
- Write formal technical report and convey engineering message efficiently.
- Use commercial engineering test equipment to determine mechanical properties of engineering materials.
- Design and make conventional and high performance Portland cement concrete mixtures and evaluate their fresh and hardened properties.
- Apply the field quality control procedures in the manufacturing and placing of Portland cement concrete and hot-mix asphalt

CEEN381. HYDROLOGY AND WATER RESOURCES ENGINEERING. 3.0 Semester Hrs.
Equivalent with CEEN481,ESGN459,
This course introduces the principles of physical hydrology and fundamentals of water resources engineering. Topics include groundwater, surface water, precipitation, infiltration, evapotranspiration, sediment transport, flood and drought analysis, lake and reservoir analysis, water-resources planning, water quality engineering, stormwater management, and engineering design problems. 3 hour lecture; 3 semester hours. Prerequisite: CEEN310.

Course Learning Outcomes

- Explain the hydrologic cycle.
- Evaluate the rainfall- runoff process utilizing infiltration techniques and unit hydrograph concepts.
- Apply hydrologic routing methods to evaluate the movement of a flood hydrograph through a channel or reservoir.
- Explain flood frequency analysis and utilize probability concepts and frequency distributions to evaluate hydrologic data.
- Model the rainfall-runoff process for a watershed using the HEC HMS software.
- Compute the peak discharge for an urban area watershed using the rational method.
- Compute normal depth and design an open channel using uniform flow concepts.
- Analyze and design open channel structures.
- Evaluate the occurrence and length of a hydraulic jump using momentum principles.
- Evaluate the occurrence of critical depth and design channel transitions.
- Obtain information not in textbooks or lectures.
- Gain experience on professional presentation and technical report writing.

CEEN398. SPECIAL TOPICS IN CIVIL AND ENVIRONMENTAL ENGINEERING. 0-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

CEEN398. SPECIAL TOPICS. 0-6 Semester Hr.

CEEN398. SPECIAL TOPICS. 0-6 Semester Hr.

CEEN398. SPECIAL TOPICS. 0-6 Semester Hr.

CEEN399. INDEPENDENT STUDY. 1-6 Semester Hr.
Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Variable credit; 1 to 6 credit hours. Repeatable for credit. Prerequisite: Independent Study form must be completed and submitted to the Registrar.

CEEN399. INDEPENDENT STUDY. 1-6 Semester Hr.

CEEN401. LIFE CYCLE ASSESSMENT. 3.0 Semester Hrs.
Which is more sustainable: paper vs plastic, hybrid vs electric vehicles? LCA is a powerful tool used to answer these questions; LCA quantifies the environmental sustainability of a product or process. Students will learn to conduct an LCA during a semester-long project of their choosing. At the end of the course students should be able to sit for the ACLCA professional LCACP certification exam. Prerequisite: Junior standing.
Course Learning Outcomes

- 1. Identify environmental sustainability challenges and opportunities for engineered systems from a life-cycle perspective
- 2. Draw a process flow diagram and Create a life cycle inventory
- 3. Understand and calculate different environmental impact categories
- 4. Conduct a simple life cycle assessment for a product or process
- 5. Utilize LCA results for decision making

- 6. Understand the process for conducting an ISO 14000 series certified LCA

CEEN402. PROJECT ENGINEERING. 3.0 Semester Hrs.
Project Engineers - through their "big picture" understanding of overall project completion requirements, technical knowledge of the components that have to be coordinated & assembled, and application of people skills - get things done. This career-oriented course focuses on the roles & responsibilities, skills, and character of the Project Engineer as a problem-solver, integrator, and leader. Content, procedural, and relationship project needs essential for project execution success are identified. Practical instruction and exercises are given - formulated around industry documents and templates - on key project execution best practices such as estimating (cost, weight, etc.), scheduling, quality, earned value, constructability, risk management, and root-cause analysis. Emotional Intelligence is introduced along with identification of skills that are essential for leading projects and people to success. Management, leadership, and ethical principles and best practices are illustrated through case studies of complex, high-profile domestic and international projects. Prior to taking the course, design and analysis courses along with any project/construction management experience beneficial but not expected. Courses recommended concurrently include courses equivalent to CEEN591, CEEN594, EBGN553, and MNGN509 are advantageous but not required. 3 hours lecture; 3 semester hours. Prerequisite: CEEN320.
Course Learning Outcomes

- Differentiate the unique roles & responsibilities and skill set requirements of a Project Engineer
- Organize a Work Breakdown Structure, use it as a basis for developing estimates for cost and schedule, and critically assess project progress by calculating Earned Value
- Develop a simple project schedule using manual Arrow-on-Node and electronic Microsoft Project methods; propose schedule compression options and their impact on a troubled project
- Develop a simple Constructability Register with a fundamental understanding of engineer vs. constructor motivations
- Develop a simple Risk Register, Risk Matrix, and Risk Mitigation Plan
- Identify the management and emotional skills that enable a Project Engineer to achieve effective project delivery and personal integrity and success

