

Civil and Environmental Engineering

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Bachelor of Science in Civil Engineering

Common Prerequisites

CHM 1045	General Chemistry I
CHM 1045L	General Chemistry Lab I
CHM 1046	General Chemistry II
CHM 1046L	General Chemistry Lab II
MAC 2311	Calculus I
MAC 2312	Calculus II
MAC 2313	Multivariable Calculus
MAP 2302	Differential Equations
PHY 2048	Physics with Calculus
PHY 2048L	General Physics Lab I
PHY 2049	Physics with Calculus II
EGN 3311	Statics
EGN 3321	Dynamics
STA 3311	Statistics
or	
EIN 3235	Evaluation of Engineering Data

Degree Program Hours: Minimum 128

The Civil Engineering curriculum provides a program of interrelated technical areas of Civil Engineering with their fundamental core subjects of the engineering program. The technical interdisciplinary courses are in the areas of construction, geotechnical, environmental, structural, surveying, transportation, and water resources engineering.

Civil engineers play an essential role in serving people and the environmental needs of society. These needs relate to shelter, mobility, water, air and development of land and physical facilities.

The academic program is designed to meet the State of Florida's articulation policy as well as to satisfy criteria

outlined by the Accreditation Board for Engineering and Technology (ABET), among others.

Lower Division Preparation

To qualify for admission to the upper division program, FIU undergraduates must have met all the lower division requirements (see the Undergraduate Studies portion of this catalog for specific requirements) including completion of at least 60 semester hours of pre-engineering courses which include 'C' for Engineers or Computer Tools for CE, Calculus I & II, Multivariable Calculus, Probability and Statistics, or Evaluation of Engineering Data, Differential Equations, Chemistry I & II and Labs, Physics I with Calculus and Lab, Physics II with Calculus with a grade of 'C' or better and must be otherwise acceptable into the program. See the example semester by semester program in the following pages.

Effective pursuit of engineering studies requires careful attention to both the sequence and the type of courses taken. It is therefore important, and the college requires, that each student plan a curriculum with the departmental faculty advisor.

All students must comply with the University Core Curriculum Requirements for the University as well as comply with departmental requirements for Social Science, Humanities, and English. Students may find that some courses satisfy both requirements; therefore, it is important to contact the department advisor for assistance. The department requires a minimum of 15 semester hours in the area of Humanities and Social Science. The student should refer to the semester by semester program for a list of approved courses. Requirements also include Engineering Drawing with CAD application (unless previously taken), Engineering Economy and Ethics and Legal Aspects. All transfer students should refer to the General Information section of this catalog to determine if they have met the requirements for Humanities, Social Science, and English at their previous institution. Students who transfer from a State of Florida community college with an Associate of Arts degree must fulfill departmental requirements for Social Science and Humanities.

A minimum grade of 'C' is required in all writing, physics, chemistry and mathematics courses.

A minimum grade of 'C' is required of all Civil Engineering courses and prerequisite courses.

Students who have been dismissed for the first time from the University due to low grade, may appeal to the Dean for reinstatement. A second dismissal will result in no possibility of reinstatement.

Other Requirements

Students must pass the CLAST or have it waived, must have a minimum 2.0 GPA, must complete all required classes, and must otherwise meet all of the state and university requirements in order to graduate.

Students who enter the university with fewer than 60 transferred credits must take 9 summer credits. Refer to the appropriate sections in the Catalog's for more information.

Courses are to be taken in the proper sequence. Any course taken without the required prerequisites and corequisites will be dropped automatically before the end of the term, resulting in a 'DR' or 'DF'.

Upper Division Course Objectives

The program of study encourages the development of a broadly educated civil engineering graduate, who can succeed as a productive engineer with a continued professional growth. The courses listed as requirements for the BS degree not only provide the students with mathematical and scientific knowledge, but also include other essentials areas necessary for a successful engineering career. The courses have been designed to increase student competence in written and oral communication skills as well as develop critical thinking and creative problem solving strategies. Course projects are designed to teach engineering science fundamentals and their applications while providing enriching opportunities for laboratory and computer-based experiences. Furthermore, students are supplied with an understanding of the economic, social, ethical and professional responsibilities of engineers in our society and are encouraged to include sustainable development in all project designs.

Foreign Language Requirement

Students must meet the University Foreign Language Requirement. Refer to the appropriate sections in the Catalog's General Information for Admission and Registration and Records.

