CIVIL ENGINEERING

Department Website: Civil Engineering (https://www.gonzaga.edu/school-of-engineering-applied-science/degrees-and-programs/civil-engineering/)

Civil engineers are problem solvers who utilize sophisticated technologies to find safe and sustainable solutions to a wide variety of the challenges facing our world. A civil engineer plans, designs, and supervises construction of numerous infrastructure facilities required by modern society. These facilities exist in both the public and private sectors and vary in scope and size. Examples of civil engineering projects include bridges, roadways, buildings, transportation systems, irrigation water supply and treatment systems, wastewater collection and treatment systems, flood control and river restoration facilities, solid and hazardous waste management, and environmental restoration. Civil engineers have important roles in analysis, design, management, regulatory enforcement, and policy development. To participate effectively in this broad scope of activities, civil engineers acquire technical and problem-solving skills, and the ability to communicate clearly and effectively. Students completing the requirements for a degree in civil engineering have a choice of technical electives from six subdiscipline areas: Environmental Engineering, Geotechnical Engineering, Structural Engineering, Transportation Engineering, Water Resources Engineering, and Construction Engineering.

The department of Civil Engineering, in conjunction with its various constituencies, has clearly defined program objectives. These engineering program objectives are listed in the School of Engineering and Applied Science section of this catalog, and by the Gonzaga University Mission Statement that may be found at the beginning of the catalog.

The Bachelor of Science in Civil Engineering degree program is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org/), under the General Program Criteria and the Civil and Similarly Named Engineering Programs Program Criteria.

Civil Engineering (BS) Major Program Requirements

Course	Title	Hours
First Year		
Fall		
DEPT 193	FYS:	3
MATH 157	Calculus and Analytic Geometry I	4
CHEM 101	General Chemistry I	3
CHEM 101L	General Chemistry I Lab	1
PHIL 101	Reasoning	3
COMM 100	Communication and Speech	3
	Hours	**17**
Spring		
CENG 225	Geology	3
ENSC 205	Statics	3
MATH 258	Calculus and Analytic Geometry II	4
PHYS 121	Physics I	4
PHYS 121L	Physics I Lab	1
PHIL 201	Philosophy of Human Nature	3
	Hours	**18**
Second Year		
Fall		
CENG 261	Introduction to Geomatics	2
CENG 261L	Introduction to Geomatics Lab	1
MATH 259	Calculus and Analytic Geometry III	4
CENG 252	Civil Fluid Mechanics	3
ENGL 101	Writing	3
Religion Requirement: Christianity and Catholic Traditions		3
	Hours	**16**
Spring		
ENSC 301	Mechanics of Materials I	3
ENSC 306	Dynamics	3
MATH 260	Ordinary Differential Equation	3
MATH 321	Statistics for Experimentalist	3
Religion Requirement: World or Comparative Religion		3
	Hours	**15**
Third Year		
Fall		
CENG 301	Structural Analysis I	3
CENG 331	Soil Mechanics	3
CENG 331L	Soil Mechanics Lab	1
CENG 318	Transportation Engineering	3
Programming Elective		2-3
CENG 380	Construction Materials and Engineering	2
CENG 380L	Construction Materials and Engineering Lab	1
Ethics Corse Elective		3
	Hours	**18-19**
Spring		
CENG 303	Environmental Engineering	3
CENG 303L	Environmental Engineering Lab	1
CENG 391	Civil Engineering Design and Practice	3
CENG 352	Water Resources Engineering	3
CENG 352L	Water Resources Engineering Lab	1
CENG 412	Concrete Design	3
Programming Elective		3
	Hours	**17**
Fourth Year		
Fall		
CENG 404	Sustainable Systems and Design	3
ENSC 491	Senior Design Project I	2
Core Broadening Requirement- (two required: History, Literature, Soc & Behav Sci)		3
Technical Elective		3
Technical Elective		3
Technical Elective		3
	Hours	**17**
Spring		
ENSC 400	Foundations of Engineering Exam [1]	0
CORE 432	CIS:	3
ENSC 492	Senior Design Project II	3
Core Broadening Requirement		3
Technical Elective [2]		3
Technical Elective		3
	Hours	**15**
	Total Hours	**133-134**

1. The Fundamentals of Engineering Examination must be taken as part of the ENSC 400 Foundations of Engineering Exam course.
2. Civil engineering students enrolled in the Hogan Entrepreneurial Program can waive one technical elective.