CEEN405. NUMERICAL METHODS FOR ENGINEERS. 3.0 Semester Hrs.
Introduction to the use of numerical methods in the solution of problems encountered in engineering analysis and design, e.g. linear simultaneous equations (e.g. analysis of elastic materials, steady heat flow); roots of nonlinear equations (e.g. vibration problems, open channel flow); eigenvalue problems (e.g. natural frequencies, buckling and elastic stability); curve fitting and differentiation (e.g. interpretation of experimental data, estimation of gradients); integration (e.g. summation of pressure distributions, finite element properties, local averaging); ordinary differential equations (e.g. forced vibrations, beam bending). All course participants will receive source code consisting of a suite of numerical methods programs. 3 hours lecture; 3 semester hours. Prerequisite: CSCI200 or CSCI260 or CSCI261 or MATH307, MATH225.
Course Learning Outcomes

- Students will understand when numerical methods are needed in engineering analysis as opposed to analytical methods.
- Students will understand the source of errors in numerical methods.
- Students will have a thorough understanding of direct and indirect numerical methods for solving linear simultaneous equations.
- Students will have a thorough understanding of iterative solution methods for nonlinear equations.
- Students will have a thorough understanding of numerical methods for solving eigenvalue equations.
- Students will have a thorough understanding of numerical methods for interpolation, curve-fitting and numerical differentiation of engineering data.
- Students will have a thorough understanding of numerical integration techniques in engineering analysis.
- Students will have a thorough understanding of numerical method for solving initial value ordinary differential equations using one-step and multi-step methods.

CEEN406. FINITE ELEMENT METHODS FOR ENGINEERS. 3.0 Semester Hrs.
A course combining finite element theory with practical programming experience in which the multidisciplinary nature of the finite element method as a numerical technique for solving differential equations is emphasized. Topics covered include simple structural elements, beams on elastic foundations, solid elasticity, steady state analysis and transient analysis. Some of the applications will lie in the general area of geomechanics, reflecting the research interests of the instructor. Prerequisite: CEEN311 or MEGN212, MATH225.
Course Learning Outcomes

- Students will have a thorough understanding of rod and beam finite elements and their application to simple structural analysis problems.
- Students will have a thorough understanding of beam on elastic foundation problems and beam buckling.
- Students will have a thorough understanding of 2D frame analysis using beam-rod elements.
- Students will have an understand of solid elastic analysis using 2D finite elements under plane strain, plane stress and axisymmetric conditions.
- Students will have a thorough understanding of 2D steady state (Laplacian) problems of seepage and heat flow.
- Students will have a thorough understanding of 1D and 2D transient problems of seepage and heat flow by finite elements in space and finite differences in time.

CEEN410. ADVANCED SOIL MECHANICS. 3.0 Semester Hrs.
Advanced soil mechanics theories and concepts as applied to analysis and design in geotechnical engineering. Topics covered will include seepage, consolidation, shear strength and probabilistic methods. The course will have an emphasis on numerical solution techniques to geotechnical problems by finite elements and finite differences. 3 hour lectures; 3 semester hours. Fall even years. Prerequisite: CEEN312.
Course Learning Outcomes

- Calculate effective stress under various conditions including drained, undrained, with seepage, and under surcharge loads.
- Explain the fundamentals of flow nets, including methods of solution, their construction, and interpretation to solve seepage problems.
- Interpret and analyze the effects of boundary conditions and soil properties on seepage patterns.
- Calculate the amount and rate of settlement for different boundary and initial conditions.

- Perform slope stability analysis and calculations using analytical methods, charts, methods of slices, and slope stability software.
- Explain different failure criteria for soils including Tresca, Mohr-Coulomb, and Drucker-Prager type models. Assess their applicability under various scenarios.
- Use finite element programs to solve problems of seepage, consolidation, and slope stability.

CEEN411. UNSATURATED SOIL MECHANICS. 3.0 Semester Hrs.
Equivalent with CEEN512,
Systematic introduction of soil mechanics under partially saturated conditions. Topics include principles of seepage under variably saturated conditions, principle of the effective stress, shear strength theory, and hydraulic and mechanical properties. When this course is cross-listed and concurrent with CEEN511, students that enroll in CEEN511 will complete additional and/or more complex assignments. Prerequisite: CEEN312.
Course Learning Outcomes

- Explain the scope of unsaturated soils in natural and engineered environments.
- Define soil water potential and soil water characteristic curve.
- Quantify fundamental soil properties using weight-volume relationships.
- Define soil hydraulic conductivity function.
- Describe effective stress and suction stress in soil.
- Define suction stress characteristic curve.
- Quantify soil moisture and suction distributions in typical earthen structure settings.
- Quantify suction stress and effective stress distributions in typical earthen structure settings.
- Recognize the need for lifelong learning and be able to do so.

CEEN415. FOUNDATION ENGINEERING. 3.0 Semester Hrs.
Techniques of subsoil investigation, types of foundations and foundation problems, selection of basis for design of foundation types. Open-ended problem solving and decision making. Prerequisite: CEEN312. 3 hours lecture; 3 semester hours.