Upper Division Program

The basic upper division requirements for the BSCE degree are as follows:

ENG 1110C	Engineering Drawing (Required unless previously taken)	3
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Engineering Sciences (20)

CGN 2420	Computer Tools for CE	3
CWR 3201	Fluid Mechanics	3
CWR 3201L	Fluid Mechanics Laboratory	1
EEL 3003	Electrical Engineering I (<i>Non EE</i>)	3
EGM 3520	Engineering Mechanics of Materials	3
EGM 3520L	Materials Testing Lab	1
EGN 3311	Statics	3
EGN 3321	Dynamics	3

Civil Engineering Curriculum (44)

CCE 4031	Project Planning for CE	3
CEG 4011	Geotechnical Engineering I	3
CEG 4011L	Soil Testing Laboratory	1
CES 3100	Structural Analysis	3
CES 4702	Reinforced Concrete Design	3
CGN 4802	Civil Engineering Senior Design Project	3
CWR 3103	Water Resources Engineering	3
ENV 3001	Introduction to Environmental Engineering	3
ENV 3001L	Environmental Laboratory I	1
SUR 2101C	Surveying	3
TTE 4201	Transportation and Traffic Engineering	3
C.E. Elective	(min)	3
C.E. Elective	(min)	3
C.E. Elective	(min)	3
C.E. Elective	(min)	3
C.E. Elective	(min)	3

Note: Students may be eligible to select some graduate level civil engineering technical electives as approved by the instructor and the undergraduate advisor.

Combined BS/MS Program

Students who pursue a BS degree and are in their senior year and have at least a 3.3 GPA on both overall and upper division courses may apply to the department to enroll in the combined BS/MS program upon recommendation from three CEE faculty members. Students must also submit an on-line application to the University Graduate School for admission to the MS program. In addition to the admission requirements of the combined BS/MS program, students must meet all the admission requirements of both the department and the University Graduate School.

Students enrolled in the program may count up to nine credit hours of CEE graduate courses as credits for both the BS and MS degrees. The combined BS/MS program has been designed to be a continuous program. However, upon completion of all the requirements of the undergraduate program, students will receive their BS degrees. Students in this program have up to one year to complete the master's degree after receipt of the bachelor's degree. Students who fail to meet this one year post BS requirement or who elect to leave the combined program at any time and earn only the BS degree will have the same access requirements to regular graduate programs as any other student, but will not be able to use the nine credits in both the bachelor's and master's degrees.

For each of the graduate courses counted as credits for both BS and MS degree, a minimum grade of B is required. All double counted courses must be at 5000 level or higher. Students enrolled in the program may count up to nine credit hours of CEE graduate courses toward the elective engineering BS requirements as well as toward the MS degree. Only graduate courses with formal lectures can be counted for both degrees. The students are responsible for confirming the eligibility of each course with the Undergraduate Advisor.

Students interested in the program should consult with the Undergraduate Advisor on their eligibility for the program. The students should also meet the Graduate Program Director to learn about the graduate program and available courses before completing the application form and submitting it to the Undergraduate Advisor. Applicants will be notified by the department and the University Graduate School of the decision on their applications.

Undergraduate students enrolled in the program are encouraged to seek employment with a department faculty to work as student assistants on sponsored research projects. The students will be eligible for graduate assistantships upon admission into the graduate school.

Combined BS/MBA Program

Students, who pursue a BS degree and are in their first semester of the senior year, with at least a 3.3 GPA on both overall and upper division courses may, upon recommendation from three CEE faculty members, apply to the department to enroll in the combined BS/MBA program. Students must also submit an on-line application to the University Graduate School for admission to the MBA program. In addition to the admission requirements of the University Graduate School and those of the College of Business Administration.

The MBA curriculum at the Chapman Graduate School of business consists of 9 credit hours of pre-core courses, 31 credit hours of core courses, 3 credit hours of

professional development seminars, and 12 credit hours of elective courses, for a total of 55 credit hours.

The pre-core of 9 credit hours may be considered for waiver based on prior course work or exemption exams. An evaluation will be conducted at the time of admission to determine eligibility for a waiver by the MBA program graduate advisor.

In addition, students can count up to three CEE graduate courses as credits for both the BS electives and the MBA electives, for a total savings of 9 credit hours. The following is a list of eligible CEE graduate courses:

CCE 5035	Construction Engineering Management
CCE 5036	Advanced Project Planning for Civil Engineers
CCE 5505	Computer Integrated Construction Engineering
CCE 5405	Advanced Heavy Construction Techniques
CGN 5315	Civil Engineering Systems
CGN 5320	GIS Applications in Civil and Environmental Engineering
CGN 5930	Special Topics*
ENV 5007	Environmental Planning
ENV 5008	Appropriate Technology for Developing Countries
ENV 5105	Air Quality Management
ENV 5659	Regional Planning Engineering
ENV 5666	Water Quality Management
ENV 5905	Independent Study*
ENV 5930	Special Topics in Environmental Engineering*
TTE 5007	Transportation Systems in Developing Nations
TTE 5015	Fundamentals of Traffic Engineering
TTE 5100	Transportation and Growth Management
TTE 5606	Transportation Systems Modeling and Analysis
URP 5312	Urban Land Use Planning
URP 5316	Environmental and Urban Systems

*These courses should have management, decision making and/or cost estimating components.

