Civil and Environmental Engineering

Program Description

The Department of Civil & Environmental Engineering (CEE) offers design-oriented and student-centered undergraduate programs in Civil Engineering and Environmental Engineering. The degrees build upon fundamental engineering principles and provide specialization within Civil 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.

The Civil Engineering degree offers breadth in several Civil Engineering fields: Construction Engineering, Engineering Surveying, Environmental Engineering, Geotechnical Engineering, Structural Engineering, and Water Resources. Civil students can elect to further specialize in one or more of these areas by selecting related courses to fulfill their Civil Engineering Technical Electives.

The Environmental Engineering degree introduces students to the fundamentals of environmental engineering including the scientific and regulatory basis of public health and environmental protection. The degree is designed to prepare students to investigate and analyze 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. Topics covered include water reclamation and reuse, hazardous waste management, contaminated site remediation, environmental science, water and wastewater treatment, and regulatory processes.

The programs leading to the degree Bachelor of Science in Civil Engineering and to the degree Bachelor of Science in Environmental Engineering are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

The department also offers two minors and two ASIs. Majors are encouraged to use free elective courses to gain knowledge in another discipline and incorporate either an Area of Special Interest (ASI) or a minor. This adds to the flexibility of the program and qualifies students for a wide variety of careers.

Program Educational Objectives

The Civil Engineering and Environmental Engineering programs contribute to the educational objectives described in the CSM Graduate Profile and the ABET Accreditation Criteria. Program Educational Objectives (PEOs) of these programs are as follows:

- Graduates will uphold the standards of Mines as critical and creative innovators, motivators, collaborators, communicators, and leaders.
- Graduates will be successfully employed in engineering, science, or other impactful careers.
- Graduates will engage in continual learning by pursuing additional educational opportunities such as advanced degrees, professional licensure, conferences, training, networking, and society membership.
- Graduates will be ambassadors of their field, contributing to collective knowledge in industry, research, and society.
- 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.
- 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 Objectives

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.

Curriculum

During the first two years at Colorado School of Mines, students complete a set of core courses that includes mathematics, basic sciences, and engineering sciences. Course work in mathematics gives engineering students tools for modeling, analyzing, and predicting physical and chemical phenomena. The basic sciences of physics and chemistry provide an appropriate foundation in the physical sciences; engineering science then builds upon these basic sciences and focuses on applications.

The core curriculum also includes an introduction to engineering design principles and practices. These courses emphasize design methodology and stress the creative and synthesis aspects of the engineering profession. The core curriculum also includes complementary courses in the humanities and social sciences which explore the links between the environment, human society, and engineering.

In the final two years, students complete discipline-specific advanced engineering courses. Civil Engineering students explore soil mechanics, structural theory, design of foundations, design of steel or concrete structures, and Civil Engineering technical electives. Environmental Engineering students explore water chemistry and water quality, air pollution, the fate and transport of chemicals in the environment (air, water, and soil), water resources, environmental policy, and Environmental Engineering technical electives. At the student's discretion, free electives (9 credits) can be used to either satisfy his/her personal interest in a topic or the credits can be used to pursue an "area of special interest" (12 semester hours) or a minor (at least 18 semester hours). All students complete a capstone engineering design course that is focused on an in-depth, realistic, and multi-disciplinary engineering project.

Students interested in a research experience, in addition to their undergraduate curriculum, are encouraged to work on an Independent Study project with one of the Civil & Environmental Engineering faculty. These projects can offer an applied experience that is relevant to future graduate studies and a professional career.