CEEN419. RISK ASSESSMENT IN GEOTECHNICAL ENGINEERING. 3.0 Semester Hrs.
Soil and rock are among the most variable of all engineering materials, and as such are highly amenable to a probabilistic treatment. Assessment of the probability of failure or inadequate performance is rapidly gaining ground on the traditional factor of safety approach as a more rational approach to design decision making and risk management. Probabilistic concepts are also closely related to system reliability and Load and Resistance Factor Design (LRFD). When probability is combined with consequences of failure, this leads to the concept of risk. This course is about the theory and application of various tools enabling risk assessment in engineering with an emphasis on geotechnical applications.
Course Learning Outcomes

- Understand basic principles of probability theory and apply them to the geotechnical engineering applications.
- Understand the consequences of design failure and risk in geotechnical engineering
- Have the ability to compute probability in geotechnical engineering using hand and computational tools
- Successfully complete homework assignments and exam questions

CEEN421. HIGHWAY AND TRAFFIC ENGINEERING. 3.0 Semester Hrs.
(I) The emphasis of this class is on the multi-disciplinary nature of highway and traffic engineering and its application to the planning and design of transportation facilities. In the course of the class the students will examine design problems that will involve: geometric design, surveying, traffic operations, hydrology, hydraulics, elements of bridge design, statistics, highway safety, transportation planning, engineering ethics, soil mechanics, pavement design, economics, environmental science. 3 credit hours.
Course Learning Outcomes

- The intent is to give a good sense of the transportation planning/engineering practice to gain a solid understanding of key principles, some of which will appear on the Professional Engineers' Exam. Some topics will be studied more in-depth than others to solve real-world transportation problems. Students will be able to apply critical thinking related to how, why, and when transportation projects are completed. This course will provide insight as to whether transportation could be a career choice.

CEEN422. DESIGN OF HUMAN FACTORS AND SAFETY IN CONSTRUCTION. 3.0 Semester Hrs.
This course will provide an in-depth examination of the physical, cognitive, organizational, and environmental factors that influence safety outcomes in the construction industry. As one of the most hazardous global sectors, construction requires engineers who can recognize, evaluate, and mitigate risks stemming from both technical conditions and human behavior. This course introduces students to foundational safety principles, OSHA regulations, and the leading causes of accidents, including fall, struck-by, electrocution, and caught-in/between hazards, while exploring how fatigue, stress, perception, communication, workload, and decision-making shape safety performance on job sites. Students will analyze real construction drawings, site conditions, and case studies to design safety systems, training programs, and hazard-mitigation strategies that are both code-compliant and human-centered. Through lectures, hands-on activities, accident investigation exercises, and team-based projects, students will learn to apply engineering design methods to produce safety solutions that prioritize public health, worker well-being, and operational efficiency. Emphasis is placed on emerging safety technologies, behavior-based safety, leading indicators, and the critical roles of owners, designers, and managers in fostering a proactive safety culture. This course prepares future construction engineers and managers to create safer, more resilient, and more productive job sites by integrating technical expertise with human factors engineering. Prerequisite: CEEN320.
Course Learning Outcomes

- Explain the details of human factors and safety in the construction industry.
- Identify the most common causes of accidents and fatalities in hazardous areas in construction projects.
- Understand the OSHA standards and the enforceable requirements for worker safety and health in the construction industry.
- Design safety systems and training that comply with codes & regulations.
- Explain the details of different emerging technologies that can be used in the construction industry to improve safety and productivity.

CEEN424. INTEGRATED DESIGN AND CONSTRUCTION. 3.0 Semester Hrs.

Students will examine the various elements of design and construction functions within the framework of multiple design-build construction methodologies. The curriculum provides an in-depth analysis of the fundamental principles of project delivery, encompassing the initial pursuit planning phase through to project completion, as illustrated by actual Mines construction projects. Instruction will cover teambuilding and leadership development, stakeholder requirements, site considerations, integrated design processes, safety protocols, cost estimation, mobilization strategies, scheduling, procurement procedures, communication, risk management, project controls, project closeout, and commissioning—presented throughout the classes design-build lifecycle lessons. In-class design activities will include cost estimating for progressive design-build projects, critical lift planning, and material placement sequencing. This comprehensive course is designed to equip students with the skills necessary to excel in design-build execution and prepare for leadership roles within the industry. Prerequisite: CEEN320 and CEEN322.

Course Learning Outcomes

- Identify, formulate, and solve real-world construction problems using engineering principles.
- Explain the details of different construction industry delivery methods and their associated benefits.
- Explain concepts of various construction methods, such as earthwork, excavation, foundation support systems, soil erosion and control, concrete, steel structure, wood structure, asphalt concrete, and temporary traffic control and their impacts in mobilization, pre-construction, construction, and commissioning.
- Develop construction plans and specifications that integrate equipment capabilities, productivity, material properties, and logistical constraints for efficient construction project execution.
- Evaluate the impact of different construction methods with the use of project controls such as scheduling, cost, safety, quality and risk included in the basis of design using case studies to propose alternative solutions that address potential challenges.
- Become familiar with design principles applied in building information management systems and virtual design in construction modeling.
- Experience learned academic principles in design-build during construction site visits and thru contractor guest lectures of design-build projects both past and on-going at the Mines Campus.
- Communicate construction concepts, technical solutions, and design justifications clearly and logically in written and oral formats.

CEEN425. CEMENTITIOUS MATERIALS FOR CONSTRUCTION. 3.0 Semester Hrs.

(II) Cementitious materials, as the most commonly used construction materials, are the main focus of this course and variety of cementitious materials including Portland and non-Portland cements, supplementary cementitious materials, concrete and sprayed concrete (shotcrete), and grouts with their needed additional constituents are covered in this course. This course provides a comprehensive treatment of engineering principles and considerations for proper design, production, placement and maintenance of high quality cementitious materials for infrastructure. In addition, cementitious materials and techniques used for ground improvement purposes are covered in this course. Spring odd years. Prerequisite: CEEN 311.

