

Department of Civil Engineering and Construction

The baccalaureate program in civil engineering is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410) 347-7700.

The baccalaureate program in construction is accredited by the American Council for Construction Education and is a charter member of the Associated Schools of Construction.

FACULTY Emeritus Professors Dini, Muvdi, Guest; Professors Adrian, Al-Khafaji (chair), Fuessle; Associate Professors Elhouar, Hindi, Maillacheruvu, Rebholz, Seckler; Assistant Professors Abed, El-Chabib, Schattler; Temporary Instructor George.

The Department of Civil Engineering and Construction offers undergraduate programs in both civil engineering (B.S.C.E.) and construction (B.S.C.).

Mission

Produce graduates who possess a keen awareness of the global dimensions of our profession, leadership skills required to serve our society, and the technical knowledge to pursue multiple career paths, including advanced degrees. To achieve our mission, our department will strive to achieve the following civil engineering program objectives:

1. Offer an ABET-accredited program in Civil Engineering that promotes diversity and leadership, and employs a systematic assessment process to ensure that graduates possess the ability to excel in a wide range of civil engineering careers.
2. Offer a Civil Engineering program that provides the academic environment needed to promote teamwork, communication skills, good citizenship, ethics and public service so that graduates have the needed knowledge, experience, and professionalism to be leaders in their profession and society.
3. Offer an international program to ensure that Civil Engineering graduates have the needed understanding of relevant global issues and other cultures in order to pursue careers overseas and thrive in our complex and multicultural world.
4. Pursue relevant and mutually beneficial partnerships with the Civil Engineering profession to ensure that

our graduates and faculty continue to benefit from and contribute to the professional community.

5. Offer a well-publicized reward system that values excellence in the traditional areas of teaching, scholarship, and service to ensure continued fulfillment and improvement of the Civil Engineering program and outcomes.
6. Promote research and scholarship activities that provide meaningful opportunities for students and faculty to participate in the development and application of new knowledge in Civil Engineering.
7. Secure the financial resources and facilities necessary to sustain the quality and distinctiveness of an imaginative Civil Engineering program that effectively responds to the needs of our profession in a changing world.

The Department

Facilities The curriculum is supported by 14 cutting-edge laboratory and computer facilities equipped with modern hardware and software. Laboratories include multimedia, ArchiCad modeling, simulation, emerging technologies, fluid mechanics/hydraulics, surveying, concrete design, asphalt pavement design, construction, structural, geotechnical, estimating, design projects, machine shop, and research. The department has four computer laboratories, three using PC's and the fourth Macintosh G4's. The computers have a wide range of software, including multimedia software such as Authorware and Toolbook, Autocad 2000, Photoshop, Dreamweaver, Fireworks, SAP 2000, Working Model (a simulation program), word processing, spreadsheets, Powerpoint, database management programs, etc. The computer facilities are available to CEC students on a 24-hour basis.

Internationalization and the Global Explorer Program The Global Explorer Program is designed to expand the professional capabilities, stimulate intellectual growth, and broaden the personal perspective of all participants. Arrangements have been made with universities around the world to send our students overseas either for short courses, a semester, or an entire year. The department is committed to giving all of our students the opportunity to study overseas. Students with financial need have received financial support that enables them to study abroad for equal to or less than what it would cost to study on campus. Financial aid is

available to students choosing to study for a semester or a year overseas at another institution. Since 1995, close to 250 students have studied overseas. Each year, more than 30 students go to England, Denmark, and Egypt to study under the guidance of CEC faculty.

Scholarships Currently 40 annual and endowed scholarships are available to students.

Placement For the past ten years CEC graduates have had a 100% placement, with starting salaries that are very competitive nationwide. Employers perceive our students as having the capability to “hit the ground running” with a minimum amount of supervision.

Leadership A focus of the department is the development of leadership skills in our students. Students are encouraged to participate in student professional organizations and academic honorary organizations by being officers or committee chairs. Leadership skills are also developed through service and outreach programs that teach good citizenship. Our students have designed and built playgrounds and running tracks and have done work for Women’s Strength, and the South Side Mission. Many of our students, both in civil engineering and construction, participate in the outstanding “Bridge Pal” program designed to foster an interest in engineering by high school and grade school students.

Faculty Qualifications The faculty have published more textbooks than any other civil engineering or construction department of a similar size in the United States. These textbooks are used at a large number of highly regarded institutions. CEC faculty have received numerous awards for teaching excellence and scholarship, as well as for their professional contributions. They have conducted research for national, state, and local sponsors, benefitting society and our students.

Graduation To graduate, students must meet all university and college graduation requirements. Additionally, CE students must achieve a minimum GPA of 2.25 in civil engineering courses to graduate.

Graduate Program In addition to the undergraduate program described above, the Department offers a graduate program leading to the Master of Science in Civil Engineering degree. Details of this program may be found in the Graduate Catalog. The graduate program allows talented undergraduate students to engage in scholarly research activities and to enroll in advanced courses to meet their special interests and needs.

Civil Engineering

The Department of Civil Engineering and Construction offers an ABET-accredited BSCE program that provides students the necessary background for continued professional growth and prepares them for engineering careers. The program offers a broad spectrum of specialties including structures, water resources, environmental engineering, transportation, highway and pavement design, geotechnical engineering, and construction management. The

curriculum is designed to give students the broad technical background required for modern civil engineering practice and/or to pursue higher education. Students are trained to be leaders who understand their critical roles in the development and maintenance of society’s infrastructure.

The program is founded on a strong core in mathematics as well as natural and engineering sciences. Design practices in civil engineering are integrated throughout the curriculum, culminating in a capstone design course under the supervision of well-qualified faculty and industrial partners. A sequence of courses in the humanities and social sciences helps students understand the impact of engineering solutions on society. The courses selected in the humanities and social sciences are chosen to provide both breadth and depth and meet university general education requirements. An approved list of courses that satisfy these requirements may be obtained from the student’s academic advisor. The curriculum gives students as much flexibility in technical electives as possible while meeting all accreditation requirements. The student may select either the civil engineering program or the civil engineering program with the environmental engineering option. Typical four-year curricula are given for both programs.

