

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

<http://www.pacific.edu/Academics/Schools-and-Colleges/School-of-Engineering-and-Computer-Science/Academics-/Majors/Civil-Engineering-.html>

Phone: (209) 932-2805

Location: John T. Chambers Technology Center

Programs Offered

Bachelor of Science in Civil Engineering

Program Educational Objectives

Within a few years of graduation, graduates of the Civil Engineering program are expected to:

- Plan, design, evaluate, construct, operate, maintain, analyze, advance, and manage civil engineering systems
- Pursue professional licensure and certifications
- Engage in life-long learning and pursue advanced level studies
- Develop professional skills and leadership skills
- Participate in the civil engineering profession and in the community

Students who complete the BS degree in Civil Engineering will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Bachelor of Science in Civil Engineering

Student must complete a minimum of 120 units of academic work and a minimum of 32 units of Cooperative Education in order to earn the bachelor of science degree in civil engineering.

I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

Note: 1) CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

Note: 1) No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

Note: 1) Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

Note: 1) Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

II. Major Requirements

Mathematics and Science (minimum 30 units)

MATH 051	Calculus I	4
MATH 053	Calculus II	4
Math Elective: Select one of the following:		4
MATH 055	Calculus III	
MATH 075	Introduction to Linear Algebra	
MATH 057	Applied Differential Equations I: ODEs	4
PHYS 053	Principles of Physics I	5
Select one of the following: *		4-5
CHEM 024	Fundamentals of Chem	
CHEM 025	General Chemistry	
CHEM 027	General Chemistry	
Math or Science Elective ***		3-4

Geological or Biological Science Elective ****	3-4
Engineering Science:	
IDEA 010 Interdisciplinary Design and Success **	2
ENGR 019 Computer Applications in Engineering	3
ENGR 020 Engineering Mechanics I (Statics)	3
ENGR 025 Professional Practice Seminar	1
ENGR 030 Engineering and Computing Ethics in Society	3
ENGR 045 Materials Engineering	3
ENGR 045L Materials Engineering Lab	1
ENGR 120 Engineering Mechanics II (Dynamics)	3
ENGR 121 Mechanics of Materials	3
Select one of the following:	2-4
ECPE 041 Circuits & 041L and Circuits Laboratory	
IDEA 020 Interdisciplinary Design and Innovation	
Minimum 2 unit 100-Level SOECS elective or ECPE 041/ECPE 041L or IDEA 020	
Professional Practice (minimum 32 units)	
ENGR 181 Professional Practice	1-16
ENGR 182 Professional Practice	1-16
ENGR 183 Professional Practice	1-16
Civil Engineering Core:	
CIVL 015 Civil Engineering Graphics	3
CIVL 060 Water Quality	4
CIVL 100 Structural Engineering	4
CIVL 130 Fluid Mechanics I	3
CIVL 130L Fluid Mechanics I Lab	1
CIVL 132 Environmental Engineering	4
CIVL 133 Water Resources Engineering	4
CIVL 140 Geotechnical Engineering	4
CIVL 180 Engineering Synthesis	4
EMGT 170 Project Decision Making	4
Select four of the following from a, b and c:	12
a. Civil Engineering Analysis Electives	
CIVL 022 Geomatics	
CIVL 134 Groundwater	
CIVL 145 Engineering Geology	
CIVL 160 Structural Analysis	
CIVL 163 Introduction to Earthquake Engineering	
CIVL 171 Water and Environmental Policy	
CIVL 173 Sustainable Engineering	
CIVL 191 Independent Study	
CIVL 193 Special Topics	
CIVL 197 Undergraduate Research	
EMGT 115 Building Information Modeling	
EMGT 174 Engineering Project Management	
b. Civil Engineering Design Electives:	
CIVL 136 Design of Water Quality Control Facilities	
CIVL 138 Solid Waste Systems Design and Management	
CIVL 141 Earth Structure Design	
CIVL 150 Transportation Engineering	
CIVL 151 Construction Engineering	
CIVL 164 Structural Timber Design	
CIVL 165 Structural Steel Design	

CIVL 166 Reinforced Concrete Design	
CIVL 193 Special Topics (c. Infrastructure Systems Electives:)	
c. Infrastructure Systems Electives:	
CIVL 022 Geomatics	
CIVL 150 Transportation Engineering	
CIVL 151 Construction Engineering	
CIVL 171 Water and Environmental Policy	
EMGT 115 Building Information Modeling	
EMGT 176 Systems Engineering Management	