Programming Electives

Courses from the following list satisfy the programming elective requirement. Others may be approved by department chair.

Code	Title	Hours
ENSC 244	Computer Methods for Engineers	3
CPSC 121	Computer Science I	3

Technical Electives

Courses from the following list satisfy the technical elective requirements. Students work with their faculty advisor to select five technical elective courses to create a specialized plan of study that can be highly specialized or with a broad focus among the civil engineering sub-disciplines: construction (C), environmental engineering (E), geotechnical engineering (G), structural engineering (S), Transportation (T), and water resources engineering (W).

Typically Offered in Fall

Code	Title	Hours
CENG 411	Steel Design (S)	3
CENG 417	Traffic Engineering (T)	3
CENG 424	Water Treatment Processes (E)	3
CENG 473	Foundation Design (G, S)	3

Typically Offered in Spring

Code	Title	Hours
CENG 415	Masonry and Timber Design (S)	3
CENG 418	Transportation System Design (T)	3
CENG 420	Structural Dynamics	3
CENG 422	Structural Systems Design (S)	3
CENG 444	Air Pollution (E)	3
CENG 450	Watershed Modeling (W, E)	3
CENG 480	Construction Management (C)	3
MENG 465	Introduction to Finite Element	3

Occasionally Offered

Code	Title	Hours
CENG 414	Waste Management (E)	3
CENG 421	Stormwater Management	3
CENG 454	Biological Treatment Processes (E)	3
CENG 464	Ground Behavior for Structures (G, S)	3
MENG 465	Introduction to Finite Element (G, S)	3
MENG 465	Introduction to Finite Element (G, S)	3

Typically Offered Even-Number Summers

Code	Title	Hours
CENG 440	GU-in-Delft:Sustainable Cities (3-week study abroad course in the Netherlands) (E, G, S, T, W)	4

Optional Concentration:
Construction Concentration

Course	Title	Hours
First Year		
Fall		
DEPT 193 Core: Engineering First-Year Seminar I		3
MATH 157	Calculus and Analytic Geometry I	4
CHEM 101	General Chemistry I	3
CHEM 101L	General Chemistry I Lab	1
PHIL 101	Reasoning	3
COMM 100	Communication and Speech	3
	Hours	**17**
Spring		
CENG 225	Geology	3
ENSC 205	Statics	3
MATH 258	Calculus and Analytic Geometry II	4
PHYS 121	Physics I	4
PHYS 121L	Physics I Lab	1
PHIL 201	Philosophy of Human Nature	3
	Hours	**18**
Second Year		
Fall		
CENG 261	Introduction to Geomatics	2
CENG 261L	Introduction to Geomatics Lab	1
MATH 259	Calculus and Analytic Geometry III	4
CENG 252	Civil Fluid Mechanics	3
ENGL 101	Writing	3
ECON 200	Economic Analysis	3
	Hours	**16**
Spring		
ENSC 301	Mechanics of Materials I	3
ENSC 306	Dynamics	3
MATH 260	Ordinary Differential Equation	3
MATH 321	Statistics for Experimentalist	3
Religion Requirement: Christianity and Catholic Traditions		3
PHIL 301	Ethics	3
	Hours	**18**
Third Year		
Fall		
CENG 301	Structural Analysis I	3
CENG 331	Soil Mechanics	3
CENG 331L	Soil Mechanics Lab	1
Religion Requirement: World or Comparative Religion		3
CENG 380 & 380L	Construction Materials and Engineering and Construction Materials and Engineering Lab	3
ACCT 263	Accounting Analysis	3
	Hours	**16**
Spring		
CENG 303	Environmental Engineering	3
CENG 303L	Environmental Engineering Lab	1
CENG 391	Civil Engineering Design and Practice	3
CENG 352	Water Resources Engineering	3
CENG 352L	Water Resources Engineering Lab	1
CENG 412	Concrete Design	3
	Hours	**14**
Fourth Year		
Fall		
CENG 318	Transportation Engineering	3
CENG 404	Sustainable Systems and Design	3
Select one of the following:		
CENG 411	Steel Design	
CENG 415	Masonry and Timber Design	
CENG 422	Structural Systems Design	
CENG 464	Ground Behavior for Structures	
CENG 473	Foundation Design	
ENSC 491	Senior Design Project I	2
Core Broadening Requirement: (two required Hist, Lit, Soc & Behav Sci)		3
BUSN 283	Business Law	3
	Hours	**14**

