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 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 lecturership; all of which are designed to bring prominent civil engineers to campus to speak with students and faculty.

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 are listed below. For more detailed information students should look at the Civil Engineering Department website (http://engineering.jhu.edu/civil/undergraduate-studies). 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)
EN.530.103 Introduction to Mechanics I 4
& EN.530.104 and Introduction to Mechanics II
or AS.171.101 General Physics: Physical Science Major I
or AS.171.107 General Physics for Physical Sciences Majors (AL)
AS.171.102 General Physics: Physical Science Majors II 4
or AS.171.108 General Physics for Physical Science Majors (AL)
AS.173.111 General Physics Laboratory I 2
& AS.173.112 and General Physics Laboratory II
AS.030.101 Introductory Chemistry I 3
AS.030.105 Introductory Chemistry Lab I 1
EN.510.201 Introductory Materials Science for Engineers 3
One additional (N) elective * 3
Mathematics (16 credits)
AS.110.108 Calculus I 4
AS.110.109 Calculus II (For Physical Sciences and Engineering) 4
AS.110.202 Calculus III 4
or AS.110.211 Honors Multivariable Calculus 4
EN.550.291 Linear Algebra and Differential Equations 4
Humanities and Social Sciences (18 credits)
Students are encouraged to create a program of study that is supplemented by meaningful classes outside of engineering. ** 18
Free Electives
Select 6-7 credits of free electives 6
Civil Engineering Fundamentals (21 credits)
EN.560.141 Perspectives on the Evolution of Structures 3
EN.560.201 Statics & Mechanics of Materials 4
EN.560.202 Dynamics 4
EN.560.206 Solid Mechanics & Theory of Structures 4
EN.560.220 Civil Engineering Analysis 3
EN.570.351 Introduction to Fluid Mechanics 3
Professional Practice (12-13 credits)
EN.660.105 Introduction to Business (or EN.660.300+ CLE Management/Leadership Track) 4
EN.661.110 Professional Writing and Communication (or EN.661.300+ CLE Professional Communication) 3
EN.560.451 Civil Engineering Design I 2
EN.560.452 Civil Engineering Design II 3
EN.560.491 Civil Engineering Seminar I .5
EN.560.492 Civil Engineering Seminar II .5
Technical Areas (25 credits)
EN.570.301 Environmental Engineering Fundamentals I 3
EN.570.302 Water & Wastewater Treatment 3
EN.560.305 Soil Mechanics 4
EN.560.320 Structural Design I 3
EN.560.325 Structural Design II 3
EN.560.330 Foundation Design 3
EN.560.348 Probability & Statistics for Engineers 3
EN.560.498 Survey of Systems Engineering Tools 3
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. ***

Total Credits 128

* We recommend either AS.270.220 The Dynamic Earth: An Introduction to Geology or AS.270.205 Introduction to Geographic Information Systems and Geospatial Analysis.

** 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 two 3-credit H elective courses and two 3-credit in S elective courses. Two additional 3-credit courses may be taken in either area: H or S. A minimum of one H and one S elective course must be at or above the 300-level. One writing-intensive requirement must be fulfilled by the H/S electives. This can either be done through AS.060.113/AS.060.114 Expository Writing or a 300-level, Writing-Intensive, H or S elective course. Given the increasingly global nature of the civil engineering field, students are also required to take one H or S course from the KSAS International Studies major (see http://krieger.jhu.edu/internationalstudies/courses/). (http://www.krieger.jhu.edu/internationalstudies/courses/)

*** Technical electives (all required to be at or above the 300-level) are designed to provide students with greater depth in one or more of the civil engineering technical areas above. To that end, a minimum of one 3-credit technical elective must be in a civil engineering technical area. One 3-credit technical elective must have an E distribution credit, but may be a course offered outside of traditional civil engineering areas, and one 3-credit technical elective may come from any (Q), (N), or (E) course. While the Department of Civil Engineering allows some flexibility in students’ choice of technical electives, we advise that to the extent possible, students select their technical electives from within the department’s offerings.

