Civil Engineering

Civil engineers apply sophisticated analysis and design techniques to advance the needs of society for shelter, infrastructure, and a safe environment. Graduates are employed in the fields of structural analysis and design, soil mechanics and foundation design, environmental engineering and policy, materials engineering, and coastal and ocean engineering, and increasingly are taking on far-reaching management roles in infrastructure, hazard mitigation, sustainability, and technical roles in the planning, design, and construction of large-scale engineered systems. In addition, a civil engineering degree provides exposure to broad societal challenges and the logical thinking necessary for pursuing careers in other professional fields, such as law, business, and medicine.

The Department of Civil Engineering offers programs at the undergraduate, graduate, and postdoctoral levels. Civil Engineering at Hopkins offers a unique balance centered in mechanics fundamentals, and enriched by state-of-the-art tools in modeling, simulation, and physical experimentation. The small size of the CE Department fosters a collegial, close-knit relationship between the students, staff, and faculty, while our partnerships with other Johns Hopkins departments provide a wide range of collaborative opportunities that span the larger disciplines of fluids, systems, structures, and materials. A wide range of research opportunities distinguishes the program. Students have participated in projects on structural reliability, earthquake resistance of structures, testing and analysis of historic bridges, computational design of materials, failure of brittle materials, cold-formed steel members and their connections, and coastal and ocean engineering to name a few. A five-year bachelor's/master's degree program is also offered. Graduates of Johns Hopkins University have traditionally risen to leadership roles in education, research, industry, and government.

Facilities

The Department's teaching and research labs are located in Latrobe Hall and the Stieff Building. Teaching laboratories, all located in Latrobe Hall, include a modern multi-use facility for exploring experiments in statics, mechanics of materials, dynamics and other courses, a dedicated soil mechanics laboratory, and a dedicated computing facility. Research laboratories include the Smart Structures and Hybrid Testing Laboratory, the Thin-walled Structures Laboratory, and the Sensor Technology and Infrastructure Risk Mitigation (STIRM) Laboratory in Latrobe Hall, and the Coastal Engineering Laboratory in the Stieff Building. The department also provides space for undergraduate research, the student chapter of the American Society of Civil Engineers, a graduate student lounge, and office space for doctoral students.

The department sponsors an undergraduate and graduate seminar series, as well as the Richard J. Carroll endowed lectureship; all of which are designed to bring prominent civil engineers to campus to speak with students and faculty.

Financial Aid

Scholarships and other forms of financial assistance for undergraduates are described under Admissions and Finances (http://e-catalog.jhu.edu/archive/2013-14/undergrad-students/admissions-and-finances). In addition, some undergraduate students are employed by departmental faculty to provide assistance on research projects.

Financial assistance to graduate students is available on a competitive basis in the form of partial or complete tuition fellowships, fellowships with stipends, teaching assistantships, and research assistantships. In addition to university-wide fellowships, graduate students in civil engineering are also eligible for fellowships from the Joseph Meyerhoff Scholarship Fund, the Richard D. Hickman Endowment, and the Hoomes Rich Graduate Fellowship.

The mission of the undergraduate program is to educate intellectual leaders of the profession by instilling in them a fundamental understanding of the mathematical principles of physics and nature that underlie engineering science, a practical appreciation of the challenges of creative engineering design, and a sense of responsibility for professional service. The undergraduate program has been designed to provide a firm foundation in a wide breadth of modern civil engineering so that within a few years our graduates attain:

1. a. an advanced degree in engineering or
   b. required experience toward professional licensure as an engineer, or
   c. an advanced degree in a field other than engineering, or
   d. a position within an organization that broadly supports the goals of civil engineering; and

2. a position or degree that values adaptability and innovation in their work.

Building on the strengths of the faculty and supporting our vision for the field of civil engineering, the department emphasizes four technical areas: environmental engineering, geotechnical engineering, structural engineering, and systems engineering. Some flexibility is built into the curriculum so that students may pursue advanced topics in one or more of these areas. Upon completion of the B.S. in civil engineering, students will demonstrate:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multidisciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in lifelong learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The program has been accredited by ABET, the Accreditation Board for Engineering and Technology, since 1936.
### Requirements for the B.S. Degree

The B.S. degree in civil engineering requires 128 credits. A brief summary of the requirements, given below, is intended only as a guide; these requirements were in effect for students matriculating during the 2012–2013 Academic Year. Students matriculating afterwards or looking for more detailed information should look at the department website at [http://eng.jhu.edu/wse/civil/page/current_ugrad](http://eng.jhu.edu/wse/civil/page/current_ugrad). Each student is assigned an advisor who will provide guidance to ensure all requirements are met.