The combined BS/MBA program has been designed to be a continuous program. During this combined BS/MBA program, upon completion of all requirements of the undergraduate program, students will receive their BS degrees. Students may also elect to permanently leave the combined program at any time and earn only the BS degree. Students who elect to leave the combined program and earn only the BS degree will have the same access requirements to regular graduate programs as any other student, but will not be able to use the 9 credits in both the BS and MBA degrees.

For each of the graduate courses counted as credits for both BS and MBA degrees, a minimum grade of "B" is required. Students are responsible for confirming the eligibility of each course with the undergraduate advisor.

Students interested in the program should consult with the undergraduate advisor on their eligibility to the program. The students should also meet the MBA graduate program advisor to learn about the graduate program and available courses before completing the application form and submitting it to the undergraduate advisor. Final decision for admission to the MBA program will be made by the University Graduate School upon

recommendation by the College of Business Administration. Applicants will be notified by the department and the University Graduate School of the decision on their applications.

Professional Graduation Requirement

Students must take and pass CGN 4930 (FE Seminar) or show evidence of passing the state FE (EIT) examination to fully fulfill departmental graduation requirements.

Civil Engineering Program

Students may have a different sequence of courses as arranged with their advisor. For a complete program information, students should refer to the Program Summary Sheet available at the Department.

First Semester: (13)

MAC 2311	Calculus I	4
CHM 1045	General Chemistry I	3
CHM 1045L	General Chemistry I Lab	1
SLS 1501	Freshman Experience	1
ENC 1101	Freshman Composition	3
EGN 2030	Ethics & Legal Issues	1

Second Semester: (15)

MAC 2312	Calculus II	4
ENC 1102	Literary Analysis	3
PHY 2048	Physics with Calculus	4
PHY 2048L	General Physics Lab I	1
EGN 1033	Technology, Humans, and Society	3

Third Semester: (14)

ECO 2013	Macroeconomics	3
or		
ECO 2023	Microeconomics	3
MAC 2313	Multivariable Calculus	4
CHM 1046	General Chemistry II	3
CHM 1046L	General Chemistry Lab II	1
EGN 1110C	Engineering Drawing	3
<i>(Required unless previously taken)</i>		

Fourth Semester: (16)

PHY 2049	Physics with Calculus II	4
MAP 2302	Differential Equations	3
CGN 2420	Computer Tools for CE	3
SPC 2600	Public Speaking	3
or		
CRW 2001	Creative Writing	3
Humanities with Writing*		
3		

Fifth Semester: (12)

EGN 3311	Statics	3
EEL 3003	Electrical Engineering I	3
SUR 2101C	Surveying	3
Humanities with Writing II*		
3		

Sixth Semester: (13)

STA 3033	Introduction to Probability and Statistics for CS	3
or		
EIN 3235	Evaluation of Engineering Data	3
EGN 3321	Dynamics	3
EGM 3520	Engineering Mechanics of Materials	3
EGM 3520L	Engineering Mechanics of Material Lab	1
ENC 3211	Technical Writing	3

Seventh Semester: (14)

CWR 3201	Fluid Mechanics	3
CWR 3201L	Fluid Mechanics Lab	1
CES 3100	Structural Analysis	3

ENV 3001	Introduction to Environmental Engineering	3
ENV 3001L	Environmental Laboratory I	1
EIN 3354	Engineering Economy	3

Eighth Semester: (16)

CEG 4011	Geotechnical Engineering I	3
CEG 4011L	Soil Testing Laboratory	1
CCE 4031	Project Planning for Civil Engineers	3
TTE 4201	Transportation & Traffic Engineering	3
CE Elective		3
CE Elective		3

Ninth Semester: (18)

CWR 3101	Water Resources	3
CES 4702	Reinforced Concrete Design	3
CGN 4802	Civil Engineering Senior Design Project	3
CE Elective		3
CE Elective		3
CE Elective		3

Student are required to either complete the CGN 4980 CE Seminar course or pass the FE exam

***Humanities with Writing: (6)**

Choose 2 courses from the following: At least 1 of the courses must have a history component.