Freshman Year

First Semester

CE 100 Intro. to Civil Engineering	1
ENG 101 English Composition	3
MTH 121 Calculus I.....	4
COM 103 Oral Communication Process	3
Gen. Ed. ¹ - Western Civilization	3
Gen. Ed. ¹ - Non-Western Civilization.....	3
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	17

Second Semester

CE 150 Mechanics I	3
MTH 122 Calculus II.....	4
PHY 110 University Physics I.....	4
CON 132 Construction Graphics	2
CE 124 Emerging Technologies in Civil Engineering	2
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	15

Sophomore Year

First Semester

CE 206 Surveying.....	2
CE 250 Mechanics II	3
CHM 110 General Chemistry I.....	3
CHM 111 General Chemistry I Lab	1
MTH 223 Calculus III	4
CE 224 CADD in Civil Engineering.....	3
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	16

¹ General education courses may be selected from an approved list for each category. They may be taken in any sequence, not necessarily in the semester indicated. The general education sequence must reflect depth of study; see your academic advisor for an approved list. Other University general education requirements are satisfied by specific courses required above.

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Second Semester

CE 202 Digital Computation & Numerical Methods	3
CE 301 Mechanics of Materials	3
CE 303 Structural Materials Lab	2
CHM 112 Engineering Chemistry	3
Gen. Ed. ¹ - Fine Arts.....	3
MTH 224 Elementary Differential Equations	4
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	18

Junior Year

First Semester

CE 304 Fluid Mechanics.....	3
CE 359 Structural Analysis.....	4
Engineering Science Elective ²	3
Gen. Ed. ¹ - ENG 305 Technical Writing.....	3
CE 308 Geotechnical Engineering	4
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Second Semester

CE 310 Probability, Statistics, & Decision Making	3
CE 360 Intro. to Environmental Engineering	4
CON 396 Construction Estimating	3
CE 356 Pavement Design.....	3
Basic Science ²	3
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	16

Senior Year

First Semester

CE 403 Reinforced Concrete	3
CE 442 Design of Steel Structures	3
Gen. Ed. ¹ - Social Forces.....	3
Electives ²	6
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	15

Second Semester

CE 498 Civil Engr. Design Project	3
Electives ²	6
Gen. Ed. ¹ - Human Values.....	3
Gen. Ed. ¹ - Social Forces.....	3
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	15
Total Hours	129

Civil Engineering Technical Electives

18 credit hours

All electives selected by the student should be approved by the student's academic advisor. The student should select his/her technical electives to reflect career objectives.

Students wishing to enroll in a CE graduate-level course must have a minimum 2.5 GPA in CE courses.

²Technical electives must be chosen from an approved list. See "Technical Electives."

1. Basic Science

Students may apply up to a maximum of 9 semester hours but not less than 3 semester hours from the following courses:

Any physics course above 200

Any biology course

Any chemistry course above CHM 116

Any geological science course above 101

2. Engineering Science

Students may apply up to a maximum of 9 semester hours but must take IME 301, EE 327, or ME 301.

ME 301 Thermodynamics I

ME 302 Thermodynamics II

ME 521 Intermediate Fluid

ME 556 Mechanics of Composite Materials

ME 577 Finite Element Methods in Engineering

IME 301 Engineering Economy I

IME 313 Operations Research I

EE 205 Fundamentals of Circuit Analysis

EE 327 Fundamentals of Electrical Engineering I

EE 328 Fundamentals of Electrical Engineering II

3. Civil Engineering

Students must select a minimum of 6 semester hours.

Group A: Civil Engineering Science Courses

Students may apply up to a maximum of 9 semester hours.

CE 465 Surface Water Hydrology

CE 480 Transportation Engineering

CE 508 Advanced Soil Mechanics

CE 510 Advanced Numerical Methods

CE 541 Transport Phenomena in Environmental Systems

CE 544 Advanced Hydraulics

CE 546 Groundwater Hydrology and Hydraulics

CE 555 Environmental Regulations and Policy

CE 560 Advanced Structural Analysis

CE 573 Advanced Mechanics of Materials

CE 575 Structural Dynamics

CE 580 Highway Safety and Risk Management

CE 582 Economic Analysis for Highways and Transportation Systems

CE 586 Pavement Management Systems

CE 591 Special Topics I

CE 592 Special Topics II

Group B: Civil Engineering Design

Students may apply up to a maximum of 12 semester hours and not less than 3 semester hours.

CE 422 Foundation Analysis and Design

CE 430 Water Supply and Hydraulic Engineering

CE 515 Advanced Foundation Engineering

CE 542 Physiochemical Process Design

CE 543 Biological Process Design

CE 550 Geoenvironmental Engineering

CE 562 Advanced Steel Design

- CE 565 Advanced Concrete Design
- CE 567 Prestressed Concrete
- CE 581 Traffic Signal System Optimization & Simulation
- CE 585 Advanced Pavement Design
- CE 591 Special Topics I
- CE 592 Special Topics II

4. Mathematics, Business, and Computer Science

- Students may apply up to a maximum of 6 semester hours.
- Any mathematics course above MTH 224
- Any business, accounting, marketing or economics course.
- Any computer science course above CS 202

5. Other

- Students may apply up to a maximum of 6 semester hours.
- CE 491 Special Topics I
- CE 492 Special Topics II
- CE 522 Advanced CADD
- CE 524 Multimedia Applications in CEC
- CE 526 Advanced Cost Estimating for Construction
- CE 528 Advanced Scheduling
- CE 529 Construction Contract Administration
- CE 536 TQM Principles in Construction
- CE 537 Simulation in CEC
- CON 356 Construction Industry Safety Practices
- CON 390 Microcomputers in Construction
- CON 392 Construction Management
- CON 394 Construction Labor and Unions
- CON 395 Construction Claims and Change Orders
- CON 489 Alternate Material Structures
- CON 492 Construction Contracts
- CON 494 Advanced Construction

Civil Engineering with Environmental Engineering Option

The *Peterson's Guide* states that environmental engineering involves the engineering control of activities, processes, and systems that affect the environment—adversely or favorably. Primary emphasis is on the scientific and engineering development, design, and operation of water resource quality management systems involving agricultural, industrial, and municipal water supply treatment; wastewater treatment; solid waste disposal; remediation of contaminated sites; and reclamation (recycling). Also considered are gaseous and solid waste analyses and the design and management of process control systems.