No course listed as a requirement may be taken satisfactory/unsatisfactory. Any other course used to fulfill a requirement under humanities and social sciences or under unspecified electives can be taken S/U. Technical electives may be taken satisfactory/unsatisfactory only with the approval of the advisor. No more than two grades of D in the required engineering and technical electives may be counted.

#### Basic Science (20 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>EN.530.103</td>
<td>Introduction to Mechanics I</td>
<td>4</td>
</tr>
<tr>
<td>or AS.171.101</td>
<td>General Physics: Physical Science Major I</td>
<td></td>
</tr>
<tr>
<td>EN.530.104</td>
<td>Introduction to Mechanics II</td>
<td></td>
</tr>
<tr>
<td>or AS.171.102</td>
<td>General Physics: Physical Science Majors II</td>
<td></td>
</tr>
<tr>
<td>AS.173.111</td>
<td>General Physics Laboratory I</td>
<td>2</td>
</tr>
<tr>
<td>or AS.173.112</td>
<td>General Physics Laboratory II</td>
<td></td>
</tr>
<tr>
<td>AS.030.101</td>
<td>Introductory Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>AS.030.105</td>
<td>Introductory Chemistry Lab I</td>
<td>1</td>
</tr>
<tr>
<td>EN.510.201</td>
<td>Introductory Materials Science for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>One additional (N) elective</td>
<td>4</td>
<td></td>
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</tbody>
</table>

#### Mathematics (16 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>AS.110.108</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>AS.110.109</td>
<td>Calculus II (For Physical Sciences and Engineering)</td>
<td></td>
</tr>
<tr>
<td>AS.110.202</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>or EN.550.251</td>
<td>Math Models/Decision Mkg</td>
<td></td>
</tr>
<tr>
<td>&amp; EN.550.252</td>
<td>and Math Models-Decision Making: Stochastic Models</td>
<td></td>
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#### Humanities and Social Sciences (18 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.550.291</td>
<td>Lin Alg &amp; Diff Equations</td>
<td>4</td>
</tr>
</tbody>
</table>

Students are encouraged to create a program of study that is supplemented by meaningful classes outside of engineering.

#### Unspecified Electives

Select 7 credits of unspecified electives

#### Civil Engineering Fundamentals (21 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.560.141</td>
<td>Perspectives on the Evolution of Structures</td>
<td>3</td>
</tr>
<tr>
<td>EN.560.201</td>
<td>Statics &amp; Mechanics of Materials</td>
<td>4</td>
</tr>
<tr>
<td>EN.560.202</td>
<td>Dynamics</td>
<td>4</td>
</tr>
<tr>
<td>EN.560.206</td>
<td>Solid Mechanics &amp; Theory of Structures</td>
<td>4</td>
</tr>
<tr>
<td>EN.560.220</td>
<td>Civil Engineering Analysis</td>
<td>3</td>
</tr>
<tr>
<td>EN.560.351</td>
<td>Introduction to Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>or EN.570.351</td>
<td>Introduction to Fluid Mechanics</td>
<td></td>
</tr>
</tbody>
</table>

#### Professional Practice (12 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.660.105</td>
<td>Introduction to Business (or EN.660.300+ CLE Management/Leadership Track)</td>
<td>4</td>
</tr>
</tbody>
</table>

#### Technical Electives (9 credits)

Students may explore one or more of the civil technical areas (environmental engineering, geotechnical engineering, structural engineering, and systems engineering) in greater depth through technical electives.

#### Technical Areas (25 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN.570.301</td>
<td>Environmental Engineering Fundamentals I</td>
<td>3</td>
</tr>
<tr>
<td>EN.570.302</td>
<td>Water &amp; Wastewater Treatment</td>
<td>3</td>
</tr>
<tr>
<td>EN.560.305</td>
<td>Soil Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>EN.560.320</td>
<td>Structural Design I</td>
<td>3</td>
</tr>
<tr>
<td>EN.560.325</td>
<td>Structural Design II</td>
<td>3</td>
</tr>
<tr>
<td>EN.560.330</td>
<td>Foundation Design</td>
<td>3</td>
</tr>
<tr>
<td>EN.560.348</td>
<td>Probability &amp; Statistics in Civil Engineering</td>
<td>3</td>
</tr>
<tr>
<td>EN.560.498</td>
<td>Survey of Systems Engineering Tools</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Total Credits

129

* (AS.270.205 Introduction to Geographic Information Systems and Geospatial Analysis, AS.270.220 The Dynamic Earth: An Introduction to Geology, AS.030.102 Introductory Chemistry II are encouraged)