* AP CHEM scores of 4 or 5, or IB CHEM Higher Level scores of 5, 6, or 7, will satisfy the elective

**Students who transfer in with 28 or more units are exempt from taking IDEA 010.

***Math or Science Elective can be one of the following: BIOL 035, BIOL 041, BIOL 051, BIOL 061, CHEM 027, CHEM 121, CHEM 123, CHEM 161, GESC 041, GESC 047, GESC 051, GESC 053, GESC 102, GESC 148, MATH 037, MATH 039, MATH 055, MATH 072, MATH 110, MATH 130, MATH 131, MATH 141, MATH 145, PHYS 055, or PHYS 057. *Note: The same course cannot be used to satisfy both the "Math Elective" and the "Math or Science Elective" requirement.*

***Geological or Biological Science Elective can be one of the following: BIOL 035, BIOL 041, BIOL 051, BIOL 061, GESC 041, GESC 047, GESC 051, GESC 053, GESC 102, or GESC 148

Note: A minimum of one structural design elective (3 units minimum) and one infrastructure systems elective (3 units minimum) must be taken.

Master of Science in Engineering Curriculum

All students who receive an MSE complete a set of core courses that cover the broader subjects of research and analysis. Students choose from one of four concentrations: Civil Engineering, Mechanical Engineering, Engineering Management, or Computer Engineering/Electrical Engineering. Students must complete a minimum of 30 units with a Pacific cumulative grade point average of 3.0 in order to earn the Master of Science in Engineering.

A. Thesis Option

1. Students must complete a minimum of 30 units.
2. All students must perform independent research that must culminate in the completion of a thesis based on the findings of the research. For successful completion of the thesis course, students must submit a research proposal, conduct the research, write the thesis, and successfully complete a final oral defense.
3. All students complete six units of ENGR 299, Thesis Research.
4. The Concentration Requirements specified must be satisfied.

B. Non-thesis Option

1. Students must complete a minimum of 30 units.
2. For the Non-thesis Option, students may choose to do a project or they may satisfy all the unit requirements through coursework.
 - a. For the *project* option, students complete up to 6 units of research under the supervision of an SOECS faculty member. Upon completion of the project, the student submits a comprehensive report.

- b. Students may elect to satisfy the entire degree through *coursework*.
- c. Both project and coursework options must satisfy the Concentration Requirements specified.

Master of Science in Engineering with a concentration in Civil Engineering

Within the Civil Engineering concentration, students can focus on the areas of environmental or structural engineering. Students must complete a minimum of 30 units with a Pacific cumulative grade point average of 3.0 in order to earn the Master of Science in Engineering degree.

Core Courses

ENGR 201	Techniques in Research	3
Select one of the following Math or Computational Science Elective:		
ENGR 219	Numerical Methods for Engineering	3
ENGR 250	Probability and Statistics for Engineering and Computer Science	
Breadth Elective (one from approved list for concentration)		
Select one of the following options:		6
A) Thesis Option		
ENGR 299	Thesis	
B) Project Option		
ENGR 291	Graduate Independent Study	
ENGR 297	Graduate Research	
C) Course Work Option (Non-Thesis)		
Courses Approved by Advisor as Coherent Plan, including at least one 200 level CIVL course		
Concentration Requirements		
Four 200 level CIVL courses Approved by Advisor as Coherent Plan		12
Additional Elective		3

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Note: 1) CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning

Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

Note: 1) No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

Note: 1) Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

Note: 1) Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

II. Major Requirements

Mathematics and Science (minimum 30 units)

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Math Elective: Select one of the following:		
MATH 055	Calculus III	
MATH 075	Introduction to Linear Algebra	
MATH 057	Applied Differential Equations I: ODEs	4
PHYS 053	Principles of Physics I	5
Select one of the following: *		
CHEM 024	Fundamentals of Chem	
CHEM 025	General Chemistry	
CHEM 027	General Chemistry	
Math or Science Elective ***		
Geological or Biological Science Elective ****		3-4

Engineering Science:

IDEA 010	Interdisciplinary Design and Success **	2
ENGR 019	Computer Applications in Engineering	3
ENGR 020	Engineering Mechanics I (Statics)	3
ENGR 025	Professional Practice Seminar	1
ENGR 030	Engineering and Computing Ethics in Society	3
ENGR 045	Materials Engineering	3
ENGR 045L	Materials Engineering Lab	1
ENGR 120	Engineering Mechanics II (Dynamics)	3
ENGR 121	Mechanics of Materials	3
Select one of the following: 2-4		