The field of environmental engineering has undergone significant growth over the past decade, a documented trend that is expected to continue well into the 21st century. This growth has brought with it a need for trained personnel to address existing environmental concerns and prevent future problems.

The Congressional Office of Technology Assessment has stated that, nationwide, the demand for professionals trained in the area of hazardous waste cleanup alone grew from 5,000 in 1985 to 11,500 in 1990, and was expected to double again by 1995. The overall demand is estimated to be as many as 5,000 new environmental engineers per year, but only one-third are currently being supplied by educational programs.

Freshman Year

First Semester

CE 100 Intro. to Civil Engineering	1
ENG 101 English Composition	3
MTH 121 Calculus I.....	4
Gen. Ed. ¹ - Western Civilization	3
Gen. Ed. ¹ - Social Forces.....	3
COM 103 Oral Communication Process	3
	17

Second Semester

CE 150 Mechanics I	3
MTH 122 Calculus II.....	4
PHY 110 University Physics I.....	4
CON 132 Construction Graphics	2
CE 124 Emerging Technologies in Civil Engineering	2
	15

Sophomore Year

First Semester

CE 206 Surveying.....	2
CE 250 Mechanics II	3
CHM 110 General Chemistry I.....	3
CHM 111 General Chemistry II.....	1
MTH 223 Calculus III	4
CE 224 CADD in Civil Engineering.....	3
	16

Second Semester

CE 202 Digital Computation & Numerical Methods	3
CE 301 Mechanics of Materials	3
CE 360 Intro. to Environmental Engineering	4
CHM 112 Engineering Chemistry	3
MTH 224 Differential Equations	4
	17

Junior Year

First Semester

CE 304 Fluid Mechanics.....	3
Engineering Science Elective ²	3
Gen. Ed. ¹ - ENG 305 Technical Writing.....	3
Gen. Ed. ¹ - Fine Arts.....	3
CE 308 Geotechnical Engineering.....	4
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Second Semester

CHM 315 Environmental Chemistry	3
CE 542 Physiochemical Processes Design	3
Environmental Science Elective (BIO 300, 395; CHM 250; GES 150, 312, 410, 461)	3
CON 396 Construction Estimating	3
CE 310 Probability, Statistics, and Decisions.....	3
Gen. Ed. ¹ - Human Values.....	3
	18

Senior Year

First Semester

CE 550 Geoenvironmental Engineering.....	3
CE 543 Biological Processes Design.....	3
Technical Electives ²	3
Gen. Ed. ¹ - Social Forces.....	3
Gen. Ed. ¹ - Non-western Civilization	3
	15

Second Semester

CE 498 Civil Engineering Design Project	3
CE 430 Water Supply and Hydraulic Engineering.....	3
Technical Electives ²	9
	15
Total Hours	129

Environmental Engineering Concentration Technical Electives

- All electives selected by the student should be approved by the student's academic advisor. It is important for the student to be aware of prerequisites when selecting electives. The student should plan his/her technical elective selections with his/her academic advisor during his/her junior year.
- Engineering Science Elective-Fall Semester of Junior Year
The student shall select one of the following three courses.
 - ME 301 Thermodynamics
 - EE 327 Fundamentals of Electrical Engineering I or EE 205 Fundamentals of Circuit Analysis
 - IME 301 Engineering Economics
- Environmental Science Elective-Spring Semester of Junior Year
The student shall select one environmental science course from the listing of basic science electives listed below.
 - BIO 300 Population, Resources and the Environment
 - BIO 395 General Microbiology
 - BIO 460 Ecology
 - CHM 250 Organic Chemistry
 - GES 150 Principles of Engineering Geology
 - GES 312 Structural Geology and Tectonics
 - GES 410 Principles of Geochemistry
 - GES 461 Introductory Geophysics

- All technical electives should be selected from the approved listing. The approved listing is designed such that the student may select their technical electives to develop a geoenvironmental or an environmental engineering management focus. The student may also select their technical electives from both areas. The student must select their technical electives such that they accumulate 3 semester hours of design. A listing of the approved technical electives follows on the next page.

Environmental Engineering Electives

Geoenvironmental Focus

GES 450 ¹ Hydrogeology
CE 508 Advanced Soil Mechanics
CE 510 Advanced Numerical Methods
CE 544 Advanced Hydraulics
CE 546 Groundwater Hydrology and Hydraulics
CE 555 Environmental Regulations and Policy
CE 591 Special Topics I
CE 592 Special Topics II

Environmental Engineering Management Focus

GES 450 ¹ Hydrogeology
CE 510 Advanced Numerical Methods
CE 526 ¹ Advanced Cost Estimating, Construction
CE 528 ¹ Advanced Scheduling
CE 529 ¹ Construction Contract Administration
CE 541 Transport Phenomena in Env. Systems
CE 544 Advanced Hydraulics
CE 555 Environmental Regulations and Policy
CE 591 Special Topics I
CE 592 Special Topics II

Course Descriptions

CE 100 Introduction to Civil Engineering 1 hr.

Introduction to the civil engineering and environmental engineering professions. Introduction to fundamental engineering concepts; engineering design; engineering ethics; professional societies; introductions to computers and computer applications. Cross-listed as CON 100. Prerequisites: freshman standing or consent of instructor.