Course Learning Outcomes

- 1. Describe the main properties of concrete constituents and their influence on the behavior • Describe the cement composition, phases, types, and the hydration process • List the different types of cements and their proper applications • Select the right types of admixtures to be used in different applications and situations • Describe the effects of supplementary cementitious materials on concrete properties
- 2. Design and Test Cementitious Construction materials to meet specifications • Design conventional and high performance Portland cement concrete mixtures with supplementary cementitious materials to meet specifications • Design concrete mix for spraying applications to meet the requirements for ground support needs • Identify the appropriate testing method for evaluation of concrete properties
- 3. Propose ground improvement solutions for different ground conditions using Cementitious Materials • Describe the different ground improvement techniques and explain the differences among current techniques • Identify the appropriate type of ground improvement and specify the requirements for the materials needed
- 4. Apply the concepts learned in the class in understanding the nature, types and applications of cementitious materials by • Selecting a topic of interest related to Cementitious Materials • Conducting research in groups • Presenting the work in written and oral presentation formats

CEEN426. DURABILITY OF CONCRETE. 3.0 Semester Hrs.

(II) This course will provide an in-depth overview of concrete properties relevant to deterioration, including transport, mechanical, physical, and chemical properties. After this course, students should be able to identify, quantify, and mitigate against various deterioration mechanisms, such as freezing and thawing, sulfate attack, alkali-aggregate reactions, acid attack, and corrosion of steel rebar. This course will also illustrate how to test materials for durability (hands-on activities included) and ways in which construction methods may affect durability. Students will learn the strengths and limitations of the worlds most ubiquitous building material.

Course Learning Outcomes

- 1. Explain how the microstructure of concrete develops.
- 2. Explain how the microstructure of concrete affects engineering properties.
- 3. Identify different deterioration mechanisms that affect concrete and explain how they impact concrete durability.
- 4. Explain the principles behind various durability tests.
- 5. Conduct durability tests and assess the performance.

CEEN427. CONSTRUCTION AND DESIGN LAW. 3.0 Semester Hrs.

Construction and Design Law introduces students to the legal frameworks, professional responsibilities, and risk management principles that govern modern construction and design practice. This course equips future engineers, construction managers, and design professionals with the legal literacy needed to navigate contractual relationships, regulatory constraints, and dispute resolution processes within the built environment. Students will examine the formation, interpretation, and enforcement of construction contracts; explore tort liability, professional negligence, and statutory compliance; and analyze the legal duties of owners, contractors, designers, and regulatory entities across a variety of project delivery methods. Emphasis is placed on applying legal principles to real-world scenarios through case studies, current litigation examples, and examples drawn from more than thirty years of forensic, design, and jurisprudence experience. Students will draft and critique contract clauses, interpret claims and legal documents, and explore ethical challenges inherent to construction law, including issues of safety, expert testimony, and professional responsibility. The course also introduces strategies for mitigating legal risk through effective contract language, documentation practices, and compliance planning. Through interactive discussions, guest lectures, and collaborative exercises, students develop practical skills to communicate, negotiate, and make informed decisions in legally and ethically complex project environments. Prerequisite: CEEN320.

Course Learning Outcomes

- Apply key legal principles (e.g., contract formation, tort liability, and statutory compliance) to analyze and resolve disputes commonly encountered in construction projects.
- Draft and critique construction contracts and subcontracts, identifying clauses that allocate risk, define scope, and establish dispute resolution mechanisms, with attention to industry standards and legal enforceability. This will include AIA and EJCDC family of contracts.
- Evaluate the legal responsibilities and professional liabilities of designers, contractors, and managers under various delivery methods (e.g., Design-Bid-Build, Design-Build, CM-at-Risk), and recommend strategies to mitigate risk in the contract, design and construction phases.
- Interpret and respond to legal documents such as liens, change orders, and claims for delay or defects, demonstrating procedural fluency in construction law documentation.
- Analyze real-world case studies involving construction litigation or arbitration, and understand the formulation of legally sound arguments from multiple stakeholder perspectives. The instructor will provide over 30 years of experience in this setting with real world case studies.
- Design a compliance strategy for a hypothetical construction project that integrates building codes, zoning laws, environmental regulations, and safety standards into the project contracts and means to carry out this during the construction process.
- Reflect on ethical dilemmas in construction law (e.g., bid shopping, undocumented labor, biases in testimony, issues around safety violations), and defend a course of action using legal reasoning, background and factual backup, while considering the professional ethics.
- Collaborate in interdisciplinary teams to simulate contract negotiation and dispute resolution, demonstrating metacognitive awareness of communication styles, negotiation tactics, and legal risk assessment, and our role in construction and design in the jurisprudence setting.

CEEN429. SURVEYING FOR ENGINEERS AND INFRASTRUCTURE DESIGN PRACTICES. 3.0 Semester Hrs.

This course provides integrated professional experience in surveying, geospatial analysis, and roadway design. Students perform precise field measurements, apply curved-earth models and coordinate systems, and analyze spatial data within an engineering framework. Students develop a roadway alignment using field-collected data and produce professional documentation in AutoCAD Civil 3D. Fieldwork is completed in small crews and emphasizes accuracy, redundancy, and professional accountability. Prerequisite: CEEN331.