ECPE 041 & 041L	Circuits and Circuits Laboratory	
IDEA 020	Interdisciplinary Design and Innovation	
Minimum 2 unit 100-Level SOECS elective or ECPE 041/ECPE 041L or IDEA 020		

Professional Practice (minimum 32 units)

ENGR 181	Professional Practice	1-16
ENGR 182	Professional Practice	1-16
ENGR 183	Professional Practice	1-16

Civil Engineering Core:

CIVL 015	Civil Engineering Graphics	3
CIVL 060	Water Quality	4
CIVL 100	Structural Engineering	4
CIVL 130	Fluid Mechanics I	3
CIVL 130L	Fluid Mechanics I Lab	1
CIVL 132	Environmental Engineering	4
CIVL 133	Water Resources Engineering	4
CIVL 140	Geotechnical Engineering	4
CIVL 180	Engineering Synthesis	4
EMGT 170	Project Decision Making	4
Select four of the following from a, b and c:		12
a. Civil Engineering Analysis Electives		
CIVL 022	Geomatics	
CIVL 134	Groundwater	
CIVL 145	Engineering Geology	
CIVL 160	Structural Analysis	
CIVL 163	Introduction to Earthquake Engineering	
CIVL 171	Water and Environmental Policy	
CIVL 173	Sustainable Engineering	
CIVL 191	Independent Study	
CIVL 193	Special Topics	
CIVL 197	Undergraduate Research	
EMGT 115	Building Information Modeling	
EMGT 174	Engineering Project Management	
b. Civil Engineering Design Electives:		
CIVL 136	Design of Water Quality Control Facilities	
CIVL 138	Solid Waste Systems Design and Management	
CIVL 141	Earth Structure Design	
CIVL 150	Transportation Engineering	
CIVL 151	Construction Engineering	
CIVL 164	Structural Timber Design	
CIVL 165	Structural Steel Design	
CIVL 166	Reinforced Concrete Design	
CIVL 193	Special Topics (c. Infrastructure Systems Electives:)	
c. Infrastructure Systems Electives:		
CIVL 022	Geomatics	
CIVL 150	Transportation Engineering	
CIVL 151	Construction Engineering	
CIVL 171	Water and Environmental Policy	
EMGT 115	Building Information Modeling	
EMGT 176	Systems Engineering Management	

* AP CHEM scores of 4 or 5, or IB CHEM Higher Level scores of 5, 6, or 7, will satisfy the elective

** Students who transfer in with 28 or more units are exempt from taking IDEA 010.

*** Math or Science Elective can be one of the following: BIOL 035, BIOL 041, BIOL 051, BIOL 061, CHEM 027, CHEM 121, CHEM 123, CHEM 161, GESC 041, GESC 047, GESC 051, GESC 053, GESC 102, GESC 148, MATH 037, MATH 039, MATH 055, MATH 072, MATH 110, MATH 130, MATH 131, MATH 141, MATH 145, PHYS 055, or PHYS 057. *Note: The same course cannot be used to satisfy both the "Math Elective" and the "Math or Science Elective" requirement.*

*** Geological or Biological Science Elective can be one of the following: BIOL 035, BIOL 041, BIOL 051, BIOL 061, GESC 041, GESC 047, GESC 051, GESC 053, GESC 102, or GESC 148

Note: A minimum of one structural design elective (3 units minimum) and one infrastructure systems elective (3 units minimum) must be taken.

Civil Engineering Courses

CIVL 015. Civil Engineering Graphics. 3 Units.

Coverage of the principles and applications of graphics in engineering design. Pictorial and isometric sketching and orthographic projection and use of auxiliary views and sections are used. Drafting standards and conventions, dimensioning and tolerances. Layout and assembly drawings, detail drawings and production drawings using AutoCAD software. Laboratory work is included. Prerequisite: ENGR 010 or IDEA 010 with a "C-" or better (may be taken concurrently).

CIVL 022. Geomatics. 3 Units.

This course is an introduction to geomatics engineering which includes in depth coverage of plane surveying and an introduction to Global Navigation Satellite Systems (GNSS), geodetics and geospatial sciences. Fundamental surveying methods and equipment will be presented in both a lecture and a hands-on laboratory section. Topics include: error theory, leveling, traverse computations, topography, coordinate systems, construction surveying, geometric design, Global Navigation Satellite Systems (GNSS), photogrammetry and the presentation of other emerging and relevant technologies. Prerequisite: MATH 041 with a "C-" or better or a passing score on the University's trigonometry placement test.