Bachelor of Science in Civil Engineering Degree Requirements:

Freshman

Fall		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 or CBEN 110			4.0
HASS100	NATURE AND HUMAN VALUES			3.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
				16.0
Spring		**lec**	**lab**	**sem.hrs**
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
PHGN100	PHYSICS I - MECHANICS			4.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
S&W	SUCCESS AND WELLNESS			1.0
EDNS151	CORNERSTONE - DESIGN I			3.0
				16.0

Sophomore

Fall		lec	lab	sem.hrs
CEEN210	INTRODUCTION TO CIVIL INFRASTRUCTURE			2.0
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CEEN241	STATICS			3.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
HASS200	GLOBAL STUDIES			3.0
				17.0
Spring		**lec**	**lab**	**sem.hrs**
CEEN310	FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING			3.0
CEEN267	DESIGN II: CIVIL ENGINEERING, EDNS 262, EDNS 261, or EDNS 251			3.0
CEEN311	MECHANICS OF MATERIALS			3.0
MATH201	INTRODUCTION TO STATISTICS			3.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
CEEN315	CIVIL AND ENVIRONMENTAL ENGINEERING TOOLS			2.0
				17.0
Summer		**lec**	**lab**	**sem.hrs**
CEEN331	ENGINEERING FIELD SESSION, CIVIL			3.0
				3.0

Junior

Fall		lec	lab	sem.hrs
CEEN350	CIVIL AND CONSTRUCTION ENGINEERING MATERIALS			3.0
CEEN314	STRUCTURAL THEORY			3.0
CEEN312	SOIL MECHANICS			3.0
CEEN312L	SOIL MECHANICS LABORATORY			1.0
MATH225	DIFFERENTIAL EQUATIONS			3.0
EBGN321	ENGINEERING ECONOMICS*For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
				16.0
Spring		**lec**	**lab**	**sem.hrs**
CE BREADTH	Civil Engineering Breadth Elective*			3.0
CE BREADTH	Civil Engineering Breadth Elective*			3.0
CEEN415	FOUNDATION ENGINEERING			3.0
STR ELECT	Structural Design Elective**			3.0
MEGN315	DYNAMICS			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
				18.0

Senior

Fall		lec	lab	sem.hrs
EDNS491	CAPSTONE DESIGN I			3.0
CE ELECT	Civil Engineering Technical Elective***			3.0
CE ELECT	Civil Engineering Technical Elective***			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
FREE	Free Elective			3.0

FREE	Free Elective			3.0
				18.0
Spring		**lec**	**lab**	**sem.hrs**
EDNS492	CAPSTONE DESIGN II			3.0
CE ELECT	Civil Engineering Technical Elective***			3.0
CE ELECT	Civil Engineering Technical Elective***			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective			3.0
FREE	Free Elective			3.0
				15.0

Total Semester Hrs: 136.0

*** *Civil Engineering Breadth Electives*** - Students must take a minimum of two courses from this list. These courses may count as Civil Engineering Technical Electives or Free Electives if not used to meet this requirement.

CEEN301	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: WATER
CEEN360	INTRODUCTION TO CONSTRUCTION ENGINEERING
CEEN381	HYDROLOGY AND WATER RESOURCES ENGINEERING

**** *Structural Design Elective*** - Students must take a minimum of one course from this list. These courses may count as Civil Engineering Technical Electives or Free Electives if not used to meet this requirement.