Sample B.S. Program
To view a sample civil engineering program, visit the Civil Engineering website and click on Undergraduate Studies, Academic Advising or click here. (http://engineering.jhu.edu/civil/wp-content/uploads/sites/10/2014/08/2014-Sample-Program-Mechanics-Option.pdf) 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 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
### Financial Aid

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

### Combined Bachelor’s/Master’s 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. For students who are admitted to this program, the two degrees typically require five years total to complete. The other option combines a B.S. in Civil Engineering with a Master of Science in Engineering Management (M.S.E.M.) (http://msem.engineering.jhu.edu). Formal application through the M.S.E.M. Department (http://msem.engineering.jhu.edu) is required. Students enrolled in a Combined B.S./M.S.E. program are awarded a Dean’s Master’s Fellowship, covering half their tuition, after they have completed eight semesters of undergraduate study. More information about these programs can be found at http://engineering.jhu.edu/academics/combined-bachelors-masters/.

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 successfully complete one of two requirements in order to obtain the M.S.E. degree: either the 10 courses (course-only) option, or the 8 courses and a

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>EN.560.206</td>
<td>Solid Mechanics &amp; Theory of Structures</td>
<td>4</td>
</tr>
<tr>
<td>EN.560.491</td>
<td>Civil Engineering Seminar I</td>
<td>0.5</td>
</tr>
<tr>
<td>EN.560.492</td>
<td>Civil Engineering Seminar II</td>
<td>0.5</td>
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Students must choose to focus in one of the following three technical areas, completing two courses in one area of their choice.

#### Structural Engineering

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>EN.560.320</td>
<td>Structural Design I</td>
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<tr>
<td>EN.560.325</td>
<td>Structural Design II</td>
</tr>
<tr>
<td>EN.560.440</td>
<td>Applied Finite Element Methods</td>
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<td>EN.560.445</td>
<td>Advanced Structural Analysis</td>
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#### Geotechnical Engineering

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<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>EN.560.305</td>
<td>Soil Mechanics &amp; Foundation Design</td>
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<tr>
<td>&amp; EN.560.315</td>
<td>Probability &amp; Statistics for Engineers</td>
</tr>
<tr>
<td>&amp; EN.560.415</td>
<td>Survey of Systems Engineering Tools</td>
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#### Systems Engineering

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<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>EN.560.348</td>
<td>Civil Engineering Seminar I</td>
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<tr>
<td>&amp; EN.560.448</td>
<td>Civil Engineering Seminar II</td>
</tr>
<tr>
<td>&amp; EN.560.498</td>
<td>Applied Finite Element Methods</td>
</tr>
<tr>
<td>&amp; EN.560.497</td>
<td>Advanced Structural Analysis</td>
</tr>
</tbody>
</table>

### Total Credits

30

### Typical Timeline for Ph.D. Students

**Year 1 Fall:**
- Arrival prior to start of classes
- Selection of first semester courses (typically 4) with advisor

### Requirements for the Ph.D. Degree

There are a number of Whiting School of Engineering policies related to Ph.D. students, which are listed at http://engineering.jhu.edu/graduate-policies. Ph.D. student requirements for the Civil Engineering Department include:

- 10 Courses*
- Department Qualifying Examination (DQE)
- Annual Meetings and Reports to Ph.D. Advisory Committee
- Annual Review
- Graduate Board Oral Examination (GBO)
- Responsible Conduct of Research Course (AS.360.625)
- Academic Ethics (EN.500.603)
- Final Ph.D. Thesis Defense

*All courses must be completed with a grade of B or better. At least 8 of the 10 courses must be at the 600- or 700-level. Note that students entering with a Masters degree may receive a maximum of 4 transfer courses. The number of transfer courses accepted is determined by the Department. Students transferring courses from a prior Masters degree must fulfill the remainder of the course requirement with courses only at the 600- or 700-level. Typically, in the Spring of the first year a student’s permanent advisor will consult with the Department to determine the appropriate number of transfer courses. These credits may accelerate the timeline given below. These are guidelines, and exceptions may be made under special circumstances.