CE 124 Emerging Technologies in CEC 2 hrs.

Examination of emerging computer technologies and their relevancy to Civil Engineering and Construction. Introduction to common software including spreadsheet, word processing, databases, graphics and presentation. Exposure to multimedia tools such as text, image, sound video and animation. Introduction to E-mail and Web page development. Cross-listed as CON 124.

CE 150 Mechanics I 3 hrs.

Analysis of two- and three-dimensional force systems by vector algebra. Application of principles of equilibrium to particles, rigid bodies, and simple structures. Friction, distributed forces, center of gravity, centroids, moments of inertia. British and metric systems of units and applications. Prerequisite: C or better in MTH 121. Corequisite: MTH 122.

- CE 200 Engineering Co-op** **4 hrs.**
Full-time cooperative education assignment for civil engineering students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/Unsatisfactory. Prerequisites: Sophomore standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of engineering and technology Co-op coordinator and Co-op faculty advisor.
- CE 202 Digital Computation & Numerical Methods** **3 hrs.**
State-of-the-art algorithms used in solving complex engineering problems. Mathematical models involving ordinary and partial differential equations. Initial value, boundary value, and transient problems in civil engineering. Prerequisite: MTH 223.
- CE 206 Surveying** **2 hrs.**
Theory and applications of measurements of horizontal distances, differences in elevations, horizontal angles, vertical angles, bearings, azimuths, and plane area. Simple horizontal circular curves, topographic surveys and mapping. Prerequisite: CON 132.
- CE 224 CADD in Civil Engineering** **3 hrs.**
Examinations of the graphical capabilities of current computer aided design and drafting (CADD) systems. Theoretical and hands-on applications of the most widely used CADD systems available for civil engineering applications. Cross listed as CON 224.
- CE 250 Mechanics II** **3 hrs.**
Kinematics and kinetics of particles and rigid bodies using vector analysis. Kinetics includes principles of force-mass-acceleration, work-energy, and impulse-momentum. Prerequisite: C or better in CE 150. Corequisite: MTH 223.
- CE 301 Mechanics of Materials** **3 hrs.**
Internal forces; stress, strain, and their relations; stresses and deformations in axial and torsional loading; indeterminate problems; stresses and deformations in flexural members; transformation of stresses; introduction to member design; column buckling analysis. Prerequisite: C or better in CE 150 or equivalent.
- CE 303 Structural Materials Laboratory** **2 hrs.**
Experimental study of mechanical properties of steel and concrete. Tensile, compressive, and flexural behavior of steel. Concrete mix design, brittleness, and microstructure. Mechanical properties of timber. Prerequisite: CE 301 or concurrent enrollment.
- CE 304 Fluid Mechanics** **3 hrs.**
Fluid properties and fluid motion: basic laws of fluid motion in integral form; applications of basic laws in solving fluid flow problems. Hydrostatics, dimensional analysis, similitude, and incompressible viscous flow (both laminar and turbulent) in conduits. Introduction to open channel flow. Laboratory experiments to demonstrate theory and flow measurement in conduits and open channels. Prerequisite: C or better in CE 250; MTH 223.
- CE 308 Geotechnical Engineering** **4 hrs.**
Physical properties of soils, soil profiles, and deposits. Soil strength determination. Flow of water through soil masses. Prerequisite: CE 301; CE 304 or concurrent enrollment.
- CE 310 Probability, Statistics and Decision Making in Civil Engineering** **3 hrs.**
Basic probabilistic and statistical decision principles used in civil engineering design and practice. Probabilistic models and decision theory. Corequisite, MTH 224.
- CE 320 Introductory Soil Mechanics** **3 hrs.**
Introduction to soil mechanics and foundation construction for non-CE majors. Soil index properties, classification, stress analysis, soil compaction, dewatering, excavations and foundation construction. Prerequisites: IMT 324 or CE 301; construction major.
- CE 356 Pavement Design** **3 hrs.**
Pavement engineering and design. Selection testing, and use of highway pavement construction materials in relation to function, environment and cost. Structural properties of asphalt concrete; laboratory experiments. Prerequisites: CE 303, CE 308 or CE 320.
- CE 359 Structural Analysis** **4 hrs.**
Analysis of statically determinate structures including influence lines. Deflections by area-moment, conjugate beam, virtual work, and Castigliano's theorem. Analysis of statically indeterminate structures including influence lines. Classical solutions by consistent displacements, three-moment theorem, moment distribution, and slope deflection methods. Matrix methods for structural analysis by stiffness approach. Prerequisite: CE 301.
- CE 360 Introduction to Environmental Engineering** **4 hrs.**
Analysis techniques and design procedures for unit operations and unit processes of water and waste water treatment. Techniques for examination of water and waste water quality. Corequisite: CHM 112.
- CE 401 Seminar** **1 hr.**
Papers, reviews, and discussion of current technical literature. Prerequisite: senior standing in civil engineering.
- CE 403 Reinforced Concrete Design** **3 hrs.**
Theory and design of reinforced concrete structures: beams, columns, slabs, walls, and buildings. Current ACI Code provisions for elastic and ultimate design. Prerequisite: CE 359.
- CE 422 Foundation Analysis and Design** **3 hrs.**
Analysis and design of footings, raft foundations, retaining walls, piles, and caissons, based on current theories and design considerations in soil mechanics, concrete, and steel. Prerequisites: CE 308, 403.

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CE 430 Water Supply & Hydraulic Engineering 3 hrs.
Water use and wastewater generation. Conveying and distributing water. Wastewater and stormwater conveyance system design. Design of storage structures and other systems for water conservation and water use; open channel flow, closed conduit flow, hydraulic structures, hydraulic power conversion. Prerequisite: CE 304.

CE 442 Design of Steel Structures 3 hrs.
Design of metal structural members. Behavior of members and connections. Theoretical and practical considerations in member selection and joint design. Prerequisite: CE 359.