Course Learning Outcomes

- Perform fundamental surveying operations to accurately measure and locate positions, elevations, distances, and angles on the earth's surface using contemporary field equipment and established procedures.
- Apply curved-earth models, including the ellipsoid and geoid, to analyze spatial data and execute mathematical transformations between surface representations with appropriate precision.
- Connect contemporary surveying practice to its theoretical and methodological origins, explaining how classical techniques inform modern standards of accuracy, reliability, and professional judgment.
- Design and develop a roadway alignment by integrating field observations, horizontal and vertical curve geometry, and earthwork calculations, and produce a professional-quality plan and profile using AutoCAD Civil 3D.
- Evaluate survey data for accuracy, propagate error, and determine whether results satisfy specified project tolerances and engineering standards.
- Operate effectively within a professional survey crew by planning field activities, executing assigned roles, managing data collection, and delivering reliable project outcomes within a three-person team structure.

CEEN430. ADVANCED STRUCTURAL ANALYSIS. 3.0 Semester Hrs.

Introduction to advanced structural analysis concepts. Nonprismatic structures. Arches, Suspension and cable-stayed bridges. Structural optimization. Computer Methods. Structures with nonlinear materials. Internal force redistribution for statically indeterminate structures. Graduate credit requires additional homework and projects. 3 hour lectures; 3 semester hours. Prerequisite: CEEN314.

Course Learning Outcomes

- Draw and interpret Shear and Moment Diagrams for beams and frames.
- Determine internal and external forces in a cables subjected to concentrated loads, self weight and uniform loads.
- Understand load path for cable supported structures.
- Determine internal and external forces in an arch.
- Learn and understand approximate methods for solutions of beams, trusses and frames.
- Determine slope and displacement of beams, trusses and frames using principals of virtual work.
- Understand and interpret structural optimization of beams and frames.
- Understand how stiffness affects load path and internal force redistribution for statically indeterminate members.
- Analyze statically indeterminate beams using various methods.
- Understand non-prismatic and non-linear structural behavior.
- Define, Identify and verify boundary conditions in 3d computer-aided structural analysis software.
- Understand 3d computer aided structural analysis software.

CEEN433. MATRIX STRUCTURAL ANALYSIS. 3.0 Semester Hrs.

Equivalent with CEEN533,

Focused study on computer oriented methods for solving determinate and indeterminate structures such as trusses and frames. Classical stiffness based analysis method will be introduced with hands-on practice to develop customized matrix analysis program using Matlab. Commercial structural analysis programs will also be introduced during the class and practiced through class projects. When this course is cross-listed and concurrent with CEEN533, students that enroll in CEEN533 will complete additional and/or more complex assignments. 3 lecture hours, 3 semester hours. Prerequisite: CEEN314.

Course Learning Outcomes

- Gain fundamental understanding on Matrix analysis method and procedure.
- Be able to program basic linear member finite element code using Matlab.
- Use a commercial structural analysis software to solve typical structural analysis problems.

CEEN439. MASONRY DESIGN . 3.0 Semester Hrs.
In this course students will learn about masonry design and construction, the history of masonry, the components of masonry and relevant codes and standards. Students will learn how to design masonry bearing walls, shear walls, beams, lintels and columns for both gravity and lateral loads, reinforced and unreinforced masonry. Prerequisites: CEEN314.
Course Learning Outcomes

- Explain basic masonry components, including clay brick, concrete block, mortar, grout and reinforcing.
- Analyze and design unreinforced masonry structures.
- Describe the behavior of masonry structures.
- Design various masonry components including; bearing walls, shear walls, beam, lintels and columns for various loads including, flexure, axial forces and shear.
- Learn, Identify and communicate the methods of masonry construction and detailing.
- Read, interpret and apply the applicable building codes for masonry design.

CEEN442. DESIGN OF WOOD STRUCTURES. 3.0 Semester Hrs.
(II) The course develops the theory and design methods required for the use of wood as a structural material. The design of walls, beams, columns, beam-columns, shear walls, and structural systems are covered with consideration of gravity, wind, snow, and seismic loads. Prerequisite: CEEN311.
Course Learning Outcomes

- Gain fundamental knowledge on engineered wood products, be able to recognized these products and find their design values in the code reference material.
- Be able to navigate NDS code and SDPWS provisions.
- Be able to design and check light frame wood structural components and simple systems.
- Be able to design and check typical mass timber structural components and simple systems.

CEEN443. DESIGN OF STEEL STRUCTURES. 3.0 Semester Hrs.
To learn application and use the American Institute of Steel Construction (AISC) Steel Construction Manual. Course develops an understanding of the underlying theory for the design specifications. Students learn basic steel structural member design principles to select the shape and size of a structural member. The design and analysis of tension members, compression members, flexural members, and members under combined loading is included, in addition to basic bolted and welded connection design. 3 hours lecture; 3 semester hours. Prerequisite: CEEN314.
Course Learning Outcomes

- Learn fundamental principles in steel design, gain familiarity with AISC design manual and code.
- Gain competence in the capacity calculation of structural steel members subjected to axial and transverse loads, and simple bolted and welded connections.
- Be able to read, interpret, and apply building code requirements related to steel members and simple connections.
- Be able to analyze and design simple steel structures under given load combinations.