### Typical Timeline for Ph.D. Students

**Year 1 Fall:**
- Arrival prior to start of classes
- Selection of first semester courses (typically 4) with advisor
• Language/communication testing and placement for International Students
• Responsible Conduct of Research Course (AS.360.625) (https://engineering.jhu.edu/wse-research/resources-policies-forms/responsible-conduct-of-research)
• Academic Ethics Course (EN.500.603)
• First semester coursework and teaching assistant/research assistant duties where assigned
• Determination of permanent advisor in first semester

**Year 1 Intersession:**
• Intersession research
• Oral Department Qualifying Exam (DQE) (completed in early January)
• Annual review must be completed by January 31

**Year 1 Spring:**
• Second semester coursework and teaching assistant/research assistant duties where assigned
• Advisor and student identify Ph.D. Thesis Committee and student meets with members individually
• Responsible Conduct of Research course (AS.360.625)

**Year 1 Summer:**
• Research

**Year 2 Fall:**
• Research
• Coursework (typically fewer than in Year 1)
• Ph.D. Thesis Committee Meeting required prior to end of Fall semester

**Year 2 Intersession:**
• Research
• Annual review must be completed by January 31

**Year 2 Spring:**
• Research
• Coursework (typically finishing up this semester)

**Year 2 Summer:**
• Research

**Year 3:**
• Research (Year-round)
• Ph.D. Thesis Committee Meeting
• Annual review must be completed by January 31
• GBO: Exact timing determined by advisor in consultation with the student

**Year 4 and Beyond:**
• Research (Year-round)
• Ph.D. Thesis Committee Meeting every Fall prior to the end of the semester
• Annual review must be completed by January 31

**Final semester:**
• Thesis Defense

**Language/Communication Testing and Placement**
All Ph.D. students who do not have a prior degree from an English speaking university must take an English Language Assessment. If it is determined at the assessment that the student needs further English language instruction, he/she will be required to take 370.600 or equivalent.

**Determination of Permanent Advisor**
In some cases students are admitted to work with a specific advisor, in which case the permanent advisor is the faculty member listed in the admissions letter. In other cases students are not assigned a specific advisor at the time of the admission letter. During September and October of the first semester, these students should meet with the faculty, discuss their research interests, and learn more about the research being conducted by the faculty. By the beginning of November the student must state his/her preference(s) for a permanent advisor. The faculty will meet and determine the final advisor placements prior to the end of the semester. Every effort will be made to match students with their requested advisors, but financial constraints may not always make this possible.

**Intersession**
Intersession (the period between Fall and Spring terms) is an important time for research. Intersession is not a vacation. Any leave taken during intersession is subject to the policies outlined in the Graduate Student Assistant Leave Guidelines (http://engineering.jhu.edu/include/content/pdf/RA_TA%20leave%20guidelines%20(FINAL).pdf). Release time (if any) granted in that period must be approved by the advisor.

**Department Qualifying Examination (DQE)**
The DQE is a comprehensive oral exam designed to determine whether or not the student is properly prepared to continue in the Ph.D. program. All first-year students studying for a Ph.D. take the DQE after their first semester of enrollment, typically in early January of the first year. This exam tests whether the student is prepared to continue in their Ph.D. studies based on their grasp of basic undergraduate-level and beginning graduate-level Civil Engineering knowledge. Possible outcomes of the exam are Pass, Retake, or Fail. Only an outcome of Pass is considered passing the exam. If the student receives a Retake, they are provided a single retake of the exam, typically in the Fall or early January of their second year. Possible outcomes of this exam retake are Pass or Fail. If the outcome of the exam is Fail, the student may pursue, with approval from the chair, a M.S.E. degree. Financial support for such a student during this period is not typical.

**Annual Reviews**
Reviews of all Ph.D. students in Civil Engineering must be performed annually prior to January 31, which is consistent with the WSE policy found on the WSE Academic Policies & Procedures (http://engineering.jhu.edu/graduate-studies/academic-policies-procedures-graduate) webpage. The review process follows the format given in the annual review form. The completed form must be submitted to the Academic Program Coordinator by January 31. If this annual review is not completed by this date, the student’s funding may be jeopardized.

**Ph.D. Thesis Committee**
Every Ph.D. student must have a Thesis Committee of at least 3 faculty members. The Advisor, in consultation with his/her Student, selects the makeup of the committee, and this information is recorded in the student’s file. The student is expected to meet with this committee a
The minimum of once per year. The thesis committee also typically serves as a subset of the actual GBO examination committee and forms the final Ph.D. defense committee. This committee must consist of a minimum of 2 full-time faculty of the Civil Engineering Department.