** Classes in the Humanities and Social and Behavioral Sciences provide students with an appreciation for societal concerns and humanistic issues, tools that are essential for a professional who serves the public good. Requirements are as follows: Students must take a minimum of 6 credits in Humanities electives and 6 credits in Social and Behavioral Studies electives. An additional 6 credits can be taken in either area. A minimum of one Humanities and one Social and Behavioral Sciences elective must be at or above the 300-level. One writing intensive requirement must be fulfilled by the Humanities/Social and Behavioral Sciences electives. This can either be done through AS.060.113 Expository Writing or a 300-level, writing intensive, Humanities, or Social and Behavioral Sciences elective. Given the increasingly global nature of the civil engineering field, students are required to take one Humanities or Social and Behavioral Sciences course from the KSAS International Studies major (see [http://www.krieger.jhu.edu/internationalstudies/courses](http://www.krieger.jhu.edu/internationalstudies/courses)).

*** All technical electives must be at or above the 300-level, at least 6 credits must be designated as (E) and at least 3 credits must be directly aligned with one of the civil technical areas. For a list of preapproved technical electives, see [http://eng.jhu.edu/wse/civil/page/current_ugrad](http://eng.jhu.edu/wse/civil/page/current_ugrad).

### Sample B.S. Program

A sample civil engineering program may be viewed at [http://eng.jhu.edu/wse/civil/page/current_undergraduate_advising](http://eng.jhu.edu/wse/civil/page/current_undergraduate_advising). This sample illustrates the general sequence of courses; individual programs may vary as a result of AP credits, study abroad, or pursuit of a minor in another department.
Minor in Principles of Civil Engineering

This program is available to nondepartmental majors only who would like an overview of the principles of civil engineering. In addition to the prerequisite courses of AS.171.101 General Physics: Physical Science Major I for Physical Science Majors, AS.110.108 Calculus I, and AS.110.109 Calculus II (For Physical Sciences and Engineering), 18 credits are required for the minor, including 12 credits from fundamental civil engineering courses and 6 credits from a two-course sequence in one of three civil technical areas (geotechnical engineering, structural engineering, or systems engineering). No D grades can be counted toward the minor.

EN.560.141 Perspectives on the Evolution of Structures 3  
EN.560.201 Statics & Mechanics of Materials 4  
EN.560.206 Solid Mechanics & Theory of Structures 4  
EN.560.491 Civil Engr Seminar I  
EN.560.492 Civil Engineering Seminar II  
Choose one of the following: 6  
EN.560.305 Soil Mechanics  
& EN.560.330 and Foundation Design (two-course sequence in Geotechnical Engineering)  
EN.560.348 Probability & Statistics in Civil Engineering  
& EN.560.498 and Survey of Systems Engineering Tools (two-course sequence in Systems Engineering)  

Total Credits 17

Combined Bachelor’s/Master’s Concurrent Programs

The Department of Civil Engineering offers combined bachelor’s/master’s degrees. One program combines a B.S. in Civil Engineering with a Master of Science in Engineering (M.S.E.) in Civil Engineering. The other option combines a B.S. in Civil Engineering with a Master of Science in Engineering Management (M.S.E.M.). Formal application through the Department is required. Students may be admitted as early as the junior year. For students who are admitted to this program, the two degrees typically require five years total to complete. For these students, there is an automatic tuition waiver of 50 percent after the first eight semesters of undergraduate work. More information about these programs can be found at www.ce.jhu.edu/current-undergraduate-concurrent/.

Civil engineering today is a dynamic, complex, and technologically sophisticated field. Powerful computational methods and high-strength materials offer new opportunities and new challenges. The Department of Civil Engineering offers a graduate program that is based primarily in mechanics of materials, systems, and structures. Fundamental to these areas is research in solid, structural, and stochastic mechanics. The graduate program is designed to instill in the student the fundamental theoretical concepts of mechanics as well as practical knowledge of modern materials, systems, and structural engineering. To be admitted to the program, students are expected to have graduated with an outstanding record in an appropriate undergraduate program.

Requirements for the M.S.E. Degree

After admission to the M.S.E. program, students must satisfactorily complete one of two requirements: 10 Courses (course-only option), or 8 Courses and a final M.S.E. Essay and Defense to obtain the M.S.E. degree. All courses must be 300-level or above, with a maximum of two (2) courses at the 300-level. With approval from the academic advisor, one of the courses counting toward the M.S.E. degree requirement may be a course at the 300-level or above from the Center for Leadership Education. Academic advisors, in consultation with the faculty in the Civil Engineering Department, will determine whether the 8 or 10 courses leading to this degree are appropriate and if they have been completed satisfactorily. No more than one course with a grade lower than a B− may be counted toward the course requirement. Typically the M.S.E. degree requires one to two years to complete if the student is making steady progress. In some cases, the degree may take longer.