CEEN443	DESIGN OF STEEL STRUCTURES
CEEN445	DESIGN OF REINFORCED CONCRETE STRUCTURES

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

2 Electives must come from a CEEN Prefix:

CEEN302	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: AIR AND WASTE MANAGEMENT
CEEN303	ENVIRONMENTAL ENGINEERING LABORATORY
CEEN401	LIFE CYCLE ASSESSMENT
CEEN402	PROJECT ENGINEERING
CEEN405	NUMERICAL METHODS FOR ENGINEERS
CEEN406	FINITE ELEMENT METHODS FOR ENGINEERS
CEEN410	ADVANCED SOIL MECHANICS
CEEN411	UNSATURATED SOIL MECHANICS
CEEN421	HIGHWAY AND TRAFFIC ENGINEERING
CEEN423	SURVEYING FOR ENGINEERS AND INFRASTRUCTURE DESIGN PRACTICES
CEEN430	ADVANCED STRUCTURAL ANALYSIS
CEEN433	MATRIX STRUCTURAL ANALYSIS
CEEN441	INTRODUCTION TO THE SEISMIC DESIGN OF STRUCTURES
CEEN446	STRUCTURAL LOADS
CEEN460	MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT
CEEN461	FUNDAMENTALS OF ECOLOGY
CEEN470	WATER AND WASTEWATER TREATMENT PROCESSES
CEEN471	WATER AND WASTEWATER TREATMENT SYSTEMS ANALYSIS AND DESIGN
CEEN472	ONSITE WATER RECLAMATION AND REUSE
CEEN475	SITE REMEDIATION ENGINEERING
CEEN477	SUSTAINABLE ENGINEERING DESIGN
CEEN479	AIR POLLUTION
CEEN480	CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT
CEEN482	HYDROLOGY AND WATER RESOURCES LABORATORY
CEEN492	ENVIRONMENTAL LAW
EBGN321	ENGINEERING ECONOMICS
GEGN466	GROUNDWATER ENGINEERING
GEGN468	ENGINEERING GEOLOGY AND GEOTECHNICS
GEGN473	GEOLOGICAL ENGINEERING SITE INVESTIGATION
MEGN416	ENGINEERING VIBRATION
MNGN321	INTRODUCTION TO ROCK MECHANICS
MNGN404	TUNNELING
MNGN405	ROCK MECHANICS IN MINING
MNGN406	DESIGN AND SUPPORT OF UNDERGROUND EXCAVATIONS

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:

CEEN100 through CEEN499 inclusive

Bachelor of Science in Environmental Engineering Degree Requirements:

Freshman				
Fall		**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
				16.0
Spring		**lec**	**lab**	**sem.hrs**
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
				16.0
Sophomore				
Fall		**lec**	**lab**	**sem.hrs**
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CEEN241	STATICS			3.0
EDNS251	CORNERSTONE DESIGN II, 261, 262, or CEEN 267			3.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
				15.0
Spring		**lec**	**lab**	**sem.hrs**
MATH225	DIFFERENTIAL EQUATIONS			3.0
CEEN310	FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING			3.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
EBGN321	ENGINEERING ECONOMICS*For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
HASS200	GLOBAL STUDIES			3.0
				15.0
Junior				
Fall		**lec**	**lab**	**sem.hrs**
CEEN301	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: WATER			3.0
CEEN381	HYDROLOGY AND WATER RESOURCES ENGINEERING			3.0
CHGN209	INTRODUCTION TO CHEMICAL THERMODYNAMICS, CBEN 210, or MEGN 361			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
MATH201	INTRODUCTION TO STATISTICS			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
FREE	Free Elective			3.0
				18.0
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
FREE	Free Elective			3.0
				18.0
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: 131.0

**** 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.

CEEN312	SOIL MECHANICS	
CEEN405	NUMERICAL METHODS FOR ENGINEERS	
CEEN401	LIFE CYCLE ASSESSMENT	
CEEN402	PROJECT ENGINEERING	
CEEN410	ADVANCED SOIL MECHANICS	
CEEN425	CEMENTITIOUS MATERIALS FOR CONSTRUCTION	3.0
CEEN426	DURABILITY OF CONCRETE	3.0
CEEN460	MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT	
CEEN461	FUNDAMENTALS OF ECOLOGY	
CEEN471	WATER AND WASTEWATER TREATMENT SYSTEMS ANALYSIS AND DESIGN	
CEEN472	ONSITE WATER RECLAMATION AND REUSE	
CEEN473	HYDRAULIC PROBLEMS	3.0
CEEN475	SITE REMEDIATION ENGINEERING	
CEEN477	SUSTAINABLE ENGINEERING DESIGN	
CEEN479	AIR POLLUTION	
CEEN492	ENVIRONMENTAL LAW	
CEEN555	LIMNOLOGY	3.0
CEEN581	WATERSHED SYSTEMS MODELING	3.0
CHGN403	INTRODUCTION TO ENVIRONMENTAL CHEMISTRY	
CHGN462	MICROBIOLOGY	
EBGN321	ENGINEERING ECONOMICS	
ENGY320	INTRO TO RENEWABLE ENERGY	
GEGN466	GROUNDWATER ENGINEERING	
GEGN473	GEOLOGICAL ENGINEERING SITE INVESTIGATION	
GEGN475	APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS	
MEGN467	PRINCIPLES OF BUILDING SCIENCE	3.0
PEGN430	ENVIRONMENTAL LAW AND SUSTAINABILITY	3.0