CIVL 060. Water Quality. 4 Units.

Students examine chemical reactions and processes in aquatic systems with engineering applications. Topics include chemical equilibrium and kinetics associated with acid-base, dissolution-precipitation, complexation, and reduction-oxidation reactions in natural and engineered environments. Laboratory work is included. Prerequisites: AP Chem with score of 4 or 5, CHEM IB Higher Level (score of 5, 6, or 7), CHEM 024 or CHEM 025 or CHEM 027; and MATH 051 with a "C-" or better.

CIVL 100. Structural Engineering. 4 Units.

Students examine the theory and applications of structural analysis and design. Topics include determination of loads, analysis of beams, trusses and frames, influence lines and indeterminate structures. Laboratory is included. Prerequisites: Completion of all Fundamental Skills; CIVL 15 or MECH 15; ENGR 19; Prerequisite can be taken concurrently: ENGR 121 with a "C-" or better (Spring).

CIVL 130. Fluid Mechanics I. 3 Units.

Students study the physical properties of fluids, statics and dynamics of incompressible fluids that include hydrostatics, conservation of mass, energy and momentum principles, laminar and turbulent flow with emphasis on pipe flow. Prerequisite: Completion of all Fundamental Skills and ENGR 120 with a "C-" or better. Corequisite: CIVL 130L.

CIVL 130L. Fluid Mechanics I Lab. 1 Unit.

Experimental analysis of concepts are discussed in CIVL 130. Prerequisite: Completion of all Fundamental Skills and ENGR 120 with a "C-" or better. Corequisite: CIVL 130.

CIVL 132. Environmental Engineering. 4 Units.

Students are introduced to the physical, chemical, and biological processes associated with water quality in natural environments and engineering systems. Topics include operation and design of water and wastewater treatment facilities as well as the occurrence, behavior and control of indoor and regional air pollution. Laboratory is included. Prerequisites: Completion of all Fundamental Skills; CIVL 015 or MECH 015; CIVL 060 with a "C-" or better.

CIVL 133. Water Resources Engineering. 4 Units.

Hydraulic and hydrologic analysis and design including pipe flow, open channel flow, elements of the hydrologic cycle, analysis of rainfall-runoff data, design applications, and the application of computers in hydrologic and hydraulic design. Laboratory is included. Prerequisites: Completion of all Fundamental Skills; CIVL 015 or MECH 015; CIVL 130 with a "C-" or better.

CIVL 134. Groundwater. 4 Units.

Aquifer properties, groundwater hydraulics in confined and unconfined aquifers under steady and unsteady flow conditions. Well hydraulics under ideal and non-ideal conditions. Constituent transport and fate in groundwater. Prerequisites: Completion of all Fundamental Skills; CIVL 130; MATH 057 with a "C-" or better.

CIVL 136. Design of Water Quality Control Facilities. 4 Units.

This advanced course covers the physical, chemical, and biological processes that are involved in the design of water and wastewater treatment plant facilities as well as applicable design standards and regulations. Prerequisites: Completion of all Fundamental Skills, CIVL 130, CIVL 132 with a "C-" or better.

CIVL 138. Solid Waste Systems Design and Management. 3 Units.

This is an introductory course to solid waste systems, that analyzes of problems associated with storage, collection, transport, processing, and disposal of solid wastes. Students review of current and expected regulatory requirements and the planning and design of solid waste management components that include systems and processes for solid waste prevention, recycling/composting, incineration, and landfilling. Prerequisite: Completion of all Fundamental Skills and CIVL 132 with a "C-" or better.

CIVL 140. Geotechnical Engineering. 4 Units.

This course covers the fundamentals of geotechnical engineering including the characterization of soils and their behavior as an engineering material. Topics include classification of soils, compaction, permeability, and consolidation. Design applications include settlement predictions, strength characterization, soil exploration programs, and an overview of shallow and deep foundations. The course includes laboratory work. Prerequisites: Completion of all Fundamental Skills; CIVL 015 or MECH 015; ENGR 121 with a "C-" or better.

CIVL 141. Earth Structure Design. 4 Units.

Evaluation of drained and undrained field conditions and the relationship between temporary and permanent design conditions over time. In-situ tests, including SPT and CPT. Analysis of lateral stresses in soil masses. Design of slopes, cantilever retaining walls, sheet piles, anchored bulkheads, and mechanically-stabilized earth walls. Design includes analysis of effects of water and seismic conditions, including liquefaction. Prerequisite: CIVL 140.