CE 465 Surface Water Hydrology 3 hrs.
Introduction to hydrological cycle. Hydrologic measurements and monitoring. Surface water hydrology: runoff and the catchment, hydrographs, unit hydrographs, hydrograph routing, urban and small watershed hydrology, hydrologic design, synthetic streamflows, simulation models, applications of probability and statistics to surface water hydrology. Prerequisites: CE 304, CE 310 or consent of instructor.

CE 480 Transportation Engineering 3 hrs.
Introduction to transportation engineering and planning as it relates to highways. Characteristics of highway systems: the driver, vehicle and roadway, traffic engineering studies, highway safety, traffic flow fundamentals, capacity and level of service concepts, intersection traffic control, transportation planning and site impact analysis, geometric design of highways. Prerequisite: CE 310.

CE 491, 492 Special Topics 1-3 hrs. each
Topics of special interest which may vary each time course is offered. Topics stated in current Schedule of Classes. If taken to satisfy one of the technical electives, applies only to the ABET "other" category. Prerequisite: senior standing.

CE 498 Civil Engineering Design Project 3 hrs.
With faculty aid, students select a design project, plan its solution including the management of the project and perform the actual design as a member of a team. Oral and written report of final design with specifications, engineering drawings, and engineering cost estimate as well as an assessment of the impact on the environment. Prerequisites: senior standing; consent of department chair.

CE 499 Advanced Multimedia Authoring in Engineering 2 hrs.
Multimedia authoring review, web authoring, 3D animation, video capturing and manipulation, anatomy of a multimedia design document, application packaging and distribution. Students will apply the learned topics to develop an integrated engineering application based on their discipline. Prerequisites: CE 224, 399.

CE 508 Advanced Soil Mechanics 3 hrs.
Consolidation theory and settlements, stress-path method, strength and deformation behavior of soils, failure theories, confined flow, flow nets, numerical analysis of flow, unconfined flow, seepage through earth dams. Laboratory experiments on consolidation and shear strength. Prerequisites: CE 308.

CE 510 Advanced Numerical Methods with Engineering Applications 3 hrs.
Selected numerical methods and applications chosen to meet current needs for solving problems in civil engineering. Prerequisite: CE 202 or equivalent.

CE 515 Advanced Foundation Engineering 3 hrs.
Advanced pile capacity formulations, buckling, and lateral loading. Mat foundations, finite difference solutions. Foundations on difficult soils. Slope stability; stability of earth dams. Excavations; geotechnical instrumentation. Prerequisite: CE 422.

CE 522 Advanced CADD 3 hrs.
Applications of CAD systems. Visualization and optimization of the processes used in construction through three-dimensional modeling and utilization in various civil engineering and construction applications. Prerequisite: CE 244 or CON 224 or consent of department chair.

CE 524 Multimedia Applications in Civil Engineering and Construction 3 hrs.
Application of state-of-the-art technology in projects during various phases from inception to completion including planning, design, procurement, construction, handing over, and operation and maintenance. Investigation of different available tools and technologies in recording, storing, and sharing project information. Prerequisite: senior or graduate standing in the College of Engineering and Technology.

CE 526 Advanced Cost Estimating for Construction Projects 3 hrs.
Advanced techniques in taking-off quantities, pricing techniques, computer estimating, and bidding strategy models. Prerequisite: CON 396.

CE 528 Advanced Scheduling 3 hrs.
Project scheduling methods with emphasis on network scheduling techniques, work breakdown structure (WBS), resource and cost loading, scheduling under uncertainties, project time compression, resource leveling, scheduling for linear projects (LOB), time-cost trade-offs, project status, reporting and updating, schedules as tools for claims documentation. Case studies. Computer based. Prerequisite: CON 392.

CE 529 Construction Contract Administration 3 hrs.
Issues in the administration and implementation of a construction contract. Coordinating and controlling the construction project under legal and ethical considerations. Prerequisites: CON 492.

CE 536 TQM Principles in Construction 3 hrs.
Theory and analysis of the Total Quality Management system as applied within the construction industry. Case studies. Prerequisite: QM 262 or IME 311.

CE 537 Simulation in Construction 3 hrs.
Decision making using simulation and simulation languages to model construction operations. Simulation of construction process using what-if analysis. Role of simulation and decision making in the planning and scheduling phases in the construction industry. Topics include introduction to discrete event simulation, generation of random numbers, queuing, simulation languages for construction. Prerequisites: senior or graduate standing; consent of instructor.

CE 541 Transport Phenomena in Environmental Systems 3 hrs.
Phenomena that affect mass balance of contaminants in environmental systems. Advection, diffusion, dispersion, and interfacial mass transfer. Physical, chemical, and biological descriptions of these processes with mathematical models. Solutions to these models with illustrations from reactor engineering and surface water quality modeling. Application to actual process reactor. Prerequisites: senior or graduate standing; consent of instructor.

CE 542 Physiochemical Processes Design 3 hrs.
Design of physical and chemical unit processes and unit operations with an emphasis on water treatment. Design of aeration systems, coagulation and flocculation processes, sedimentation tanks, filtration systems, chemical precipitation processes, ion exchange processes, and disinfection processes. Advanced purification methods including adsorption, reverse osmosis, electro-dialysis, and membrane processes. Treatment and disposal of physiochemical process sludges. Prerequisite: CE 360.

CE 543 Biological Processes Design 3 hrs.
Application of concepts from microbiology and biology to environmental engineering systems. Detailed integrated design of wastewater treatment. Microbiology of wastewater treatment processes and soil bioremediation processes. Interaction between biogeochemical phenomena and microbial processes in an environmental engineering context. Prerequisite: CE 360.

CE 544 Advanced Hydraulics 3 hrs.
Steady state closed conduit flow; flow in pipe networks. Hydraulic transients in pipelines. Open channel flow; gradually varied, spatially varied, rapidly varied flow in open channels; open channel transients. Water and wastewater treatment plant hydraulics. Sedimentation mechanics, sediment transport, design of unlined channels, bridge scour, reservoir sedimentation. Design and computer applications. Prerequisite: CE 430.