Major GPA

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

CEEN300 through CEEN499 inclusive

Bachelor of Science in Construction Engineering Degree Requirements:

Freshman

Fall		**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
				16.0

Spring		**lec**	**lab**	**sem.hrs**
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
PHGN100	PHYSICS I - MECHANICS			4.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1) or 125			4.0
EDNS151	CORNERSTONE - DESIGN I			3.0
S&W	SUCCESS AND WELLNESS			1.0
				16.0

Sophomore

Fall		**lec**	**lab**	**sem.hrs**
CEEN210	INTRODUCTION TO CIVIL INFRASTRUCTURE			2.0
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CEEN241	STATICS			3.0
HASS200	GLOBAL STUDIES			3.0
				16.0

Spring		**lec**	**lab**	**sem.hrs**
CEEN267	DESIGN II: CIVIL ENGINEERING			3.0
CEEN311	MECHANICS OF MATERIALS			3.0

CEEN360	INTRODUCTION TO CONSTRUCTION ENGINEERING			3.0
MATH201	INTRODUCTION TO STATISTICS			3.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
				16.0
Summer		**lec**	**lab**	**sem.hrs**
CEEN331	ENGINEERING FIELD SESSION, CIVIL			3.0
				3.0
Junior				
Fall		**lec**	**lab**	**sem.hrs**
CEEN312	SOIL MECHANICS			3.0
CEEN312L	SOIL MECHANICS LABORATORY			1.0
CEEN314	STRUCTURAL THEORY			3.0
CEEN350	CIVIL AND CONSTRUCTION ENGINEERING MATERIALS			3.0
MATH225	DIFFERENTIAL EQUATIONS			3.0
CEENXXX	CONSTRUCTION ENGINEERING MEANS & METHODS Prereq: CEEN360			3.0
				16.0
Spring		**lec**	**lab**	**sem.hrs**
CEENXXX	CONSTRUCTION ESTIMATING, PLANNING AND SCHEDULING Prereq:CEEN360			3.0
CEENXXX	CONSTRUCTION PROJECT ADMINISTRATION AND CONTROLS			3.0
CEEN415	FOUNDATION ENGINEERING			3.0
EBGN321	ENGINEERING ECONOMICS *For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
CAS MID-LEVEL ELECTIVE				3.0
TECHNICAL ELECTIVE	CEEN421, CEEN423, CEEN425, CEEN443, CEEN445, CEEN477, CEEN381 (PREREQ: CEEN310			3.0
				18.0
Senior				
Fall		**lec**	**lab**	**sem.hrs**
EDNS491	CAPSTONE DESIGN I			3.0
CEENXXX	INTEGRATED DESIGN AND CONSTRUCTION I Prereqs: CONSTRUCTION PROJECT ADMINISTRATION AND CONTROLS (CPAC), CONSTRUCTION ESTIMATING, PLANNING, AND SCHEDULING (CEPS)			3.0
CEENXXX	CONSTRUCTION LAW Prereq: CEEN360			3.0
CAS MID-LEVEL ELECTIVE				3.0
TECHNICAL ELECTIVE	CEEN421, CEEN423, CEEN425, CEEN443, CEEN445, CEEN477, CEEN381 (prereq: CEEN310)			3.0
TECHNICAL ELECTIVE	CEEN421, CEEN423, CEEN425, CEEN443, CEEN445, CEEN477, CEEN381 (prereq: CEEN310)			3.0
				18.0
Spring		**lec**	**lab**	**sem.hrs**
EDNS492	CAPSTONE DESIGN II			3.0
CEENXXX	INTEGRATED DESIGN AND CONSTRUCTION II Prereq: INTEGRATED DESIGN AND CONSTRUCTION I			3.0
CAS MID-LEVEL ELECTIVE				3.0
FREE ELECTIVE				3.0
FREE ELECTIVE				3.0
				15.0

Total Semester Hrs: 134.0

The Mines guidelines for Minor/ASI can be found in the Undergraduate Information section of the Mines Catalog.