Spring		
ENSC 400	Foundations of Engineering Exam [1]	0
DEPT 432 CIS:		3
CENG 480	Construction Management	3
ENSC 492	Senior Design Project II	3
BFIN 320	Principles of Finance	3
Business Elective 1		3
Business Elective 2		3
	Hours	**18**
	Total Hours	**131**

[1] The Washington State Fundamentals of Engineering Examination must be taken as part of the ENSC 400 Foundations of Engineering Exam course.

Programming Electives

Courses from the following list satisfy the programming elective requirement. Others may be approved by department chair.

Code	Title	Hours
ENSC 244	Computer Methods for Engineers	3
CPSC 121	Computer Science I	3

Business for Engineering Technologies Minor

Not optional for those pursing a degree in Civil Engineering with a Construction Concentration.

Minor in Business for Engineering Technologies

Program Requirements

This minor is designed for engineering students (at present, students in the civil engineering and engineering management disciplines) at the undergraduate level. It recognizes the career skills employers are looking for in engineers pursuing engineering and construction management roles.

Code	Title	Hours
Required Courses		
ECON 200	Economic Analysis	3
MATH 321	Statistics for Experimentalist	3
ACCT 263	Accounting Analysis	3
BFIN 320	Principles of Finance	3
BUSN 283	Business Law	3
Electives		
Select two of the following:		6
MKTG 310	Principles of Marketing	
ECON 324	Economics of Environmental Protection	
OPER 340	Operations Management	
MGMT 350	Principles of Management	
ENSC 405	Engineering Project Management	
BENT 490	Creativity, Innovation, and Entrepreneurship	
Total Hours		**21**

Courses

CENG 193. First Year Seminar. (3 Credits)
The First-Year Seminar (FYS) introduces new Gonzaga students to the University, the Core Curriculum, and Gonzaga's Jesuit mission and heritage. While the seminars will be taught by faculty with expertise in particular disciplines, topics will be addressed in a way that illustrates approaches and methods of different academic disciplines. The seminar format of the course highlights the participatory character of university life, emphasizing that learning is an active, collegial process.

CENG 225. Geology. (3 Credits)
This course emphasizes physical geology and the Earth processes. The Earth's evolution, morphology, landforms, and its constituent minerals and rocks are featured. The goal of the course is to enable the student to appreciate the geological context of engineering and associated civil engineering projects, and the forces and phenomena which affect them. Enrollment is limited to students with a major in Civil Engineering.

CENG 252. Civil Fluid Mechanics. (3 Credits)
Covers fluid properties, hydrostatics, fluid dynamics, conversation of mass, momentum and energy for incompressible fluids, dimensional analysis, civil engineering applications including closed conduit/pipe flow. Stresses the control volume approach and Eulerian description of flow.
Prerequisites: ENSC 205 with a minimum grade of D

CENG 261. Introduction to Geomatics. (2 Credits)
Basic principles of surveying data collection, analysis, and application. Measurement of elevations, distances and angles using total stations and global positioning systems. Examples of analysis of errors in measurements; application of surveying data to engineering design using GIS and 3-D models. Fall. Prerequisite: MATH 157
Prerequisites: Prerequisites exist. Refer to Zagweb.
Corequisites: CENG 261L
Students with a semester level of First Year (0-25.99 credits) may **not** enroll.