CE 546 Groundwater Hydrology & Hydraulics 3 hrs.
Groundwater in the hydrological cycle, fundamentals of groundwater flow; flow net analysis; steady-state and transient well testing techniques for parameter estimation;

multiple well systems; leaky aquifers; sea water intrusion; groundwater investigation; artificial recharge of aquifers, design of wells; subsidence and lateral movement of land surface due to groundwater pumping. Design and computer applications. Cross listed as GES 546. Prerequisites: CE 202, 304, or consent of instructor.

CE 550 Geoenvironmental Engineering 3 hrs.
Soil composition and behavior. Development and movement of groundwater. Soil sampling and monitoring of contaminants in groundwater. Drilling techniques based on soil type. Land disposal of wastes. Solidification of wastes and design of landfills. Processes affecting the distribution of inorganic and organic pollutants in the environment. Exchange among soil, water, sediment, and biota. Remediation of contaminated soil and groundwater at existing sites. Prerequisites: CE 308, CE 360.

CE 555 Environmental Regulations & Policy 3 hrs.
Description and analyses of environmental regulations and policies for air, water, groundwater, and solid wastes. Conventional and hazardous wastes. Toxicological, risk assessment, and regulatory aspects of solid and hazardous waste management; characterization of hazardous wastes and materials; waste reduction strategies; collection, storage, and transportation methods. Environmental impact statements. Prerequisite: CE 360.

CE 560 Advanced Structural Analysis 3 hrs.
Direct stiffness method for the analysis of two-dimensional trusses and frames, equivalent nodal forces, thermal and settlement effects, principle of virtual work, space trusses, grid structures, static condensation, Lagrange multipliers, tapered elements. Prerequisites: CE 202, CE 359.

CE 562 Advanced Steel Design 3 hrs.
Structural framing systems; rigid frame design; design of bracing; design of simple rigid and moment resisting connections; torsion of steel open sections; design of beams subjected to torsion; design of steel plate girders; design of composite beams. Prerequisite: CE 442.

CE 565 Advanced Reinforced Concrete 3 hrs.
Advanced topics in flexural design; torsion in beams; behavior and design of slender columns; biaxial bending of columns; design of two-way slabs; behavior and design of frame-wall structural systems; inelastic analysis of flexural members; use of strut and tie analysis; yield line analysis; design of mat foundations. Prerequisite: CE 403.

CE 567 Prestressed Concrete 3 hrs.
Theory and analysis of prestressed concrete members by various methods of prestressing; design of simple and continuous beams and slabs; prestress losses; composite beams. Extensive study of materials used in prestressed concrete. Precast concrete systems. Prerequisites: CE 403; senior or graduate standing.

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CE 573 Advanced Mechanics of Materials 3 hrs.
Two- and three-dimensional stress and strain at a point; two-dimensional elasticity; beams on elastic foundations; torsion of noncircular sections; curved beams; unsymmetrical bending; plastic collapse and limit analysis. Prerequisites: CE 301; senior or graduate standing.

CE 575 Structural Dynamics 3 hrs.
Single degree of freedom systems; multi-degree of freedom systems; lumped mass and consistent mass—MDOF beams; free and forced vibrations; earthquake loading; impact and impulsive loads; numerical procedures. Prerequisites: CE 202, CE 359.

CE 580 Highway Safety and Risk Management 3 hrs.
Safety aspects of streets and highways; planning, implementation, and evaluation of highway safety improvement projects and programs. Highway risk analysis and risk management systems. Prerequisite: senior or graduate standing.

CE 581 Traffic Signal System Optimization and Simulation 3 hrs.
Analysis and design of traffic signals for isolated intersections and coordinated systems. Hardware, communication, and detection systems associated with signal systems. Fundamental concepts of simulation of traffic operations. Application of optimization/simulation computer software programs. Prerequisites: CE 310; senior or graduate standing.

CE 582 Economic Analysis for Highways & Transportation Systems 3 hrs.
Application of engineering economy for transportation systems; analysis of congestion costs, highway transportation costs, and road user consequences; identification and measurement of highway benefits, concepts of value of time, and willingness to pay; discount rates and vest charge; concepts of depreciation and service life; life cycle cost analysis; evaluation of transportation alternatives and evaluation of completed projects and programs. Prerequisite: senior or graduate standing.

CE 585 Advanced Pavement Design 3 hrs.
Methods used to characterize, stabilize, and specify pavement materials. Methods for rigid and flexible highway and airport pavement design and analysis. Load equivalence factor and specific design considerations related to environment and traffic characteristics. Pavement overlay design. Software for pavement design and analysis using various models. Prerequisites: CE 356, senior or graduate standing.

CE 586 Pavement Management Systems 3 hrs.
Condition assessment of the infrastructure with emphasis given to pavement, deterioration modeling, engineering economics of payment systems, evaluation of project alternatives, optimization and ranking, sustainability, and strategic environment assessment for infrastructure decision-making. Prerequisite: CE 356.

CE 591 Special Topics I 1-3 hrs.
Topics of special interest, which may vary each time course is offered. Topic stated in current Schedule of Classes. Prerequisite: senior or graduate standing.

CE 592 Special Topics II 1-3 hrs.
Topics of special interest, which may vary each time course is offered. Topic stated in current Schedule of Classes. Prerequisite: senior or graduate standing.

Construction

The construction industry is large, varied, and complex. It is intimately interwoven with, and exerts significant influence on, the overall economy of our nation. Constructors—the modern construction professionals—are educated in engineering and architectural principles in the building process, allowing effective communication with the many persons with whom contact is necessary: the design professionals (engineers and architects), specialty subcontractors, manufacturers and distributors of construction materials and products, financiers and others. Additionally, and most importantly, the constructor is a manager. The constructor's education must include the essentials of contemporary management philosophy, sound business and construction practice, and enlightened human relations. This multidisciplinary curriculum has been developed from these aims which are in consonance with the goals of the Associated Schools of Construction, and with the philosophy of the American Institute of Constructors.