The M.S.E. Essay must be approved by the student’s faculty advisor and one reader, who will typically be a full-time Johns Hopkins Civil Engineering faculty member. Any external reader must be approved by the Chair of the Civil Engineering Department.

Requirements for the Ph.D. Degree

The Ph.D. in Civil Engineering degree requires a minimum approved program of 10 technical courses beyond the bachelor’s degree, eight of which must be at the 600- or 700-level. All doctoral candidates are expected to demonstrate a high level of oral and written proficiency in English. International students are encouraged to participate in ESL testing recommended courses through the Language Teaching Center. Candidates must pass a department qualifying examination of their general scientific preparation, submit for approval a detailed preliminary proposal for the dissertation, and pass a Graduate Board oral examination. The Ph.D. degree is awarded following a successful defense of the doctoral dissertation. Appropriate graduate courses taken at another institution may be used toward the Ph.D. degree; exact credits are worked out on a case-by-case basis. A master’s degree in civil engineering is generally considered sufficient evidence for a maximum of four courses. Students transferring courses from a prior master’s degree are required to fulfill the remainder of the course requirement (typically six courses) with only courses at the 600- or 700-level.

For current faculty and contact information go to http://eng.jhu.edu/wse/civil/page/ce_faculty

Faculty

Chair

Benjamin Schafer
Professor, Swirnow Family Faculty Scholar: structural stability, computational mechanics, experimental methods, thin-walled structures.

Professors

Annalingam Anandarajah
Professor (Retired): geomechanics, constitutive modeling, finite element modeling, geotechnical engineering.

William P. Ball
Joint, Part-Time, and Visiting Appointments: Professor (DOGEE): environmental engineering.

Edward J. Bouwer
Joint, Part-Time, and Visiting Appointments: Joint, Part-Time, and Visiting Appointments
Robert A. Dalrymple  
Professor and Willard and Lillian Hackerman Chair in Civil Engineering:  
coastal engineering, water wave mechanics, fluid mechanics.

J. Hugh Ellis  
Joint, Part-Time, and Visiting Appointments: Professor (DOGEE):  
structural health engineering, environmental systems.

Somnath Ghosh  
Professor and Michael G. Callas Chair in Civil Engineering: multiscale  
mechanics, finite elements, material fatigue modeling.

Lori Graham-Brady  
Professor: probabilistic mechanics, finite elements, stochastic modeling  
of materials.

Takeru Igusa  
Professor: structural dynamics, earthquake engineering, analysis of  
uncertainties.

Nicholas P. Jones  
Professor in Civil Engineering and Dean of the Whiting School of  
Engineering: structural dynamics, flow-induced vibration, wind  
engineering.

Benjamin Schafer  
Professor, Swirnow Family Faculty Scholar and Department Chair:  
structural stability, computational mechanics, experimental methods,  
thin-walled structures.

Alan T. Stone  
Joint, Part-Time, and Visiting Appointments: Professor (DOGEE):  
environmental and aquatic chemistry.

Peter R. Wilcock  
Joint, Part-Time, and Visiting Appointments: Professor (DOGEE):  
sediment transport, slope stability.

Associate Professors

James K. Guest  
Associate Professor: topology optimization, structural and material  
design optimization, computational mechanics.

Seth Guikema  
Joint, Part-Time, and Visiting Appointments: Assistant Professor  
(DOGEE): probabilistic risk analysis, environmental life-cycle  
assessment.

Judith Mitrani-Reiser  
Assistant Professor: performance-based engineering, structural  
dynamics, earthquake engineering, multi-hazard loss estimation.

Narutoshi Nakata  
Assistant Professor: structural dynamics, experimental methods, smart  
structures technology, earthquake engineering.

Sauleh Siddiqui  
Assistant Professor: optimization, equilibrium problems, systems in  
energy and environmental markets, transportation, and public health.

Assistant Research Professor

Lian Shen  
Assistant Research Professor: fluid mechanics, ocean-wind interaction,  
umerical modeling.

Adjunct Professors

Xin Chen  
Adjunct Professor: geotechnical engineering, infrastructure asset  
management.

Lucas de Melo  
Adjunct Professor: geotechnical engineering.

Lecturers

John A. Matteo  
Joint, Part-Time, and Visiting Appointments: Lecturer, Director of Design:  
structural engineering and architecture, historic structures.