CEEN445. DESIGN OF REINFORCED CONCRETE STRUCTURES. 3.0 Semester Hrs.
This course provides an introduction to the materials and principles involved in the design of reinforced concrete. It will allow students to develop an understanding of the fundamental behavior of reinforced concrete under compressive, tensile, bending, and shear loadings, and gain a working knowledge of strength design theory and its application to the design of reinforced concrete beams, columns, slabs. 3 hours lecture; 3 semester hours. Prerequisite: CEEN314.
Course Learning Outcomes

- Understand the advantages and disadvantages of reinforced concrete over other building materials with consideration of public health, safety, and welfare in terms of global, cultural, social, environmental, and economic factors.
- Define the limits of the Euler Bernoulli assumption and draw the corresponding linear strain distribution, stress distribution, and force reactions that illustrate the composite behavior of reinforced concrete in terms of the nonlinear behavior of concrete and steel reinforced bars.
- Apply the American Concrete Institute (ACI) strength design approach to design rectangular beams, one-way slabs, T-beams, double reinforced beams, and short columns.
- Design stirrup size and spacing in beams to meet ACI shear strength requirements.
- Recognize how the ACI code ensures ethical and professional responsibilities in developing designs that meet the occupancy needs of the public by developing cost-effective structures that would exhibit ductility in the event of failure.
- Calculate development length for straight and hooked bars in tension and lap splices for reinforcing steel bars in tension.
- Evaluate if a rectangular reinforced concrete beam meets ACI short- and long-term deflection criteria.

CEEN448. STRUCTURAL LOADS. 3.0 Semester Hrs.
Students will be introduced to the load types and load combinations required to design structures in compliance with building code requirements. Students will learn the theory and methods to determine the magnitude and application of loads associated with structure self-weight and occupancy. Students will be introduced to the physics underlying the requirements for environmental loads and to the accepted methods used to calculate environmental loads due to wind, snow, rain, floods, and avalanches. Students will become familiar with the common approaches used to deal with tsunami loads and blast loads. Students will learn the importance of and to recognize the load paths required to transmit applied loads from the structure to the foundation. Course offered every third semester. Prerequisite: CEEN314.
Course Learning Outcomes

- Students are expected to attend class, ask questions, utilize office hours when needed, and come to class prepared.
- Students are expected to display academic integrity (see Academic Integrity Section).

- Students will be able to determine to applicable loads to be used to design a structure, be able to calculate their magnitudes and directions, and specify load path.

CEEN449. INTRODUCTION TO THE SEISMIC DESIGN OF STRUCTURES. 3.0 Semester Hrs.

This course provides students with an introduction to seismic design as it relates to structures. Students will become familiar with the sources of seismic disturbances, the physics of seismic energy transmission, and the relationship between ground disturbance and the resulting forces experienced by structures. The theory and basis for existing building code provisions relating to seismic design of structures will be introduced. Building code requirements and design methodologies will be examined and applied. Advanced performance based seismic design method will also be introduced. Prerequisite: CEEN443, or CEEN445, or CEEN442 Co-requisite: N/A.

Course Learning Outcomes

- Gain fundamental understanding on earthquake hazard and how it is characterized for structural design.
- Understand typical lateral load path for building structures.
- Gain fundamental understanding of structural dynamics related to earthquake engineering.
- Get familiar with Seismic Design sections in ASCE7, and be able to use ASCE7 to conduct simple seismic design using equivalent lateral force procedure.
- Understand the concept of performance based seismic design method.

CEEN460. MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT. 3.0 Semester Hrs.

(I) Essentially, this course will be an introduction to the field of environmental microbiology. Although not titled as such, we will focus on all aspects of environmental microbiology including those of engineered systems. We will be particularly considering things that pertain to life in all of its forms. Expect to engage in diverse conversations pertaining to life in any of its habitats. The class has THREE ESSENTIAL ELEMENTS. The first is the lectures and the material that I, or any of the guest speakers happen to cover. The second is the material that has been assigned in the textbook. Please read the assigned textbook sections thoroughly before coming to class. Also, at times, I will be assigning current papers to read, please read them as assigned. The third is YOUR PARTICIPATION in discussions. 3 hours lecture; 3 semester hours.

Course Learning Outcomes

- Have a thorough understanding of the microbial world, as of the Fall of 2018.
- Have a new understanding of what life means.
- Have a new understanding of the Earth.
- Have a new understanding of your body.
- Have a new understanding of the rock record and a new perspective on what it means to be a civil / environmental engineer going into the future.

CEEN461. FUNDAMENTALS OF ECOLOGY. 3.0 Semester Hrs.

Biological and ecological principles discussed and industrial examples of their use given. Analysis of ecosystem processes, such as erosion, succession, and how these processes relate to engineering activities, including engineering design and plant operation. Criteria and performance standards analyzed for facility siting, pollution control, and mitigation of impacts. North American ecosystems analyzed. Concepts of forestry, range, and wildlife management integrated as they apply to all of the above. Three to four weekend trips will be arranged during the semester. Semester offering based on faculty availability.

Course Learning Outcomes

- Describe the major characteristics of the earth's biomes.
- Discuss how the physical environment affects plant and animal communities.
- Identify the major human impacts on ecosystems and elucidate ways to mitigate these impacts.
- Apply critical thinking to extrapolate from data to determine trends.
- Carry out a literature-based research project in Ecology.

CEEN470. WATER AND WASTEWATER TREATMENT PROCESSES. 3.0 Semester Hrs.

Equivalent with BELS453,EGGN453,ESGN453,

The goal of this course is to familiarize students with the unit operations and processes involved in water and wastewater treatment. This course will focus on the physical, chemical, and biological processes for water and wastewater treatment and reclamation. Treatment objectives, process theory, and practice are considered in detail. Prerequisite: CEEN301.