The program described below was developed for the typical student interested in general preparation for a construction career. A minor in business administration or management is possible by careful selection of electives and a total of 131 semester hours.

The Bachelor of Science in Construction (BSC) degree requires a minimum of 126 approved semester hours. (Courses taken to remove deficiencies, e.g., MTH 109, MTH 110, and PHY 100, must be taken in addition to the approved 126 semester hours.)

Mission

Produce graduates who possess a keen awareness of the national and global dimensions of the construction industry, leadership skills required to serve our society, and the technical knowledge to pursue multiple career paths including advanced degrees. To achieve our mission, the Construction program will strive to achieve the following objectives:

1. Offer an ACCE-accredited program in Construction that promotes diversity and leadership and employs a systematic assessment process to insure that graduates possess the ability to excel in a wide range of construction careers.
2. Offer a Construction program that provides the academic environment needed to promote teamwork, communication skills, good citizenship, ethics, and public service so that graduates possess the needed knowledge and professionalism to be leaders in the construction industry and society.
3. Offer international programs to ensure that Construction graduates have the needed understanding of relevant global issues and other cultures in order to pursue careers overseas and thrive in our complex and multicultural world.

4. Pursue relevant and mutually beneficial partnerships with the construction industry to ensure that our graduates and faculty continue to benefit from and contribute to the professional community.
5. Offer a well-publicized reward system that values excellence in the traditional areas of teaching, scholarship, and service to ensure continued fulfillment and improvement of the Construction program and outcomes.
6. Promote research and scholarship activities that provide meaningful opportunities for students and faculty to participate in the development and application of new knowledge in Construction.
7. Secure the financial resources and facilities necessary to sustain the quality and distinctiveness of an imaginative Construction program that effectively responds to the needs of our profession in a changing world.

Degree Requirements

Accreditation criteria are met by the following groups of courses:

Group I—General Education

¹ ENG 101 English Composition	3
¹ ENG 300, 301, 304, 305, or 306 Advanced Writing	3
¹ COM 103 Oral Communication Process.....	3
¹ Western Civilization	3
¹ Non-Western Civilization.....	3
¹ Human Values	3
¹ Fine Arts	3
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	21

Group II—Mathematics and Science

¹ MTH 115 or 121 Calculus I.....	4
MTH 116 or 122 Calculus II.....	3, 4
¹ PHY 107 or 110 Physics I.....	4
² Computer Programming Elective	3
¹ GES 101, 102 Principles of Earth Science.....	4
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	18-19

Group III—Business Management

¹ ECO 221 Microeconomics	3
¹ ECO 222 Macroeconomics.....	3
ATG 157 Accounting-Financial.....	3
ATG 158 Accounting-Managerial.....	3
BMA 352 Business Management	3
² Business Electives	9
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	24

¹See Gen. Ed. list in the Schedule of Classes each semester.

²Electives must be chosen from list available from the academic advisor.

College of Engineering and Technology

Group IV—Construction Science

CE/CON 124 Emerging Technologies in CEC.....	2
CON 132 Construction Graphics.....	2
CON 262 Mechanical and Electrical Systems.....	3
CON 270 Materials and Methods of Construction.....	3
CON 487 Steel and Concrete.....	3
CON 489 Alternate Materials.....	3
CE 150 or IMT 222 Statics.....	3
CE 206 Surveying.....	2
CE 301 or IMT 324 Strength of Materials.....	3, 4
CE 320 Introductory Soil Mechanics.....	3
CON 224 CADD in Construction.....	3
	30-31

Group V—Construction Management

CON 100 Introduction to Construction.....	1
CON 342 Construction Equipment and Methods.....	3
CON 356 Construction Industry Safety Practices.....	3
CON 372 Construction Methods Improvement.....	3
CON 392 Construction Management.....	3
CON 396 Construction Estimating.....	3
CON 492 Construction Contracts.....	2
CON 498 Senior Project.....	3
² CON Electives.....	9
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	30
² Elective (Group 4 or 5).....	3

Minimum semester hours required for BSC Degree	126
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Typical Curriculum

Freshman Year

First Semester

CON 100 Introduction to Construction.....	1
COM 103 Oral Communication Process.....	3
MTH 115 or MTH 121 Calculus I.....	4
¹ Gen. Educ.—Western Civilization.....	3
GES 101 Principles of Earth Science.....	3
GES 102 Principles of Earth Science Lab.....	1
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	15

Second Semester

CON 132 Construction Graphics.....	2
ENG 101 English Composition.....	3
MTH 116 or MTH 122 Calculus II.....	3, 4
PHY 107 or Physics 110.....	4
² CS Elective.....	3
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	15-16

Sophomore Year

First Semester

CE 150 Mechanics I or IMT 222 Statics.....	3
ECO 221 Microeconomics.....	3
ATG 157 Accounting-Financial.....	3
CON 270 Materials and Methods of Construction.....	3
CE 206 Surveying.....	2
CON 224 CADD in Construction.....	3
	—
	17

Second Semester

CE 301 or IMT 324 Strength of Materials.....	3, 4
ECO 222 Macroeconomics.....	3
ATG 158 Accounting-Managerial.....	3
CON 262 Mechanical & Electrical Systems for Bldgs.....	3
CE/CON 124 Emerging Technologies.....	2
¹ Gen. Ed.—Human Values.....	3
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	17-18

Junior Year

First Semester

¹ ENG 300, 301, 304, 305, or 306 Adv. Writing.....	3
CON 342 Construction Equipment and Methods.....	3
CON 372 Construction Methods Improvement.....	3
² Management Elective.....	3
² Construction Elective.....	3
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	15