Rachel H. Sangree  
Lecturer: structural engineering, historic structures.

For current course information and registration go to https://isis.jhu.edu/ 
classes/

Courses

EN.560.101. Freshman Experiences in Civil Engineering. 1  
Credit.  
An introduction to civil engineering for first-year students. This course  
welcomes freshmen to the major by exploring civil engineering design  
and the range of design projects in which professional civil engineers  
engage. Students will have the opportunity to practice the design  
process using hands-on team-based projects, with emphasis on creative  
design, graphical communication, and teamwork.  
Instructor(s): R. Sangree  
Area: Engineering.

EN.560.141. Perspectives on the Evolution of Structures. 3  
Credits.  
Why do buildings and bridges look the way they do today? Students  
will be provided the tools to answer this question for themselves  
through a study of the history of the design of buildings and bridges  
throughout the world from both engineering and architectural/aesthetic  
perspectives. Only simple mathematics is required (no calculus).  
Students will participate in individual and group critique of structures  
from engineering, architectural, and social points of view.  
Instructor(s): B. Schafer  
Area: Engineering, Quantitative and Mathematical Sciences  
Writing Intensive.

EN.560.201. Statics & Mechanics of Materials. 4 Credits.  
Basic principles of classical mechanics applied to the equilibrium  
of particles and rigid bodies at rest, under the influence of various force  
systems. In addition, the following topics are studied: free body concept,  
analysis of simple structures, friction, centroids and centers of gravity,  
and moments of inertia. Includes laboratory experience. Co-listed  
with EN.530.201. Recommended Course Background: AS.171.101, or  
EN.530.103/EN.530.104 or instructor permission.  
Instructor(s): T. Igusa  
Area: Engineering.
EN.560.202. Dynamics. 4 Credits.
Basic principles of classical mechanics applied to the motion of particles, system of particles and rigid bodies. Kinematics: analytical description of motion; rectilinear and curvilinear motions of particles; rigid body motion. Kinetics: force, mass, and acceleration; energy and momentum principles. Introduction to vibration. Includes laboratory experience.
Prerequisites: (EN.560.201 OR EN.530.201) AND AS.110.109 AND (AS.171.101 or (EN.530.103 AND EN.530.104))
Instructor(s): N. Nakata
Area: Engineering.

EN.560.206. Solid Mechanics & Theory of Structures. 4 Credits.
Application of the principles of structural analysis for statically determinant and indeterminant structures (trusses, cables, beams, arches, and frames). Calculation of internal forces and stresses in members and structures. Determination of deflections by equilibrium and energy methods. Analysis of indeterminate structures by flexibility and stiffness methods.
Prerequisites: EN.560.201 OR EN.530.201
Instructor(s): L. Graham-Brady
Area: Engineering.

EN.560.220. Civil Engineering Analysis. 3 Credits.
Civil engineering problems are formulated and then solved by numerical methods. Matrix inversion, data fitting and interpolation, root-finding, and solutions of ordinary and partial differential equations are presented. Matlab programming will be introduced to facilitate the solutions. Recommended Course Background: AS.110.106, AS.110.107/AS.110.109
Instructor(s): J. Mitrani-Reiser
Area: Engineering.

EN.560.305. Soil Mechanics. 4 Credits.
Prerequisites: EN.560.351 OR EN.570.351
Corequisites: Corequisite: EN.570.351 or EN.560.351
Instructor(s): L. De Melo
Area: Engineering.

EN.560.320. Structural Design I. 3 Credits.
Introduction to structural design using common building materials (structural steel, reinforced concrete, and wood). Emphasis will be placed on the application of solid mechanics principles to the design of structural components (beams, columns, and tension members).
Instructor(s): R. Sangree
Area: Engineering.

EN.560.325. Structural Design II. 3 Credits.
A continuation of Structural Design I, this course explores the behavior and conceptual design of structures. Emphasis is placed on identifying load paths through typical gravity and lateral load systems, modeling loads on real structures, and designing structural systems. Designing connections capable of transferring loads through a structural system will also be covered. Recommended Course Background: EN.560.320
Prerequisites: EN.560.206
Instructor(s): R. Sangree
Area: Engineering.

EN.560.330. Foundation Design. 3 Credits.
Application of soil mechanics theory and soil test results to the analysis and design of foundations for structures; retaining walls; embankments; design of pile and shallow footing foundations; slope stability.
Instructor(s): L. De Melo
Area: Engineering.

EN.560.348. Probability & Statistics in Civil Engineering. 3 Credits.
Development and applications of the analysis of uncertainty, including basic probability, statistics and decision theory, in civil engineering systems. Recommended Course Background: AS.110.109
Instructor(s): S. Siddiqui
Area: Engineering.