CENG 261L. Introduction to Geomatics Lab. (1 Credit)
Hands on laboratory to complement the topics of CENG 261.
Corequisites: CENG 261

CENG 290. Independent Study. (0-6 Credits)
May be repeated for credit.
topics determined by instructor

CENG 301. Structural Analysis I. (3 Credits)
Theory and application of engineering mechanics to the solution of internal forces in statically determinate structures subjected to static and moving loads. Introduction of energy concepts for simple indeterminate structures. Fulfills the following degree requirement(s): MENG - Tech Elective
Prerequisites: ENSC 301 with a minimum grade of D

CENG 303. Environmental Engineering. (3 Credits)
An overview of the principles of environmental engineering. Topics include material balance, environmental chemistry, risk assessment, air quality, water quality, and water and wastewater treatment. Spring.
Prerequisites: CHEM 101 with a minimum grade of D or TRAN GCHM with a minimum grade of T
Corequisites: CENG 303L
Equivalent: ENVS 421
Enrollment is limited to students with a major in Civil Engineering.

CENG 303L. Environmental Engineering Lab. (1 Credit)
This course emphasizes fundamental environmental chemistry principles and analytical techniques used to study air and water quality and treatment process performance. The course also emphasizes statistical analysis, date interpretation, and reporting requirements associated with environmental engineering. CENG 303 is a co-requisite or pre-requisite for this course.
Corequisites: CENG 303
Equivalent: ENVS 421L
Enrollment is limited to students with a major in Civil Engineering.

CENG 318. Transportation Engineering. (3 Credits)
The course will cover general knowledge in all the transportation fields including; traffic characteristics and flow theory. transportation planning. geometric design of highways, traffic safety, highway materials, and pavement design. Fall.
Prerequisites: CENG 261 with a minimum grade of D

CENG 331. Soil Mechanics. (3 Credits)
In this course the properties and behavior of soils (sand, gravel, silt and clay) are studied under various environmental conditions. The study includes weight-volume relations, soil classifications, soil compaction, seepage through porous media, normal effective stress concept, consolidation, shear strength, lateral pressures and slope stability. Laboratory and Field methods for evaluating pertinent properties, generally used for analysis and foundation design. Three hours of lecture and three hours of laboratory per week. Fall.
Prerequisites: ENSC 301 with a minimum grade of D
Corequisites: CENG 331L

CENG 331L. Soil Mechanics Lab. (1 Credit)
Hands on laboratory to complement the topics of CENG 331.
Corequisites: CENG 331

CENG 352. Water Resources Engineering. (3 Credits)
Use of fluid mechanics in the engineering analysis and design of components of hydraulic and hydrologic systems. Hydraulics topics include closed conduit flow and water distribution systems; pump selection and cavitation; steady, uniform, and gradually varied flow of water in open channels; specific energy and transitions; and culvert designs. Hydrology topics include watershed delineation; design rainfall; rainfall abstractions; unit/runoff hydrographs; peak flows; and reservoir routing/detention pond design. The associated lab course stresses a variety of practical hydraulic and hydrologic applications both in the lab and in the field including measuring pipe friction; developing pump curves and observing cavitation; analyzing hydraulic jumps; measuring flow with weirs and sluice gates; delineating watersheds; measuring infiltration rates; measuring streamflow; and the development and implementation of a student derived investigation.
Prerequisites: CENG 252 with a minimum grade of D or ENSC 352 with a minimum grade of D
Corequisites: CENG 352L

CENG 352L. Water Resources Engineering Lab. (1 Credit)
Hands on laboratory to complement the topics of CENG 352.
Corequisites: CENG 352

CENG 380. Construction Materials and Engineering. (2 Credits)
This course and laboratory course examines the manifesting and testing of various construction materials (including steel, aluminum, concrete, masonry, glass, timber, asphalt, etc.). Several laboratory experiments and field trips to local manufacturing and testing facilities are scheduled throughout the semester.
Prerequisites: ENSC 301 with a minimum grade of D