Second Semester

CON 356 Construction Safety.....	3
CON 392 Construction Management.....	3
BMA 352 Business Management.....	3
CON 396 Construction Estimating.....	3
CE 320 Intro. to Soil Mechanics.....	3
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	15

Senior Year

First Semester

¹ Gen. Ed.—Fine Arts.....	3
CON 487 Steel and Concrete Structures.....	3
CON 492 Construction Contracts.....	2
² Construction or Construction Science Elective.....	3
² Management Elective.....	3
¹ Gen. Ed. Non-Western Civilization.....	3
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	17

Second Semester

CON 498 Senior Project.....	3
CON 489 Alternative Material Structures.....	3
² Construction Elective.....	3
² Construction Elective.....	3
² Management Elective.....	3
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	15

Total Hours	126-128
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Course Descriptions

CON 100 Introduction to Construction 1 hr.
Introduction to the construction profession. Computer applications, problem solving concepts, design concepts and visualization, industry ethics, professional societies, and university services

CON 124 Emerging Technologies in CEC 2 hrs.
Examination of emerging computer technologies and their relevancy to Civil Engineering and Construction. Introduc-

tion to common software including spreadsheet, word processing, databases, graphics and presentation. Exposure to multimedia tools such as text, image, sound video and animation. Introduction to E-mail and Web Page development. Cross-listed as CE 124.

CON 132 Construction Graphics 2 hrs.
Symbols, conventions, and details of construction drawings. Emphasis on interpretation and communication of requirements of contract drawings. Prerequisite: one unit of high school or college technical drafting or consent of instructor.

CON 200 Engineering Co-op 0 hrs.
Full-time cooperative education assignment for construction students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/Unsatisfactory. Prerequisites: Sophomore standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of engineering and technology Co-op coordinator and Co-op faculty advisor.

CON 224 CADD in Construction 3 hrs.
Examination of the graphical capabilities of current computer aided design and drafting (CADD) systems. Theoretical and hands-on applications of the most widely used CADD systems available for construction applications. Cross-listed as CE 224.

CON 262 Mechanical and Electrical Systems for Buildings 3 hrs.
Survey of basic principles, methods, and equipment for building component systems related to human health and comfort. Introduces psychrometric chart, building heating systems, electrical systems, plumbing. Prerequisites: PHY 107 or 110; CON 132.

CON 270 Materials & Methods of Construction 3 hrs.
Characteristics and use of basic construction materials; introduction to materials specifications.

CON 272 Materials & Methods of Construction II 3 hrs.
A study of materials and techniques of construction used in structural frames of wood, steel, and concrete; consideration of foundation, asphalt, and advanced interior construction methods. Prerequisite: CON 270

CON 330 Housing 3 hrs.
Planning residential areas: geographic location, orientation, functions, and interrelationships of functions. Fundamentals of residential design which can result in quality living environments for all income levels. Prerequisite: junior standing.

CON 342 Construction Equipment & Methods 3 hrs.
Characteristics of contractor plant and construction equipment; methods for their efficient use. Prerequisite: junior standing in College of Engineering and Technology.

CON 352 Urban Environment 3 hrs.
Principles of land utilization and other elements related to planning and developing quality urban environments. Prerequisite: junior standing.

CON 356 Construction Industry Safety Practices 3 hrs.
Design of a safety program, risk analysis of a company's home office and field safety performance characteristics, potential problems, contingency planning, and safety audit analysis. Prerequisites: CON 270

CON 368 Advanced Environmental Technologies in Construction 3 hrs.
Survey of large scale integrated building component systems related to human health and comfort. Topics include lighting, electrical design and layout, vertical transportation, alarm and security systems, fire protection, total space conditioning, water treatment and sewage treatment, industrial piping design. Prerequisite: CON 262.

CON 372 Construction Methods Improvement 3 hrs.
Principles and methods for selection and installation of materials assemblies used in construction; industrialized and systems building; methods improvements. Prerequisite: CON 270.

CON 392 Construction Scheduling 3 hrs.
Economic considerations and tools of management: cost reporting; scheduling. Emphasis on network methods of scheduling: resource allocation and least-cost expediting. Computer aided. Prerequisite: junior standing in College of Engineering and Technology.

CON 394 Construction Labor and Unions 3 hrs.
Union and non-union activities in construction industry: analysis, organizing, bargaining, contract language, jurisdictional disputes, training, and restrictions on operating non-union. Prerequisite: junior standing.

CON 395 Construction Claims & Change Orders 3 hrs.
Record keeping and quantitative skill necessary for change orders and claims presentation or preparation. Prerequisite: junior standing in College of Engineering and Technology.

CON 396 Construction Estimating 3 hrs.
Material, equipment, and labor estimates of construction projects. Includes laboratory. Prerequisites: Junior standing in College of Engineering and Technology.

CON 409 Special Topics 1-4 hrs.
Supervised individual study of special construction topics. Prerequisite: consent of department chair.

CON 487 Steel and Concrete Structures 3 hrs.
Introduction to structural analysis and design of steel and reinforced concrete members; application to construction problems. Prerequisites: MTH 116 or 122; CE 301 or IMT 324.

CON 489 Alternate Materials Structures 3 hrs.
Introduction to structural analysis and design of timber and other structural materials such as masonry. Application to industry problems in bracing, formwork, and temporary excavation supports. Prerequisites: MTH 116 or 122; CE 301 or IMT 324.

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CON 492 Construction Contracts **2 hrs.**
Project manual concept; emphasis on Uniform System for Construction Specifications, general conditions of construction contracts, bidding requirements, and role of inspection in construction operations. Prerequisite: senior standing in College of Engineering and Technology.

CON 494 Advanced Construction Practices **3 hrs.**
Construction ethics; responsibilities and professionalism; advanced areas of business practices in construction. Prerequisites: CON 392, 492; or consent of instructor.

CON 498 Senior Project **3 hrs.**
Application of construction principles to industry projects. Prerequisites: senior standing in construction; consent of Department Chair.