PHI 2600	Introduction to Ethics	3
ARC 2701	History of Architecture	3
HUM 3306	History of Ideas	3
WOH 2001	World Civilization	3
EUH 2030	Western Civ. Europe in the Modern Era	3
AMH 2002	Modern American Civilization	3

Suggested Electives (*other electives may be chosen, as approved by Department Advisor*):

CEG 4012	Geotechnical Engineering II	4
CCE 4001	Heavy Construction	3
CGN 4321	GIS Application in Civil and Environmental Engineering	3
TTE 4804	Geometric Design of Highways	3
TTE 4203	Highway Capacity Analysis	3
CES 4320	Intro to the Design of Highway Bridges	3
CES 4600	Intro to the Design of Tall Buildings	3
CES 4605	Steel Design	3
CES 4126	Fundamentals of Pavement Design	3
ENV 4930	Special Topics in Civil Engineering	1-4

Electives for Environmental Engineering Option

ENV 4101	Elements of Atmospheric Pollution	3
ENV 4330	Hazardous Waste Assessment and Remediation	3
ENV 4351	Solid Waste Management	3
ENV 4401	Water Supply Engineering	4
ENV 4551	Sewerage and Wastewater Treatment	4
ENV 4560	Reactor Design	3
ENV 4513	Chemistry for Environmental Engineers	3
ENV 4024	Bioremediation	3
ENV 4930	Special Topics in Environmental Engineering	1-4

Electives for Construction Engineering Option

CCE 4001	Heavy Construction	3
CCE 5035	Construction Engineering Management	3
CCE 5505	Computer integrated Construction Engineering	3
CCE 5405	Advanced Heavy Construction Techniques	3

CGN 4321	GIS Applications in Civil & Environmental Engineering	3
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Note: Required credits towards graduation are 128 credit hours. Due to variation in the number of transfer credits awarded, technical electives may be required. Technical electives must be approved by the Advisor.

Bachelor of Science in Environmental Engineering**Common Prerequisites**

CHM 1045	General Chemistry I
CHM 1045L	General Chemistry Lab I
MAC 2311	Calculus I
MAC 2312	Calculus II
MAC 2313	Multivariable Calculus
MAP 2302	Differential Equations
PHY 2048	Physics with Calculus
PHY 2048L	General Physics Lab I
PHY 2049	Physics with Calculus II

Degree Program Hours: 126

The Environmental Engineering curriculum provides a background of interrelated subdisciplines of Environmental Engineering and related science subjects with the fundamental core subjects of the engineering program. The technical interdisciplinary courses are in the areas of biology, geology, chemistry, ecology, atmospheric sciences, geotechnical engineering, urban planning, water resources engineering, pollution prevention and waste management. Environmental engineers play an essential role in serving people and the environmental needs of society. These needs relate to water, air and development of land and physical facilities.

The academic program is designed to meet the State of Florida's articulation policy as well as to satisfy criteria outlined by the Accreditation Board for Engineering and Technology (ABET).

Lower Division Preparation

The lower division requirements include at least 60 semester hours of pre-engineering courses (as specified in the Undergraduate Studies portion of the University catalog) which include the common prerequisites listed above. A minimum grade of "C" is required in all writing courses, and in of the common prerequisite courses listed above.

All students must comply with the University Core Curriculum Requirements for the University as well as comply with departmental requirements for Social Science, Humanities, and English. Students may find that some courses satisfy both requirements; therefore it is important to contact the department advisor for assistance. The department requires a minimum of 15 semester hours in the area of Humanities and Social Science.

In addition, all students must meet the University Foreign Language Requirement, must pass the CLAST or have it waived, must meet all of the state and university requirements for graduation.

Upper Division Program

The upper division program of study encourages the development of a broadly educated environmental engineering graduate, who can succeed as a productive engineer with a continued professional growth. The courses listed as requirements for the BS degree not only

provide the students with mathematical and scientific knowledge, but also include other essentials necessary for a successful engineer career. The courses have been designed to increase student competence in written and oral communication skills as well as develop critical thinking and creative problem solving strategies. Course projects are designed to teach engineering science fundamentals and their applications while providing enriching opportunities for laboratory and computer-based experiences. Furthermore, students are supplied with an understanding of the economic, social and ethical responsibilities of engineers in our society and are encouraged to include sustainable development in all project designs.

Engineering Sciences (24)

Science Elective (Biological Science)**	4
Science Elective (Earth Science)**	4
EGN 3311 Statics	3
EGN 3321 Dynamics	3
EGN 3343 Thermodynamics I	3
CWR 3201 Fluid Mechanics	3
CWR 3201L Fluid Mechanics Lab	1
EEL 3003 Electrical Engineering	3

Environmental Engineering Curriculum (35)

CWR 3103 Water Resources Engineering	3
ENV 3001 Introduction to Environmental Engineering	3
ENV 3001L Environmental Laboratory I	1
ENV 4005L Environmental Laboratory II	1
ENV 4513 Chemistry for Environmental Engineers	3
ENV 4351 Solid Waste Management	3
ENV 4101 Elements of Atmospheric Pollution	3
ENV 4401 Water Supply Engineering	3
ENV 4551 Sewerage and Wastewater Treatment	3
ENV 4330 Hazardous Assessment and Remediation	3
ENV 4891 Environmental Eng. Senior Design Project	3
ENV Technical Elective	3
ENV Technical Elective	3

Course & Credit Hours Listing

The curriculum includes a sequence of courses which complies with the ABET requirements for mathematics and basic sciences, engineering science, engineering design, and general engineering degree requirements including humanities and social sciences. A typical nine semester sequence is shown below. Students may complete the program, by specific selection of science and technical elective courses, as arranged with the undergraduate program advisor and based on personal interests in a specialization area.