CENG 380L. Construction Materials and Engineering Lab. (1 Credit)
Hands on laboratory to complement the topics of CENG 380.
Corequisites: CENG 380

CENG 391. Civil Engineering Design and Practice. (3 Credits)
An integration of topics essential to the practice of civil engineering, including: 1) engineering economics concepts; 2) project management approaches; 3) contract issues and project structures, and 4) general code of conduct of engineers and ethics. Engineering economy topics will include annual cost, present worth, future worth, and rate of return concepts. Students will develop an understanding of the elements of proposals, reports, construction drawings, and specifications. Engineering law, in the context of civil engineering project will be included to further illustrate the four main topics. Spring.
Enrollment limited to students with a semester level of Fourth Year (96+ credits) or Third Year (60-95.99 credits).

CENG 404. Sustainable Systems and Design. (3 Credits)
This course explores the characteristics of sustainable systems and how design practices may encourage sustainability. Topics covered in the course will be selected for applicability to specific regions of the world and may change each year. Basic concepts include: building thermal performance, indoor and outdoor environmental quality, passive and active energy systems, water reclamation strategies, life cycle analysis and current sustainable building rating systems. Sustainable design concepts and methods are also applied to building design site development and infrastructure use. Fall.
Equivalent: ENVS 422
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

CENG 411. Steel Design. (3 Credits)
Application of basic principles of mechanics applied to the design of steel members. Design of structural members and connections using the current American Institute of Steel Construction specifications. Load and Resistance Factor Design and Allowable Stress Design procedures.
Prerequisites: CENG 301 with a minimum grade of D

CENG 412. Concrete Design. (3 Credits)
Theory and application of analytical procedures applied to the design of reinforced concrete structural members. Proportioning of beams, columns, footings, and walls in concrete structures is approached using current American Concrete Institute code specifications. Ultimate Strength Design Procedures.
Prerequisites: CENG 301 with a minimum grade of D

CENG 414. Waste Management. (3 Credits)
An overview of solid, hazardous, and industrial waste management. Topics include regulations, contaminant transport, waste sources, waste minimization, recycling, treatment and remediation technologies, landfill design and risk assessment.
Prerequisites: CENG 303 with a minimum grade of D
Equivalent: ENVS 423

CENG 415. Masonry and Timber Design. (3 Credits)
Analysis and design of masonry and timber structures. Sizing of members in masonry and timber according to applicable building codes.
Prerequisites: CENG 301 with a minimum grade of D

CENG 417. Traffic Engineering. (3 Credits)
Fundamentals of traffic engineering including traffic flow, capacity analysis, traffic signs and signals, and traffic engineering studies.
Prerequisites: CENG 318 with a minimum grade of D

CENG 418. Transportation System Design. (3 Credits)
Application of national and local standards to transportation system design situations from a multimodal perspective. Course emphasizes geometric design of roadway facilities but also incorporates design considerations for pedestrians, bicycles, and transit.
Prerequisites: CENG 318 with a minimum grade of D

CENG 420. Structural Dynamics. (3 Credits)
The analysis and response of structures to dynamic loads. Emphasis is given to dynamic loads due to earthquakes. Basic principles of the seismic design of structures.
Prerequisites: ENSC 306 with a minimum grade of D

CENG 421. Stormwater Management. (3 Credits)
Basic principles in the application of hydrology, hydraulics, soil and water chemistry, environmental law, and public policy are presented to solve problems and design projects to manage urban stormwater runoff. Key topics covered include: hydrology of urban watersheds; floodplain management; storm drainage; stormwater detention/retention; water quality improvement; and the design of low impact development best management practices.
Prerequisites: CENG 303 with a minimum grade of D and CENG 352 with a minimum grade of D

CENG 422. Structural Systems Design. (3 Credits)
Develop building code loads for structures. Approximate analysis methods for statically indeterminate structures. Matrix methods of structural analysis for 2-D and 3-D structures. Introduction to non-linear behavior of structural members.
Prerequisites: ENSC 301 with a minimum grade of D