CIVL 145. Engineering Geology. 4 Units.

This introductory course to is the study of geology in which geologic principles, data and techniques are applied to civil engineering problems. Also listed as GEOS 145. Prerequisites: Completion of all Fundamental Skills; GEOS 051 or GEOS 061 or CIVL 140 with a "C-" or better.

CIVL 150. Transportation Engineering. 4 Units.

Students study the considerations and procedures in the planning, design, and operation of various transportation systems with primary emphasis on highways. Prerequisites: Completion of all Fundamental Skills. Junior or Senior standing.

CIVL 151. Construction Engineering. 3 Units.

An introduction to construction engineering and construction management. Construction engineering topics include construction processes and construction econometrics. Construction management topics include estimating, planning, bidding, and scheduling. Prerequisites: Completion of all Fundamental Skills. Junior or Senior standing.

CIVL 160. Structural Analysis. 3 Units.

Students analyze the behavior of trusses and framed structures under gravity and lateral loads. Other topics include analysis of shear walls, the use of structural analysis software, and the buckling of frames. Prerequisites: Completion of all Fundamental Skills; CIVL 100 and MATH 057 with a "C-" or better.

CIVL 163. Introduction to Earthquake Engineering. 3 Units.

Determination of loads on structures due to earthquakes. Overview of seismology. Methods of estimating equivalent static lateral forces; response spectrum and time history analysis. Concepts of mass, damping and stiffness for typical structures. Design for inelastic behavior. Numerical solutions and code requirements. Prerequisites: Completion of all Fundamental Skills, ENGR 019, ENGR 121 with a "C-" or better.

CIVL 164. Structural Timber Design. 4 Units.

Students will study the design of timber structural members, specifically tension, compression, flexural, and beam-column elements and connections to satisfy design code requirements. Prerequisite, may be taken concurrently: CIVL 100.

CIVL 165. Structural Steel Design. 4 Units.

Students study the design of steel structural members, specifically tension, compression, flexural, and beam-column elements and connections to satisfy design code requirements. Prerequisite: Completion of all Fundamental Skills. Prerequisite may be taken concurrently: CIVL 100 with a "C-" or better.

CIVL 166. Reinforced Concrete Design. 4 Units.

Students study the design and proportioning of structural members, specifically beams, columns, one-way slabs, footings, and walls to satisfy design criteria for reinforced concrete systems. Prerequisite: Completion of all Fundamental Skills. Prerequisite may be taken concurrently: CIVL 100 with a "C-" or better.

CIVL 171. Water and Environmental Policy. 3 Units.

This course introduces students to Federal and State of California environmental regulations pertaining to air, water, hazardous wastes, and toxic substances. Topics include an overview of water rights and environmental impact assessment, relevant case studies, and examples of monitoring and enforcement issues. Prerequisite: Completion of all Fundamental Skills. Must have Junior or Senior standing.

CIVL 173. Sustainable Engineering. 3 Units.

This interdisciplinary course provides an introduction to principles and practice of sustainable engineering. Topics include the analysis of economic, social, and environmental factors, life cycle assessment, resource use and waste generation in engineering products and processes. The course also examines case studies, readings, and class discussion emphasizes analysis and development of sustainable solutions. Prerequisite: Completion of all Fundamental Skills. Junior or Senior standing.

CIVL 180. Engineering Synthesis. 4 Units.

This course is a culminating experience wherein a group of students synthesize their previous class work into one project. Both technical and non-technical concerns are addressed. One or more faculty members and/or professional engineers are involved depending upon the fields covered in the project. Prerequisites: Completion of all Fundamental Skills; EMGT 170 and 2 of the following: CIVL 100, CIVL 132, CIVL 133, CIVL 140 with a "C-" or better. Senior standing.

CIVL 191. Independent Study. 1-4 Units.

Students undertake special individual projects under the direction of one or more faculty members. Permission of department chairperson and faculty member involved.

CIVL 193. Special Topics. 4 Units.**CIVL 197. Undergraduate Research. 1-4 Units.**

This course is applied or basic research in civil engineering under faculty supervision. Permission of faculty supervisor and department chair. Student must be in good academic standing.

CIVL 231. Surface Water Quality Modeling. 3 Units.

Application of mass balance principles develop mathematical models that simulate the transport and fate of water quality constituents in rivers, estuaries, and lakes. Numerical methods that solve discrete systems of steady-state and transient equations using Excel and MATLAB are emphasized. Prerequisites: ENGR 019, CIVL 132, Graduate or blended students in the School of Engineering and Computer Science with a "C" or better or permission of instructor.