First Semester: (13)

MAC 2311 Calculus I	4
CHM 1045 General Chemistry I	3
CHM 1045L General Chemistry I Lab	1
SLS 1501 Freshman Experience	1
ENC 1101 Freshman Composition	3
EGN 2030 Ethics & Legal Aspects in Engineering	1

Second Semester: (19)

MAC 2312 Calculus II	4
ENC 1102 Literary Analysis	3
PHY 2048 Physics with Calculus I	4
PHY 2048L General Physics Laboratory I	1
EGN 1110C Engineering Drawing*	3

BSC 1010 General Biology I	3
BSC 1010L General Biology Lab I	1

Third Semester (Suggested Summer Term): (11)

Foundations of Social Inquiry***	3
MAC 2313 Multivariable Calculus	4
CHM 1046 General Chemistry II	3
CHM 1046L General Chemistry II Lab	1

Fourth Semester: (13)

PHY 2049 Physics with Calculus II	4
MAP 2302 Differential Equations	3
Humanities (with writing)	3
Societies and Identities	3

Fifth Semester: (14)

ENV 3001 Introduction to Environmental Engineering	3
ENV 3001L Environmental Laboratory I	1
EGN 3311 Statics	3
Science Elective (Earth Science)**	4
STA 3033 Introduction to Probability and Statistics for CS or equivalent	3

Sixth Semester: (15)

EGN 3343 Thermodynamics I	3
EGN 3321 Dynamics	3
EIN 3354 Engineering Economy	3
ENV 4513 Chemistry for Environmental Engineers	3
Art	3

Seventh Semester: (17)

CWR 3201 Fluid Mechanics	3
CWR 3201L Fluid Mechanics Lab	1
EEL 3003 Electrical Engineering	3
ENV 4351 Solid Waste Management	3
Science Elective (Biological Science)**	4
Humanities/Historical	3

Eighth Semester: (13)

ENV 4101 Elements of Atmospheric Pollution	3
ENV 4401 Water Supply Engineering	3
ENV 4551 Sewerage and Wastewater Treatment	3
ENV 4005L Environmental Laboratory II	1
CWR 3103 Water Resources Engineering	3

Ninth Semester: (12)

ENV 4330 Hazardous Assessment and Remediation	3
ENV 4891 Environmental Engineering Senior Design Project	3
ENV Technical Elective	3
ENV Technical Elective	3

*Required unless previously taken

**One Science Elective should be in Earth Sciences and the other should be in Biological Sciences. Electives must be selected from the following:

Earth Science electives: (one required)	
GLY 2072/L Earth Climate and Global Change	4
GLY 3039/L Environmental Geology	4
GLY 3202/L Earth Materials	4
GLY 4822/L Hydrogeology	4
MET 2010/L Meteorology & Atmospheric Physics	4

Biological Science electives (one required):

MCB 2000/L Introductory Microbiology	4
OCB 2003/L Introductory Marine Biology	4
PCB 3043/L Ecology	4
EVR 3013/L Ecology of South Florida	4

***These Social Science elective must be selected from the following:

ECO 2013 Principles of Macroeconomics 3
ECO 2023 Principles of Microeconomics 3

****ENV technical electives must be selected from the following:

CEG 4011 Geotechnical Engineering 3
CGN 4321 GIS Applications in Civil Environmental Engineering 3
CWR 5235 Open Channel Hydraulics 3
CWR 5251 Environmental Hydraulics 3
ENV 4560 Reactor Design 3
ENV 4024 Bioremediation Engineering 3
ENV 4930 Special Topics in Environmental Engineering 3
ENV 5002C Fundamentals for Environmental Engineering 3
ENV 5126 Particulate Air Pollution Control 3
ENV 5127 Gaseous Air Pollution Control 3
ENV 5104 Indoor Air Quality 3
ENV 5666 Water Quality Management 3
EVR 3010 Energy Flow in Natural and Man-made Systems 3
EVR 4321 Sustainable Resource Development 3
EVR 4592 Soils and Ecosystems 3
EVR 4026 Ecology of Biotic Resources 3
EVR 4323 Restoration Ecology 3
PHC 5409 Public Health Behavior Change Theory and Practice 3
PHC 5415 Public Health in Minority/Urban Population 3

All recommended and other technical electives must be approved by the advisor and must concentrate on relevant applications of environmental engineering design. Selection of a proper sequence would allow the student to specialize within a focus area of interest (e.g., air, water, or land resources).