Civil or Environmental Engineering Minor and ASI

ASI in Civil Engineering

Civil engineering is a closely related field to many majors on campus, including mechanical engineering, electrical engineering, petroleum engineering, geological engineering, and mining engineering. A background in civil engineering fundamentals bolsters students' credentials for careers in the construction industry, the mining industry, the energy sector, or public policy and service. This Area of Special Interest (ASI) has been carefully designed to introduce the fundamentals of the major subfields of civil engineering at Mines: structural engineering, geotechnical engineering, water resources and hydrology, environmental engineering, construction engineering, and surveying.

Students are encouraged to explore other courses relevant to this ASI and propose their own plan of study that would support the Area of Special Interest- Civil Engineering. For pre-approval on potential course substitutions to fulfill this ASI, please contact the Undergraduate Program Manager for Civil/Environmental Engineering.

Four courses (12.0 credits) are required for this ASI.

Required		**6.0**
CEEN312	SOIL MECHANICS	

CEEN314	STRUCTURAL THEORY	
Electives (See List)		6.0
Total Semester Hrs		**12.0**

Elective List: Select 2 of the following 4 courses:

CEEN301	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: WATER	3.0
CEEN331	ENGINEERING FIELD SESSION, CIVIL	3.0
CEEN360	INTRODUCTION TO CONSTRUCTION ENGINEERING	3.0
CEEN381	HYDROLOGY AND WATER RESOURCES ENGINEERING	3.0

Students that are majoring in Civil Engineering cannot complete this ASI. A student majoring in Environmental Engineering can complete this ASI by completing CEEN312, CEEN314, CEEN331, and CEEN360. Courses cannot be double-counted as Environmental Engineering Electives. Up to three of these courses may be double-counted towards the B.S. Environmental Engineering as Free Electives. This requirement ensures that there is sufficient distinction between the degree and the minor.

ASI in Environmental Engineering

Environmental engineering is at the forefront of solving the world's challenges related to earth, energy and environment. As such, an ability to apply environmental fundamentals to engineering practice within disciplines such as geological, mining, electrical, computational, mechanical, petroleum, and chemical processing industries as well as public policy and service bolsters students' credentials in those fields. This Area of Special Interest (ASI) has been carefully designed to introduce the fundamentals of environmental engineering at Mines: environmental science and chemistry, hydrology and water resources, water and wastewater treatment, and chemical implications, fate and transport to enable an understanding and application of these themes to practitioners across disciplines.

Students are encouraged to explore other courses relevant to this minor and propose their own plan of study that would support this Area of Special Interest (ASI). For pre-approval on potential course substitutions to fulfill this ASI, please contact the Undergraduate Program Manager for Civil/Environmental Engineering.

Four courses (12.0 credits) are required for this ASI.

Complete 4 of the following 5 courses:		12.0
CEEN301	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: WATER	
CEEN302	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: AIR AND WASTE MANAGEMENT	
CEEN381	HYDROLOGY AND WATER RESOURCES ENGINEERING	
CEEN470	WATER AND WASTEWATER TREATMENT PROCESSES	
CEEN480	CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT	

Students who are majoring in Environmental Engineering cannot complete this ASI. A student majoring in Civil Engineering can only earn this ASI by completing all 5 of the courses (15.0 credits total). Of those 5 courses, only 2 may be double-counted towards the major degree requirements. This additional requirement is necessary in order to ensure sufficient distinction between the degree and the ASI.

Minor in Structural Engineering

Structural engineering services are in high demand in virtually every engineering industry, spanning from construction to manufacturing to aerospace. This minor has been developed for students with an interest in the principles of solid mechanics that wish to learn how to design structures in practical applications. Topics covered in this minor include various methods and theories for structural analysis and design; finite element methods; design with steel, concrete, timber, and masonry; and an introduction to the seismic design of structures.