EN.560.351. Introduction to Fluid Mechanics. 3 Credits.
Introduction to the use of the principles of continuity, momentum, and energy to fluid motion. Topics include hydrostatics, ideal-fluid flow, laminar flow, turbulent flow, form and surface resistance with application to fluid measurement, flow in conduits, and channels, pumps, or turbines. Co-listed with EN.570.351.
Instructor(s): W. Marr
Area: Engineering.

EN.560.380. Introduction to Ocean Wind Engineering. 3 Credits.
Fundamentals of hydrodynamics, aerodynamics and flow-structure interactions with applications in coastal/ocean engineering and wind engineering. Topics include wind and current past blunt bodies, flow-induced structure vibrations, ocean waves and wave/flood loads, wind field and wind loads, sustainable energy from wind and wave and model testing.
Instructor(s): W. Marr
Area: Engineering.

EN.560.429. Preservation Engineering: Theory and Practice. 3 Credits.
The renovation of existing buildings often holds many advantages over new construction, including greater economy, improved sustainability, and the maintenance of engineering heritage and architectural character in our built environment. Yet, the renovation of existing structures presents many challenges to structural engineers. These challenges include structural materials that are no longer in widespread use (e.g., unreinforced masonry arches and vaults, cast iron, and wrought iron) as well as structural materials for which analysis and design practices have changed significantly over the last half-century (e.g., wood, steel, and reinforced concrete). This course will examine structures made of a wide variety of materials and instruct the student how to evaluate their condition, determine their existing capacity, and design repairs and/or reinforcement. The investigation and analysis procedures learned from this course may then be applied to create economical and durable structural alterations that allow for the reuse of older buildings. Site visits near Homewood campus will supplement lectures.
Prerequisites: (EN.560.201 OR EN.530.201) AND EN.560.206 AND EN.560.320 or equivalent for graduate students.
Instructor(s): J. Matteo; R. Sangree
Area: Engineering.
EN.560.440. Applied Finite Element Methods. 3 Credits.
Finite Element Methods (FEM) are one of the most powerful engineering tools that are widely used in various disciplines. This course introduces concepts, capabilities, and limitations of FEM and is intended to facilitate applications of FEM in student’s research. The course covers fundamental theories with a focus on stiffness formulation techniques, element types, and computational procedures. The course also offers finite element programming with MATLAB.
Instructor(s): N. Nakata
Area: Engineering.

EN.560.442. Equilibrium Models in Systems Engineering. 3 Credits.
Provide an introduction to equilibrium problems involving systems. The course will start with an introduction to optimization theory followed by various equilibrium problems including market, spatial, and network models. Solution techniques to these types of problems will be discussed, along with applications to systems engineering.
Recommended Course Background: AS.110.201 and AS.110.109 or equivalent.
Area: Engineering.

EN.560.445. Advanced Structural Analysis. 3 Credits.
Matrix methods for the analysis of statistically indeterminate structures such as beams, plane and space trusses, and plane and space frames. Stiffness and flexibility methods. Linear elastic analysis and introduction to nonlinear analysis.
Prerequisites: EN.560.206

Instructor(s): J. Guest
Area: Engineering.

EN.560.451. Civil Engineering Design I. 2 Credits.
A study of the engineering design process from problem definition to the final design. There are team projects which include written and oral presentations. Senior only or Permission Required
Instructor(s): J. Matteo
Area: Engineering.

EN.560.452. Civil Engineering Design II. 3 Credits.
A study of the engineering design process from problem definition to the final design. There are team projects which include written and oral presentations. Requirements: Student must be a senior in Civil Engineering.
Instructor(s): J. Matteo
Area: Engineering.

EN.560.460. Applied Structural Optimization. 3 Credits.
Basic principles of optimization applied to the design of structures. Algorithms and tools for structural component design, member selection, and structural layout (topology) optimization. Course will entail MATLAB programming and use of commercial structural engineering software.
Prerequisites: EN.560.730 or 560.445 or permission of instructor
Area: Engineering, Natural Sciences.

EN.560.481. Engineering Design of Underwater Life Support. 3 Credits.
The physiological and psychological aspects of man in the sea are presented with the related engineering requirements. Topics include hyperbaric physiology, decompression theory, carbon dioxide absorption, thermal protection, psychrometrics. saturation diving, life support equipment, deep dive systems, diving operations and hazards.
Instructor(s): W. Marr
Area: Engineering.