Course Learning Outcomes

- Identify drinking water and wastewater contaminants and measurements of concern, and select appropriate unit processes to meet treatment objectives.
- Understand and implement in the design the physical, chemical, and biological principles and mechanisms that underpin individual drinking water and wastewater treatment unit processes and control effluent water quality.
- Apply mass and energy balances and reactor design principles to predict required chemical inputs, energy demand, target contaminant removal, and residuals produced during individual unit processes and operations.
- Explore tradeoffs in process designs aimed at meeting drinking water quality targets while simultaneously considering public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- Evaluate current treatment practices and Make informed judgments about current treatment practices and designs that consider ethical and professional responsibilities to public health and safety within global, economic, environmental, and societal contexts.

CEEN472. ONSITE WATER RECLAMATION AND REUSE. 3.0 Semester Hrs.

Appropriate solutions to water and sanitation in the U.S. and globally need to be effective in protecting public health and preserving water quality while also being acceptable, affordable and sustainable. Onsite and decentralized systems have the potential to achieve these goals in rural areas, peri-urban developments, and urban centers in small and large cities. Moreover they can improve water use efficiency, conserve energy and enable distributed energy generation, promote green spaces, restore surface waters and aquifers, and stimulate new green companies and jobs. A growing array of approaches, devices and technologies have evolved that include point-of-use water purification, waste source separation, conventional and advanced treatment units, localized natural treatment systems, and varied resource recovery and recycling options. This course will focus on the engineering selection, design, and implementation of onsite and decentralized systems for water reclamation and reuse. Topics to be covered include process analysis and system planning, water and waste stream attributes, water and resource conservation, confined unit and natural system treatment technologies, effluent collection and clustering, recycling and reuse options, and system management. Prerequisite: CEEN301. 3 hours lecture; 3 semester hours.

Course Learning Outcomes

- Evaluate treatment processes, collection approaches, and effluent dispersal and reuse options, including socio-cultural contexts, for onsite/decentralized sanitation.
- Identify and use relevant design equations.
- Work in teams to effectively communicate in writing and orally to describe the synthesis of the outcomes above.

CEEN473. HYDRAULIC PROBLEMS. 3.0 Semester Hrs.

Review of fundamentals, forces on submerged surfaces, buoyancy and flotation, gravity dams, weirs, steady flow in open channels, backwater curves, hydraulic machinery, elementary hydrodynamics, hydraulic structures. Prerequisite: CEEN310 or CBEN307.

CEEN475. HAZARDOUS SITE REMEDIATION ENGINEERING. 3.0 Semester Hrs.

This course describes the engineering principles and practices associated with the characterization and remediation of contaminated sites. Methods for site characterization and risk assessment will be highlighted while the emphasis will be on remedial action screening processes and technology principles and conceptual design. Common isolation and containment and in-situ and ex-situ treatment technology will be covered. Computerized decision-support tools will be used and case studies will be presented. Prerequisite: CHGN121.

CEEN478. WATER TREATMENT DESIGN AND ANALYSIS. 3.0 Semester Hrs.

The learning objectives of this class are to build off of the information and theories presented in CEEN 470 and apply them to the design of water and wastewater treatment systems. Students will be presented with project-based assignments and, with the help of the instructors and associated lectures, will use fundamentals and commercial software to develop preliminary designs of water and wastewater systems. Students will gain experience in conventional and advanced treatment system design, software utilized by environmental consulting companies, and professional communication through the completion of this class. Course lectures will include fundamentals of design, guest lectures from practitioners, and tours of local treatment plants. Regional water and wastewater treatment employers (e.g., consultants, municipalities, industry, regulators) are actively searching for students with applied experience and this class will help promote the advancement of employment in the water and wastewater treatment field. Prerequisite: CEEN470.

Course Learning Outcomes

- Use fundamentals and commercial software to design and analyze water treatment systems.
- Integrate design aspects for development of integrated water systems to treat variable water resources.
- Summarize design components into drawings and diagrams.
- Communicate solutions and designs to practitioners through technical reports and presentations.

CEEN479. AIR POLLUTION. 3.0 Semester Hrs.

This course familiarizes students with the basic physics, chemistry and biology of major air pollutants, related health impacts, and engineered approaches used to mitigate the effects of common air pollutants. This course is also designed to provide a solid foundation in air pollution topic areas found on the FEE or PE exam. Critical US air pollution legislation is discussed. The sources of particulate and gaseous pollutants from both stationary and mobile sources, associated key chemical reactions, and approaches for control are considered. Indoor air pollution and the Gaussian dispersion model for air pollutants are discussed. Prerequisite: CEEN302. 3 hours lecture; 3 semester hours.

Course Learning Outcomes

- Characterize and compare the various types of air pollutants, their sources, fate, and health and environmental risks and impacts.
- Summarize current air quality standards and legislation.
- Identify, characterize, and assess different methods of pollution prevention and source control devices for particulate matter and other air pollutants.
- Predict downwind concentrations of pollutants under varying conditions using air pollution modeling.

CEEN480. CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT. 3.0 Semester Hrs.

Equivalent with ESGN440,

This course describes the environmental behavior of inorganic and organic chemicals in multimedia environments, including water, air, sediment and biota. Sources and characteristics of contaminants in the environment are discussed as broad categories, with some specific examples from various industries. Attention is focused on the persistence, reactivity, and partitioning behavior of contaminants in environmental media. Both steady and unsteady state multimedia environmental models are developed and applied to contaminated sites. The principles of contaminant transport in surface water, groundwater and air are also introduced. The course provides students with the conceptual basis and mathematical tools for predicting the behavior of contaminants in the environment. Prerequisite: CEEN301.