Students are encouraged to explore other courses relevant to this minor and propose their own plan of study that would support the Structural minor. For pre-approval on potential course substitutions to fulfill this minor, please contact the Undergraduate Program Manager for Civil/Environmental Engineering.

Six courses (18.0 credits) are required for this minor.

Required		**3.0**
CEEN314	STRUCTURAL THEORY [1]	
Electives (See List)		**15.0**
Total Semester Hrs		**18.0**

Elective List: Select 5 of the following 7 courses:

CEEN406	FINITE ELEMENT METHODS FOR ENGINEERS
CEEN430	ADVANCED STRUCTURAL ANALYSIS
CEEN433	MATRIX STRUCTURAL ANALYSIS
CEEN442	TIMBER AND MASONRY DESIGN
CEEN441	INTRODUCTION TO THE SEISMIC DESIGN OF STRUCTURES
CEEN443	DESIGN OF STEEL STRUCTURES
CEEN445	DESIGN OF REINFORCED CONCRETE STRUCTURES

In order to ensure sufficient distinction between the degree and the minor, Civil Engineering students must meet additional requirements to earn this minor. Courses that are required for the degree (CEEN314 and either CEEN443 or CEEN445) may not be double-counted towards the minor. Therefore, the remaining six courses on the list must be taken in order to earn the minor (CEEN406, CEEN430, CEEN442, CEEN443/CEEN445, CEEN441, and CEEN433). None of the six courses may be double-counted as Civil Engineering Technical Electives, but a maximum of three may be double-counted as Free Electives. The remaining courses used for the minor may not be applied to the B.S. Civil degree.

Students may also propose the substitution of other CEEN-prefixed structural engineering courses, such as 500-level graduate courses or approved Special Topics courses, at discretion of the approval of the department.

[1]The prerequisite to CEEN314, Structural Theory, is CEEN311 Mechanics of Materials. Students who have completed MEGN 312 Introduction to Solid Mechanics are encouraged to pursue a prerequisite override.

Minor in Water Sustainability

Assuring safe and sustainable water supplies is one of the world's most pressing challenges. Understanding the design and implementation of water systems and related infrastructure requires diverse knowledge within the water resources field but that knowledge also crosses into numerous engineering disciplines. Students that are pursuing careers in the mining industry, energy industry, manufacturing industry, chemical processing industry, and public policy sector can bolster their credentials with this minor. The Water Sustainability minor has been developed to expose students to the relevant subfields of water and environmental systems, including water chemistry, fluid mechanics, water resources and hydrology, fate and transport of chemicals in the environment, site remediation, and onsite water reclamation and reuse.

Students are encouraged to explore other courses relevant to this minor and propose their own plan of study that would support the Water Sustainability minor. For pre-approval on potential course substitutions to fulfill this minor, please contact the Undergraduate Program Manager for Civil/Environmental Engineering.

Six courses (18.0 credits) are required for this minor.

Required Courses		**12.0**
CEEN301	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: WATER	
CEEN310	FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING [1]	
CEEN381	HYDROLOGY AND WATER RESOURCES ENGINEERING	
CEEN470	WATER AND WASTEWATER TREATMENT PROCESSES	
Electives (See List)		**6.0**
Total Semester Hrs		**18.0**

Elective List: Select 2 of the following 6 courses:

CEEN471	WATER AND WASTEWATER TREATMENT SYSTEMS ANALYSIS AND DESIGN
CEEN472	ONSITE WATER RECLAMATION AND REUSE
CEEN475	SITE REMEDIATION ENGINEERING
CEEN477	SUSTAINABLE ENGINEERING DESIGN
CEEN480	CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT
CEEN482	HYDROLOGY AND WATER RESOURCES LABORATORY

Civil Engineering and Environmental Engineering majors may not pursue this minor, as there is too much overlap between degree requirements and the minor. The combined (BS + MS) degree program may be a suitable option for Civil or Environmental majors that wish to focus in Sustainable Water Engineering.

[1] Students that have completed a different variation of a fluid mechanics are encouraged to pursue a course substitution request so that the completed course can be double-counted for the minor.