EN.560.491. Civil Engr Seminar I.
Seminar series of speakers on various aspects of civil engineering. Juniors and Seniors in Civil Engineering are expected to enroll in this sequence; juniors and seniors receive one-half credit. Different speakers are invited each semester. Satisfactory/ Unsatisfactory only
Instructor(s): R. Sangree
Area: Engineering.

EN.560.492. Civil Engineering Seminar II.
Seminar series of speakers on various aspects of civil engineering. Juniors and Seniors in Civil Engineering are expected to enroll in this sequence; juniors and seniors receive one-half credit. Different speakers are invited each semester. Satisfactory/ Unsatisfactory only
Prerequisites: EN.560.491

Instructor(s): R. Sangree
Area: Engineering.

EN.560.493. Civil Engr Seminar III.
Seminar series of speakers on various aspects of civil engineering. Juniors and Seniors in Civil Engineering are expected to enroll in this sequence; juniors and seniors receive one-half credit. Different speakers are invited each semester. Satisfactory/ Unsatisfactory only
Prerequisites: EN.560.492.

Instructor(s): R. Sangree
Area: Engineering.

EN.560.494. Civil Engineering Seminar IV.
Seminar series of speakers on various aspects of civil engineering. Juniors and Seniors in Civil Engineering are expected to enroll in this sequence; juniors and seniors receive one-half credit. Different speakers are invited each semester. Satisfactory/ Unsatisfactory only
Prerequisites: EN.560.493

Instructor(s): R. Sangree
Area: Engineering.

EN.560.525. Independent Study. 3 Credits.
Instructor(s): R. Dalrymple.

EN.560.526. Independent Study Civil Engineering. 0 - 3 Credit.
Instructor(s): B. Schafer; J. Mitrani-Reiser; R. Dalrymple; R. Sangree; T. Igusa.

EN.560.535. Research in Civil Engineering. 3 Credits.
Perm. Req’d.
Instructor(s): Staff.

EN.560.536. Research in Civil Engineering. 0 - 3 Credit.
Instructor(s): Staff.

EN.560.590. Civil Engineering Internship. 1 Credit.
Instructor(s): B. Schafer; J. Guest.

EN.560.597. Summer Research - Civil Engineering. 3 Credits.
Instructor(s): Staff.

EN.560.599. Indep Study - Summer. 3 Credits.
EN.560.602. GPU Programming for Engineers.

Video graphics cards can be repurposed to perform massively parallel computations rapidly. This course will provide students the ability to program these graphics cards to speed up numerical computations. The course will begin with an introduction to C++ programming followed by concepts in parallel computing. Finally, the CUDA extensions to C++ that is used on Nvidia graphics cards. Students will be programming GPUs during the course. Recommended course background: Some programming experience.

Instructor(s): R. Dalrymple
Area: Engineering.


Basic solid mechanics for structural engineers. Stress, strain and constitutive laws. Linear elasticity and viscoelasticity. Introduction to nonlinear mechanics. Static, dynamic and thermal stresses. Specialization of theory to one- and two-dimensional cases: plane stress and plane strain, rods, and beams. Work and energy principles; variational formulations.

Instructor(s): J. Guest; L. Graham-Brady.

EN.560.620. Advanced Steel Design.

Steel Structures or comparable introductory steel design course. This course examines advanced design of structural steel buildings using the load and resistance factor design approach. Topics include plastic analysis of indeterminate structures, design of plate girders, and design of composite beams. Co-listed with EN.565.620. Recommended Course Background: EN.560.320.

EN.560.630. Structural Dynamics.

Functional and computational examination of elastic and inelastic single degree of freedom systems with classical and non-classical damping subject to various input excitations including earthquakes with emphasis on the study of system response. Extension to multi-degree of freedom systems with emphasis on modal analysis and numerical methods. Use of the principles of structural dynamics in earthquake response.

Instructor(s): M. Shields.


This is a course in the concept, design, development and integration of systems from individual systems to system-of-systems. Lessons are reinforced by case studies and assignments, taking a holistic systems view and integrating aspects of product development and system architecture within systems engineering. This course will teach UML and SysML as model based system engineering languages for systems design, analysis, and documentation in a concurrent engineering, team-oriented design setting. The system language IDEFx will be covered to the degree that students can read and interpret legacy systems documented using IDEFx. In addition to lectures, a case study approach will be employed to develop analytical, technical, management, and teamwork skills through exercises in planning, documentation, presentation, and the creative process of systems engineering design.

Instructor(s): T. Speller
Area: Engineering.