CEEN482. HYDROLOGY AND WATER RESOURCES LABORATORY. 3.0 Semester Hrs.

This course introduces students to the collection, compilation, synthesis and interpretation of data for quantification of the components of the hydrologic cycle, including precipitation, evaporation, infiltration, and runoff. Students will use hydrologic variables and parameters to evaluate watershed processes and behavior. Students will also survey and apply measurement techniques necessary for watershed studies. Advanced topics include development, construction, and application of analytical models for selected problems in hydrology and water resources. Prerequisite: CEEN381. 2 hours lecture; 3 hours lab; 3 semester hours.

Course Learning Outcomes

- Analyze hydrologic data using statistical computing software (specifically, R).
- Create a site map, delineate a watershed, and analyze geospatial data in ArcGIS.
- Collect, compile, synthesize, and interpret data for the quantification of components of the hydrologic cycle.
- Analyze flow characteristics and flow frequencies.
- Estimate peak river discharge and compare methods to do so.
- Collect field data necessary to make water resources and hydrology management decisions.
- Interpret and present results from collected field data.
- Evaluate statistical trends in precipitation, evapotranspiration, and discharge data.

- Develop and apply watershed models to investigate water resources scenarios.
- Write effective and communicative technical reports.
- Communicate scientific results to a wide audience via diverse methods.
- Collaborate in teams to gather, synthesize, and report data.

CEEN492. ENVIRONMENTAL LAW. 3.0 Semester Hrs.
Equivalent with CEEN592,PEGN530,
Specially designed for the needs of the environmental quality engineer, scientist, planner, manager, government regulator, consultant, or advocate. Highlights include how our legal system works, environmental law fundamentals, all major US EPA/state enforcement programs, the National Environmental Policy Act, air and water pollutant laws, risk assessment and management, and toxic and hazardous substance laws (RCRA, CERCLA, TSCA, LUST, etc). Prerequisites: CEEN301 or CEEN302. 3 hours lecture; 3 semester hours.

CEEN493. SUSTAINABLE ENGINEERING DESIGN. 3.0 Semester Hrs.
This course provides a comprehensive introduction to concepts of sustainability and sustainable development from an engineering point of view. Environmental and health impacts are quantitatively considered in engineering and design analysis through a Life Cycle Assessment (LCA) tool. Social considerations, a key aspect of sustainable engineering design, are integrated throughout the design analysis. Prerequisite: Senior or graduate standing.
Course Learning Outcomes

- Demonstrate sufficient familiarity with the terminology associated with sustainability and sustainable engineering to speak and write effectively about the topic.
- Compare and contrast traditional engineering design and analysis approaches with those associated with sustainable design, in particular those that go beyond the triple-bottom-line approach to include considerations of social justice and socio-technical integration.
- Apply a working knowledge of a commercially available LCA tool to an engineering design problem.
- Work in teams to effectively (1) write a project report and (2) give a presentation, both of which describe the connection between the concepts of sustainable engineering and their work, the approach they took and their conclusions and recommendations for future work.

CEEN497. PRACTICES AND PRINCIPLES OF ENVIRONMENTAL CONSULTING. 3.0 Semester Hrs.
This course provides an in-depth understanding of the environmental consulting industry with a particular focus on problem solving and project delivery to meet expectations of professional services organizations (environmental consulting firms). Using case studies, real-life consulting assignments, and business scenarios, the course offers exposure to the technical, ethical, and business challenges of winning and executing environmental projects.
Course Learning Outcomes

- 1. Understand the drivers and policies that protect our environmental and water resources.
- 2. Apply knowledge gained in the course from pragmatic problems taken from real scenarios experienced within the consulting industry
- 3. Develop an appreciation for investigations and data interpretation making science-based decisions where possible and determine when decisions may require additional information.
- 4. Know the basic process of project initiation, budgeting, management, and effective delivery in executing environmental projects.
- 5. Work with a team to interpret given data to understand what information is important to advise alternatives, planning, decisions, and design.
- 6. Consider how to tailor designs to meet objectives that protect public health and to meet environment objectives and requirements.
- 7. Use data and engineering judgement to calculate sizing of infrastructure and to develop solutions to solve local environmental problems; research and consider social and economic project considerations and outcomes
- 8. Effectively deliver quality technical products to communicate issues and basis of design; develop communication and presentations skills that effectively share information to an appropriate audience; present technical materials to instructors and peers; provide constructive feedback to peers.

CEEN497. SPECIAL SUMMER COURSE. 0-15 Semester Hr.

CEEN498. SPECIAL TOPICS IN CIVIL AND ENVIRONMENTAL ENGINEERING. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

CEEN498. SPECIAL TOPICS. 1-6 Semester Hr.

CEEN498. SPECIAL TOPICS. 0-6 Semester Hr.

CEEN498. SPECIAL TOPICS. 0-6 Semester Hr.

CEEN499. INDEPENDENT STUDY. 1-6 Semester Hr.
Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Variable credit; 1 to 6 credit hours. Repeatable for credit. Prerequisite: Independent Study form must be completed and submitted to the Registrar.

CEEN499. INDEPENDENT STUDY. 1-6 Semester Hr.

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CEEN499. INDEPENDENT STUDY. 0.5-6 Semester Hr.

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Professor and Department Head

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