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.
(I, II, S) Forces, moments, couples, equilibrium, centroids and second moments of areas, volumes and masses, hydrostatics, friction, virtual work. Applications of vector algebra to structures. Prerequisite: PHGN100 and credit or concurrent enrollment in MATH112 or MATH113. 3 hours lecture; 3 semester hours.

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. Prerequisite: EDNS151 or EDNS155 or EDNS192 or HNRS115.

CEEN298. 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.

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.
(I, II) 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. Prerequisites: CHGN122, PHGN100. 3 hours lecture; 3 semester hours.

CEEN302. FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: AIR AND WASTE MANAGEMENT. 3.0 Semester Hrs.
(I, II) 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). Prerequisite: CHGN122, PHGN100 and MATH213 or consent of instructor. 3 hours lecture; 3 semester hours.

CEEN303. ENVIRONMENTAL ENGINEERING LABORATORY. 3.0 Semester Hrs.
Equivalent with ESGN355,
(II) 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.

CEEN310. FLUID MECHANICS FOR CIVIL AND ENVIRONMENTAL ENGINEERING. 3.0 Semester Hrs.
(I, II) 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.

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. Prerequisite: CEEN241.

CEEN312. SOIL MECHANICS. 3.0 Semester Hrs.
(I, II) 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. Prerequisite: CEEN311. 3 hours lecture; 3 semester hours.

CEEN312L. SOIL MECHANICS LABORATORY. 1.0 Semester Hr.
(I, II) Introduction to laboratory testing methods in soil mechanics. Classification, permeability, compressibility, shear strength. Co-requisites: CEEN312. 3 hours lab; 1 semester hour.

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

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, CEEN311.

CEEN330. ENGINEERING FIELD SESSION, ENVIRONMENTAL. 3.0 Semester Hrs.
(S) 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. Prerequisite: CEEN301, CEEN303. Three weeks in summer session. 9 hours lab; 3 semester hours.

CEEN331. ENGINEERING FIELD SESSION, CIVIL. 3.0 Semester Hrs.
(S) 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. Prerequisite: EDNS251, ENDS261, EDNS262 or CEEN267. Three weeks (6 day weeks) in summer field session; 9 hours lab; 3 semester hours.

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.

CEEN360. INTRODUCTION TO CONSTRUCTION ENGINEERING. 3.0 Semester Hrs.
(II) 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 takeoffs and construction estimating. Application of engineering analysis and design to construction projects. 3 hours lecture; 3 semester hours.

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.

CEEN398. SPECIAL TOPICS IN CIVIL AND ENVIRONMENTAL ENGINEERING. 6.0 Semester Hrs.
(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.

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.

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.

CEEN402. PROJECT ENGINEERING. 3.0 Semester Hrs.
(I, II, S) 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: CEEN360.

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.

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.

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.

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.

CEEN415. FOUNDATION ENGINEERING. 3.0 Semester Hrs.
(I, II) 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.

CEEN421. HIGHWAY AND TRAFFIC ENGINEERING. 3.0 Semester Hrs.
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. Taught on demand.

CEEN423. SURVEYING FOR ENGINEERS AND INFRASTRUCTURE DESIGN PRACTICES. 3.0 Semester Hrs.
(I) Applications of civil engineering skills using the engineer's level, total station, GPS receiver, and commercial software for field data collection, design, and layout of civil infrastructure including survey control, roadways, intersections, and utilities such as water and sewer. The course includes basic road design, horizontal design, vertical design, centerline layout, slope/cross section staking, earthwork volume calculations, engineering astronomy, and preparation of plan/profile drawings. Some discussion of concepts and mathematics of applying GPS data to engineering projects and the principles of map projections (Mercator, Lambert, UTM, State Plane, etc.) and coordinate systems such as (North American Datum) NAD '27, NAD '83, and other reference networks is included. Prerequisite: CEEN331. 2 hours lecture; 8-9 field work days; 3 semester hours.

CEEN425. CEMENTITIOUS MATERIALS FOR CONSTRUCTION. 3.0 Semester Hrs.
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. Prerequisite: CEEN 311.