CIVL 233. Advanced Hydraulic Systems Analysis. 3 Units.

Analysis and modeling of steady and unsteady flows in pipe systems, pipe networks, gradually and rapidly varied flows and hydraulic structures in open channels. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and CIVL 130 with a "C" or better or permission of instructor.

CIVL 236. Physical and Chemical Treatment Processes. 3 Units.

Physical and chemical processes found in nature and used in engineered systems to treat water and air. Design of reactors and unit processes incorporate sedimentation, flocculation, precipitation, gas transfer, adsorption, filtration, and disinfection. Prerequisites: CIVL 132 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 237. Biological Treatment Processes. 3 Units.

Biological processes occurring naturally and developed in engineered treatment systems. Includes applicable fundamentals of microbiology, microbially-mediated chemical reactions, kinetics, design of suspended growth and fixed-film treatment systems, and nutrient removal. Prerequisites: CIVL 132 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 238. Industrial and Hazardous Waste Management. 3 Units.

Industrial and Hazardous Waste Management and Treatment is an advanced level course on technical aspects concerning the management of chemical and radioactive wastes. The course addresses regulation, management and characterization of industrial wastes, especially hazardous wastes. Emphasis is placed on site characterization, investigation of pathways and transformations, and engineered treatment processes for toxic and reactive industrial materials. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 259. Sensor Networks for Engineering Systems. 3 Units.

This course introduces sensor networks for infrastructure systems from sensor selection, system design, implementation, acquisition, and analysis. Examination of application across multiple engineering disciplines. Project based components with laboratory. Prerequisites: ECPE 131, ECPE 121; or ENGR 019, ENGR 121; or COMP 055, COMP 157 with a "C" or better; Graduate or blended students in the School of Engineering and Computer Science; or permission of instructor.

CIVL 263. Earthquake Engineering. 3 Units.

This course is an overview of seismology. Course content includes determination of loads on structures due to earthquakes, methods of estimating equivalent static lateral forces, response spectrum and time history analysis. Other topics include concepts of mass, damping and stiffness for typical structures, design for inelastic behavior. Numerical solutions and code requirements. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and CIVL 100 with a "C" or better or permission of instructor.

CIVL 265. Advanced Structural Engineering. 3 Units.

Students examine the design of steel structural members that include composite beams, plate girders and connections following the AISC specifications in addition to economy evaluation of building design, and design of frame structures and second order effects. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and CIVL 165 with a "C" or better or permission of instructor.

CIVL 266. Advanced Reinforced Concrete Design. 3 Units.

Students study the design and proportioning of structural systems to satisfy design criteria for reinforced concrete and pre-stress design in concrete. Topics include retaining walls, slabs, footing, and other structural members. Prerequisites: CIVL 166 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 267. Design of Timber Structures. 3 Units.

Students study the design and analysis of timber structures due to gravity, lateral and combined loadings. Both member and connection details are considered. The design procedures, material properties and allowable stress computations are based on UBC, and NDS and other governing standards. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science, CIVL 100, MECH 120 with a "C" or better or permission of instructor.

CIVL 275. Microbiology of Engineered Systems. 3 Units.

An introduction to the concepts of environmental microbiology for upper division undergraduates and graduate students in engineering or environmental sciences who may not possess a strong background in the biological sciences. This course will emphasize the fundamental of microbiology and microbial ecology is described in the context of environmental engineering applications. Concepts relating to energy generation, metabolism and kinetics are emphasized. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

CIVL 278. Ecological Engineering. 3 Units.

This course is a graduate-level introduction to the field of ecological engineering. Topics include the fundamental concepts of ecology and the application of ecological concepts to engineered systems. The course focuses on understanding large-scale biogeochemical cycles, investigating how these cycles have been disrupted in engineering systems, and evaluating tools and alternatives for restoring biogeochemical cycles within engineering systems. The students evaluate and apply the concepts developed in class to the resolution of ecological engineering challenges in example engineered landscapes. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science.

CIVL 291. Graduate Independent Study. 1-4 Units.

Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 293. Special Topics. 1-4 Units.

Special courses are organized and offered from time to time to meet the needs or interests of a group of students. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

CIVL 297. Graduate Research. 1-4 Units.

Applied or basic research in engineering or computer science under faculty supervision. Approval by the faculty supervisor and the department chairperson is required. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 299. Thesis. 1-6 Units.

Minimum of six units are required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of the research advisor.