Course Descriptions

Definition of Prefixes

CCE-Civil Construction Engineering; CEG-Engineering, General; CES-Civil Engineering Structures; CGN-Civil Engineering; CWR-Civil Water Resources; EGM-Engineering, Mechanics; EGN-Engineering, General; ENV-Engineering, Environmental; SUR-Surveying and Related Areas; TTE-Transportation and Traffic Engineering

CCE 4001 Heavy Construction (3). Contractor's organization, contracts, services, safety, planning and scheduling. Equipment and their economics. Special project applications, coffer-dams, dewatering, river diversions, tunnelling. Prerequisite: Permission of the instructor.

CCE 4031 Project Planning for Civil Engineers (3). Introduction to techniques for planning activities, operations, finance, budget, workforce, quality, safety. Utilize case studies as learning tools for students aspiring to superintendent positions. Prerequisite: Permission of the instructor.

CCE 5035 Construction Engineering Management (3). Course will cover construction organization, planning and implementation; impact and feasibility studies; contractual subjects; liability and performance; the responsibility of owner, contractor and engineer. Prerequisite: Permission of the instructor.

CCE 5036 Advanced Project Planning for Civil Engineers (3). Advanced techniques and methods for planning activities, operations, finance, budget, workforce, quality, safety. Utilize case studies as learning tools for students aspiring to management positions. Prerequisite: CCE 4031 or equivalent.

CCE 5505 Computer Integrated Construction Engineering (3). Course covers the discussion of available software related to construction engineering topics; knowledge based expert systems and their relevance to construction engineering planning and management. Prerequisite: CCE 4031 or equivalent.

CCE 5405 Advanced Heavy Construction Techniques (3). Heavy construction methods and procedures involved in large construction projects such as bridges, cofferdams, tunnels, and other structures. Selection of equipment based on productivity and economics. Prerequisite: Permission of instructor.

CEG 4011 Geotechnical Engineering I (3). Engineering geology, soil properties; stresses in soils; failures; criteria; consolidation and settlement; compaction, soil improvement and slope stabilization. Prerequisites: CWR 3201 and L, EGM 3520, and L, CHM 1046 and PHY 2049.

CEG 4011L Soil Testing Laboratory (1). Laboratory experiments to identify and test behavior of soils and rocks. Prerequisites: CWR 3201, CWR 3201L, EGM 3520L, EGM 3520. Corequisite: CEG 4011. (Lab fees assessed).

CEG 4012 Geotechnical Engineering II (4). Principles of foundation analysis and design: site improvement for bearing and settlement, spread footings, mat foundations, retaining walls, cofferdams, piles, shafts, caissons, tunnels, and vibration control. Computer applications. Prerequisites: CEG 4011 and L.

CEG 4126 Fundamentals of Pavement Design (3). This course is designed to provide the student with a basic understanding of the fundamental principles underlying pavement structural analysis and design. Asphalt Institute, Portland Cement Association and AASHTO methods will be covered. Prerequisites: CEG 4011, CEG 4011L, TTE 4201.

CES 3100 Structural Analysis (3). To introduce the student to the basic concepts and principles of structural theory relating to statically determinate beams, arches, trusses and rigid frames, including deflection techniques. Prerequisite: EGM 3520.

CES 4320 Introduction to the Design of Highway Bridges (3). The course covers the different types of modern highway bridges, and systematically analyzes all the components of the superstructures. Design procedures are based on AASHTO codes and specialized software. Prerequisites: CEG 4011, CES 4702.

CES 4600 Introduction to the Design of Tall Buildings (3). The course reviews the different modern high-rise structural systems, a simple analysis of wind and seismic loading to efficiently design very tall buildings. Prerequisites: CEG 4011, CES 4702.

CES 4605 Steel Design (3). The analysis and design of structural elements and connections for buildings, bridges, and specialized structures utilizing structural steel. Both

elastic and plastic designs are considered. Prerequisite: CES 3100.

CES 4702 Reinforced Concrete Design (3). The analysis and design of reinforced concrete beams, columns, slabs, retaining walls and footings; with emphasis corresponding to present ACI Building Code. Introduction to prestressed concrete is given. Prerequisite: CES 3100 with a grade of 'C' or better.

CES 5587 Topics in Wind Engineering (3). The course will cover the nature of wind related to wind-structure interaction and design loads for extreme winds, tornadoes and hurricanes. Prerequisites: CES 3100 and CWR 3201.

CGN 2420 Computer Tools for Civil Engineers (3). Introduction to common civil engineering software such as MathCad, VBA, and others. Prerequisites: EGN 1110C or equivalent.