Course will address various themes related to modeling complex systems through critical evaluation of technical articles, open discussion, faculty presentations, and computational workshops. Teams of 3-5 faculty will develop monthly units based on different themes, examples of which may include: optimization and uncertainty modeling in science and engineering, particle-based modeling, experimental and field measurements in multi-scale models, linking atomistic- to continuum-scale models, challenges in climate and ocean modeling, homogenization and upscaling of small-scale data. This course is a requirement for MCS IGERT trainees, but it is open to all graduate students.

Instructor(s): L. Graham-Brady.

EN.560.682. Introduction to Water Wave Mechanics.

The theories governing water wave motion, from linear to nonlinear waves, is presented. Wave propagation and transformation, including shoaling, refraction, and diffraction, is shown. Wave breaking and the basic interaction of waves with structures and the ocean bottom are covered.

Instructor(s): R. Dalrymple.

EN.560.691. Graduate Seminar.

Graduate students are expected to register for this course each semester. Both internal and outside speakers are included.

Instructor(s): B. Schafer.

EN.560.692. Civil Engineering Graduate Seminar.

Seminar series of speakers on various aspects of civil engineering. Different speakers are invited each semester. Full time civil engineering graduate students must enroll in the seminar course every semester unless excused by the Department.

Instructor(s): B. Schafer.

EN.560.700. Applications of Science-Based Coupling of Models.

Area: Engineering, Social and Behavioral Sciences.


This 1.5 hour course will address various themes related to modeling complex systems through critical evaluation of technical articles, open discussion, faculty presentations, and computational workshops. Teams of 3-5 faculty will develop monthly units based on different themes, examples of which may include: optimization and uncertainty modeling in science and engineering, particle-based modeling, experimental and field measurements in multi-scale models, linking atomistic- to continuum-scale models, challenges in climate and ocean modeling, homogenization and upscaling of small-scale data. This course is a requirement for MCS IGERT trainees, but it is open to all graduate students.


Variational methods and mathematical foundations, Direct and Iterative solvers, 1-D Problems formulation and boundary conditions, Trusses, 2-D/ 3D Problems, Triangular elements, QUAD4 elements, Higher Order Elements, Element Pathology, Improving Element Convergence, Dynamic Problems.

Instructor(s): S. Ghosh.


Instructor(s): B. Schafer.
EN.560.738. Applied Knowledge Discovery.
The knowledge discovery process involves a close interaction between domain experts and machine learning techniques to explore and learn from complex data sets. Most research on this subject is centered on machine learning. The emphasis in this course is on effective use of domain expertise. Applications will be chosen based on student interests.
Instructor(s): T. Igusa.

EN.560.741. Theoretical and Computational Plasticity.

EN.560.756. Earthquake Engineering.

EN.560.764. Infrastructure Asset Management.
Introduction to concept of infrastructure asset management. Topics include performance & condition data collection and modeling, geographical information system (GIS), life-cycle economic analysis, maintenance, rehabilitation, and renovation (MR&R) strategies, innovative contracting using PPP and performance based design, construction, maintenance, and operation. Undergraduates must be seniors or obtain permission of instructor.
Instructor(s): X. Chen.

This course will discuss state of the art theoretical developments and modeling techniques in nonlinear computational mechanics, for problems with geometric and material nonlinearities. Large deformation of elastic-plastic and visco-plastic materials, contact-friction and other heterogeneous materials like composites and porous materials will be considered. A wide variety of applications in different disciplines, e.g. metal forming, composite materials, polycrystalline materials will be considered. Co-listed with EN.530.772.
Instructor(s): S. Ghosh.

EN.560.782. Hydrodynamics.
Fundamentals of fluid mechanics in the context of ocean science and engineering, naval architecture, and coastal processes, at engineering scales.
Area: Engineering.

Hydrodynamics with applications in ocean vehicles and structures. Waves, winds and currents in sea environment. Interactions between waves and floating bodies. Sea loads on offshore structures.
Prerequisites: EN.560.781
Instructor(s): L. Shen.

EN.560.785. Coastal & Ocean Modeling.
Course discusses the numerical and physical modeling techniques used in coastal and ocean engineering, including finite difference, finite and boundary element methods, and particle methods. Some aspects of parallel computing will be included.
Area: Engineering, Natural Sciences.

Course introduces contemporary ocean science and engineering research, and discusses select topics in the areas of air-sea exchange, nonlinear waves, hydrodynamics, wave-turbulence interaction, and flow-structure interaction.
Prerequisites: EN.560.782 AND EN.560.783 OR INSTRUCTOR PERMISSION
Instructor(s): L. Shen.

EN.560.835. Graduate Research.
Instructor(s): Staff.

EN.560.836. Graduate Research.
Instructor(s): Staff.