CEEN426. DURABILITY OF CONCRETE. 3.0 Semester Hrs.
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.

CEEN430. ADVANCED STRUCTURAL ANALYSIS. 3.0 Semester Hrs.
(II) 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. Prerequisite: CEEN314. 3 hour lectures; 3 semester hours.

CEEN433. MATRIX STRUCTURAL ANALYSIS. 3.0 Semester Hrs.
Equivalent with CEEN533,
(II) 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. Prerequisite: CEEN314. 3 lecture hours, 3 semester hours.

CEEN441. INTRODUCTION TO THE SEISMIC DESIGN OF STRUCTURES. 3.0 Semester Hrs.
(I) 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. Prerequisites: CEEN443, or CEEN445, or CEEN440. 3 hours lecture; 3 semester hours.

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.

CEEN443. DESIGN OF STEEL STRUCTURES. 3.0 Semester Hrs.
(I, II) 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. Prerequisite: CEEN314. 3 hours lecture; 3 semester hours.

CEEN445. DESIGN OF REINFORCED CONCRETE STRUCTURES. 3.0 Semester Hrs.
(I, II) 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, and footings. Prerequisite: CEEN314. 3 hours lecture; 3 semester hours.

CEEN446. 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.

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.

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.

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.

CEEN471. WATER AND WASTEWATER TREATMENT SYSTEMS ANALYSIS AND DESIGN. 3.0 Semester Hrs.
(II) The goal of this course is to familiarize students with the design of domestic and industrial water and wastewater treatment systems. This course will focus on the combination of physical, chemical, and biological processes and technologies to form a water or wastewater treatment system. Source water quality, treatment objectives, water reuse, multi-barrier approaches, and water and energy efficiency are considered in detail. Prerequisites: CEEN470, or CEEN570, or other water or wastewater treatment design courses (for graduate students enrolled in this course). 3 hours lecture; 3 semester hours.

CEEN472. ONSITE WATER RECLAMATION AND REUSE. 3.0 Semester Hrs.
(II). 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.

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.

CEEN475. 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.

CEEN477. SUSTAINABLE ENGINEERING DESIGN. 3.0 Semester Hrs.
(I) This course is a comprehensive introduction into concept of sustainability and sustainable development from an engineering point of view. It involves the integration of engineering and statistical analysis through a Life Cycle Assessment tool, allowing a quantitative, broad-based consideration any process or product design and their respective impacts on environment, human health and the resource base. The requirements for considering social implications are also discussed. Prerequisites: Senior or graduate standing; 3 hours lecture, 3 semester hours.

CEEN479. AIR POLLUTION. 3.0 Semester Hrs.
(II) 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.

CEEN480. CHEMICAL FATE AND TRANSPORT IN THE ENVIRONMENT. 3.0 Semester Hrs.
Equivalent with ESGN440,
(II) 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.
(I) 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.

CEEN491. EROSION CONTROL AND LAND RESTORATION. 3.0 Semester Hrs.
People have been the main cause of soil erosion for over 1,000 years. Studies suggest that human activities can cause about ten times more erosion than all natural processes together. It is well known that the rates of soil erosion surpass those of soil formation. Worldwide, millions of acres of productive land are lost every year because of inappropriate land management practices. The course is oriented to graduate and undergraduate students from any field in which the relationship among soil, water, and plant is altered, with the purpose of applying the right technique to bring back the productivity of land, in a sustainable way. The student will learn about erosion processes and how to stop them, and by the end of the course the student should be able to: (1) Identify erosive processes affecting certain area; (2) Evaluate the level of soil erosion, its origin and consequences to make further management decisions; and (3) Select and design the most appropriate erosion control/land restoration technique to apply, based on cost-effectiveness, giving emphasis to maximizing environmental benefits (i.e. using plants as a main stabilization system). Prerequisite: CEEN381.

CEEN492. ENVIRONMENTAL LAW. 3.0 Semester Hrs.
Equivalent with CEEN592,PEGN530,
(I) 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.

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.

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.

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.

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