CGN 3949 Co-Op Work Experience (1-3). Supervised full-time work experience in engineering field. Limited to students admitted to the Co-op program with consent of advisor. Evaluation and reports required.

CGN 4321 GIS Applications in Civil and Environmental Engineering (3). Introduction to the basics of geographic information systems and their applications in civil and environmental engineering, landscape architecture, and other related fields. Prerequisites: TTE 4201 or ENV 3001 or CWR 3103 or the equivalents.

CGN 4802 Civil Engineering Senior Design Project (3). Mandatory course for all senior students, to experience the design of a practical project by utilizing knowledge learned from previous courses for presenting a solution. Done under the supervision of a faculty member and professional engineer. Prerequisites: CEG 4011, CEG 4011L, TTE 4201, CES 4702.

CGN 4911 Undergraduate Research Experience (1-3). Participate in research activities in the areas of structures, geotechnical, transportation, construction and environmental engineering. Prerequisite: Permission of a faculty advisor.

CGN 4930 Special Topics in Civil Engineering (1-4). A course designed to give groups of students an opportunity to pursue special studies not otherwise offered.

CGN 4949 Co-Op Work Experience (1-3). Supervised full-time work experience in engineering field. Limited to students admitted to the Co-op program with consent of advisor. Evaluation and report required.

CGN 4980 Civil Engineering Seminar (1). Basic principles and applications of civil engineering, including structural, transportation, environmental, geotechnical, construction, and water resources engineering for civil engineering students. Prerequisite: Permission from undergraduate advisor.

CWR 3103 Water Resources Engineering (3). Hydrologic and hydraulic engineering fundamentals: hydrologic cycle, hyetographs, hydrographs, frequency analysis, pipe systems, turbomachinery, open channels, structures, and groundwater. Prerequisites: CWR 3201, CWR 3201L, STA 3033 or EIN 3235.

CWR 3201 Fluid Mechanics (3). A study of the properties of fluids and their behavior at rest and in motion.

Continuity, momentum, and energy principles of fluid flow. Prerequisite: EGN 3321. Corequisite: CWR 3201L.

CWR 3201L Fluid Mechanics Laboratory (1). Application of fluid mechanics principles in the laboratory. Experiments in surface water, ground-water and pipe flow. Corequisite: CWR 3201. (Lab fees assessed).

CWR 4530 Modeling Applications in Water Resources Engineering (3). Model applications in hydrology, hydraulics, hydrosystems engineering and environmental interconnections. Prerequisite: CWR 3201. Corequisite: CWR 3103.

CWR 5140C Ecohydrology (3). Hydrology of ecosystems, interaction between the hydrologic cycle and vegetative processes. Prerequisite: Permission of the instructor.

CWR 5535C Advanced Modeling Applications in Water Resources Engineering (3). Complex model applications in hydrology, hydraulics, hydrosystems engineering and environmental interconnections. Prerequisite: Permission of the instructor.

EGM 3520 Engineering Mechanics of Materials (3). Analysis of axial, torsional, bending, combined stresses, and strains. Plotting of shear, moment and deflection diagram with calculus applications and interpretations. Prerequisites: CGN 2420, MAC 2313, MAP 2302 and EGN 3311 with a grade of 'C' or better.

EGM 3520L Materials Testing Laboratory (1). Introduction to measurements of basic mechanical properties of materials. Experiments include axial tension, compression, torsion, flexure, and the response of simple structural elements. Prerequisites or Corequisites: EGM 3520, MAC 2312 and EGN 3311. (Lab fees assessed).

EGN 1110C Engineering Drawing (3). Introduction to elementary design concepts in engineering, principles of drawing, descriptive geometry, pictorials and perspectives and their computer graphics counterpart.

EGN 2030 Ethics and Legal Aspects in Engineering (1). Codes of ethics, professional responsibilities and rights, law and engineering, contracts, torts, evidence.

EGN 3311 Statics (3). Forces on particles, equilibrium of forces, moments, couples, centroids, section properties, and load analysis of structures. Prerequisites: MAC 2312 and PHY 2048.

ENV 3001 Introduction to Environmental Engineering (3). Introduction to environmental engineering problems; water and wastewater treatment, air pollution, noise, solid and hazardous wastes. Prerequisites: CHM 1046 and CHM 1046L, MAC 2312 and permission of undergraduate advisor. Corequisite: ENV 3001L.

ENV 3001L Environmental Laboratory I (1). A corequisite to ENV 3001. Practical applications of the theory learned in the course and experience in detecting and measuring some environmental problems. Prerequisites: CHM 1046 and CHM 1046L, MAC 2312 and permission of undergraduate advisor. Corequisite: ENV 3001. (Lab fees assessed).