CENG 424. Water Treatment Processes. (3 Credits)
The theory and design of water treatment processes. Develops contaminant fate and transport theory in engineered and natural systems focusing on reactor hydraulics and reaction kinetics. Granular and membrane filtration, coagulation, disinfection, ion exchange, adsorption, and gas transfer processes are designed for water and wastewater treatment systems. Additional topics include water reuse and water treatment for low-income, remote communities.
Prerequisites: CENG 303 with a minimum grade of D
Equivalent: ENVS 424

CENG 426. Stream Restoration. (3 Credits)
Course presents fundamentals of stream restoration: Hydrologic, sediment transport, geomorphic, and ecological principles applicable to (1) assessment of stream channel condition, (2) developing approaches to stream management and restoration, and (3) evaluating project performance. Approach emphasizes the inter-related nature of hydrology, hydraulics, sediment transport, geomorphology, fisheries, and aquatic and riparian ecology. Provides students opportunities to literally get their feet wet while making various observations and measurements in field exercises to evaluate physical and ecological stream characteristics assess stream stability.
Prerequisites: CENG 352 with a minimum grade of D
Equivalent: ENVS 425

CENG 427. Infrastructure Design. (3 Credits)
Design and construction supervision of the infrastructure required for land development. Topics include roadway geometry, water supply pipelines, sewer pipelines, and storm water drainage. Students will prepare design drawings, project plans, project reports, project specifications, and construction cost estimates that address regulatory requirements.
Prerequisites: CENG 352 with a minimum grade of D and CENG 391 with a minimum grade of D

CENG 440. GU-in-Delft:Sustainable Cities. (4 Credits)
Covers the design of urban areas to promote sustainable development including the structural, transportation, energy, water, and food production systems. Use of comparative case studies to explore historical and regional differences in cities and their impacts on the environment and resource consumption.

CENG 444. Air Pollution. (3 Credits)
An introduction to the field of air pollution and its control. Topics include regulations, air pollution sources, health effects, meteorology, and the theory and design of control techniques.
Prerequisites: CENG 303 with a minimum grade of D

CENG 450. Watershed Modeling. (3 Credits)
Basic principles of hydrologic modeling are presented and practices. Key topics covered include watershed delineation, land use change impact on runoff, flooding impact, bridge/culvert hydraulics, and GIS data analysis. Students will gain an understanding and be able to apply the USACE software tools: HEC-HMS and HEC-RAS. Design projects will focus on applying these models to design stormwater management facilities and size bridges and culverts to minimize flooding impacts.
Prerequisites: CENG 352 with a minimum grade of D

CENG 454. Biological Treatment Processes. (3 Credits)
The theory and design of biological processes for water and wastewater treatment. Topics include basic microbiology, activated sludge, membrane bioreactors, bioremediation, as well as biological treatment systems for water reuse, small on-site treatment systems, and air pollution.
Prerequisites: CENG 303 with a minimum grade of D

CENG 464. Ground Behavior for Structures. (3 Credits)
This course is an advanced soil mechanics class, and presents ground considerations related to supporting civil engineering structures and facilities of various types. Treatment of in-place testing of the ground, obtaining the necessary information, and estimating soil behavior in the context of soil-structure interaction is included. Numerous applied examples of structural facilities are used throughout to further relate theory to practice.
Prerequisites: CENG 331 with a minimum grade of D

CENG 473. Foundation Design. (3 Credits)
General principles behind foundation design. Shallow and deep foundation design: spread footings and pile foundation. Retaining structures: sheet-pile walls, bulkheads and cofferdams.
Prerequisites: CENG 301 with a minimum grade of D and CENG 331 with a minimum grade of D

CENG 480. Construction Management. (3 Credits)
This course covers topics such as project management, scheduling, cost estimating, and other relevant topics to the construction industry. Various aspects of construction engineering and equipment productivity and operation are included.
Enrollment limited to students with a semester level of Fourth Year (96+ credits) or Third Year (60-95.99 credits).