ENV 3949 Co-Op Work Experience (3). Supervised full-time work experience in engineering field. Limited to students admitted to the Co-op program with consent of advisor.

ENV 4005L Environmental Laboratory II (1). Laboratory experiments on applications of environmental engineering concepts related with air, water, land and environmental health involving data collection, analysis and interpretation. Prerequisites: ENV 3001L, CWR 3201L, and permission of the instructor.

ENV 4024 Bioremediation Engineering (3). Biotransformation of sub-surface contaminants in gaining recognition as a viable treatment tool. This course provides students with quantitative methods required to design bioremediation systems. Prerequisites: ENV 3001 and ENV 3001L.

ENV 4101 Elements of Atmospheric Pollution (3). The air pollution problem, causes, sources, and effects. Historical development. Physical, political, and economic factors in its control. Prerequisites: CWR 3201 and CWR 3201L or EML 3126 and 3126L, ENV 3001 and ENV 3001L.

ENV 4330 Hazardous Waste Assessment and Remediation (3). Generation, transport, treatment and disposal of hazardous waste; risk assessment and treatment of contaminated media. Prerequisite: One year of General Chemistry.

ENV 4351 Solid Waste Management (3). Sources, amounts and characteristics of solid wastes; municipal collection systems; method of disposal; energetic consideration in the recovery and recycle of wastes. Prerequisites: PHY 2049, and CHM 1046 and CHM 1046L.

ENV 4401 Water Supply Engineering (3). Quantity, quality, treatment, and distribution of drinking water. Prerequisites: CWR 3201 and CWR 3201L, ENV 3001 and ENV 3001L. Corequisite: ENV 4401L.

ENV 4401L Water Laboratory (1). Laboratory exercises in the physical, chemical, and bacteriological quality of potable water. Prerequisites: CWR 3201, ENV 3001 and ENV 3001L. Corequisite: ENV 4401. (Lab fees assessed).

ENV 4513 Chemistry for Environmental Engineers (3). A practical basis for applying microbial and physicochemical principles to understand reactions occurring in natural and engineered systems including water/wastewater treatment processes. Prerequisite: Permission of the instructor.

ENV 4551 Sewerage and Wastewater Treatment (3). Collection and transportation of wastewater, design of sanitary and storm sewers. Physical, chemical, and biological principles of wastewater treatment. Prerequisites: CWR 3201 and CWR 3201L, ENV 3001 and ENV 3001L. Corequisite: 4551L.

ENV 4551L Wastewater Laboratory (1). Laboratory exercises in the physical, chemical, and bacteriological quality of raw and treated wastewaters. Prerequisites: CWR 3201 and CRW 3201L, ENV 3001 and ENV 3001L. Corequisite: ENV 4551. (Lab fees assessed).

ENV 4560 Reactor Design (3). A theoretical and practical basis for reaction kinetics to understand multi-phase reactions, analysis and design of batch and continuous flow reactors.

ENV 4891 Environmental Engineering Senior Design Project (3). Team design project involving applications of fundamental environmental engineering concepts to project design, specifications, contracts and implementation. Emphasis on written and oral communication. Prerequisites: ENV 4401, ENV 4551, and CWR 3103.

ENV 4910 Undergraduate Research Experience (1-3). Participate in research activities in the areas of air, land and water systems and associated environmental health impacts. Prerequisites: Permission of a faculty advisor.

ENV 4930 Special Topics in Environmental Engineering (1-4). A course designed to give groups of students an opportunity to pursue special studies not otherwise offered.

ENV 4949 Co-Op Work Experience (3). Supervised full-time work experience in engineering field. Limited to students admitted to the Co-op program with consent of advisor. Evaluation and reports required.

SUR 2101C Surveying (3). Computations and field procedures associated with the measurement of distances and angles using tape, level, transit, EDMs, and total station. Laboratory is included with field measurements. Prerequisite: EGN 1110C.

TTE 4201 Transportation and Traffic Engineering (3). Transportation characteristics; transportation planning, traffic control devices, intersection design, network design, research. Prerequisites: STA 3033 or EIN 3235 and SUR 2101C.

TTE 4203 Highway Capacity Analysis (3). Procedures involved in the capacity analysis of interrupted and uninterrupted flow highway facilities. Applications of highway capacity analysis software. Prerequisites: TTE 4201 or permission of instructor.

TTE 4804 Geometric Design of Highways (3). Parameters governing geometric design of highways; curve superelevation, widening of highway curves, intersection design; highway interchanges, use of AASHTO design guidelines. Prerequisite: TTE 4201.

TTE 4930C Transportation Seminar (1-3). Oral presentations made by students, guests, and faculty members on current topics and research activities in traffic and transportation engineering. Prerequisite: TTE 4201.