**Ph.D. Thesis Committee Meeting**

Thesis Committee meetings are expected to occur annually in the fall from Year 2 until the Ph.D. final defense. The student is required to submit a report to the committee members at least one week prior to the meeting. A typical report would include a literature review of the field relevant to the student’s research, a progress report of research performed to date, goals for research in the coming year, and a basic timeline of expected activities in the remaining years of the Ph.D. degree. The committee meeting should consist of a presentation of key aspects of the report, along with discussion and feedback from the Thesis Committee. In certain cases, particularly in later years of the Ph.D. degree, it may be deemed acceptable for the student to meet individually with members of the committee in lieu of the group meeting; however, such an exception can only be granted with permission of the Advisor and all committee members. Once the Thesis Committee meeting is completed, the Ph.D. Thesis Committee Meeting Form must be signed by the members of the committee and submitted to the Department.

**Responsible Conduct of Research**

Every Ph.D. student of the Whiting School of Engineering is required to take a Responsible Conduct of Research course (details on the requirement can be found on the WSE Policy on the Responsible Conduct of Research Training [http://engineering.jhu.edu/wse-research/resources-policies-forms/responsible-conduct-of-research] webpage. For Civil Engineering students, this should be completed in Spring or Summer of the first year of studies. Students who do not complete this requirement prior to Fall of their third year of studies may put their funding in jeopardy.

**GBO Examination**

The University maintains complete guidelines for the Graduate Board Orals here ([http://homewoodgrad.jhu.edu/academics/graduate-board/degree-candidacy](http://homewoodgrad.jhu.edu/academics/graduate-board/degree-candidacy)). The GBO committee consists of 5 members, (3 in Department, 2 outside) with 2 alternates (1 in Department, 1 outside) and is selected by the Chair of the Department and the Director of Graduate Studies, who will consult with the student’s advisor. When a Ph.D. student and advisor feel that the student is ready to take the GBO, the advisor should consult with the Director of Graduate Studies and the Civil Engineering Academic Program Coordinator to initiate the process of scheduling the exam. Both students and advisors should be aware that 4-6 weeks advance notice is needed in order to allow for scheduling the exam with the faculty and with the Graduate Board.

The exact format of each GBO examination is specified by the individual Chair of the GBO committee. The student may be requested to provide to the GBO committee prior to the examination some written document describing his or her research. In such cases, the latest annual Thesis Committee report and/or a recent conference or journal publication may suffice. It is typical that the student would be asked to provide a brief presentation of research at the beginning of the examination (no more than 10 slides, no longer than 10 minutes). The examination questions may be on any topic of the committee members’ choosing, but many of the questions relate to the student’s coursework and research. At the conclusion of the examination, the GBO committee may recommend pass, conditional, pass, fail with re-examination, fail (final) as detailed here ([http://homewoodgrad.jhu.edu/academics/graduate-board/degree-candidacy](http://homewoodgrad.jhu.edu/academics/graduate-board/degree-candidacy)).

**M.S.E. Degree for Ph.D. Students**

Ph.D. students may petition for a Master of Science degree following their GBO Examination. If the student passes the GBO, he/she may file for a non-terminal M.S.E. degree. If the student fails (final) the GBO, he/she may petition for a terminal M.S.E. degree. In all instances the student must have satisfied the M.S.E. degree course requirements as detailed here ([http://engineering.jhu.edu/civil/graduate-studies/mse-requirements](http://engineering.jhu.edu/civil/graduate-studies/mse-requirements)).

In instances where the research is highly interdepartmental, the student, with permission of the advisor, may request that the M.S.E. degree be awarded by another department in the Whiting School of Engineering. In such cases, the student must have satisfied M.S.E. degree requirements and receive the approval of, and an accepted application to, the awarding Department, as well as satisfied M.S.E. degree requirements of the Civil Engineering Department and receive approval from the Civil Engineering Chair. In all cases, the awarding of any JHU M.S.E. degree to a Civil Engineering Ph.D. student may only occur after the student has completed the GBO exam.

**Thesis Defense**

The Thesis Defense is the final examination before conferral of the Ph.D. degree. The student defends his/her thesis in a seminar setting that is open to the public. The seminar is followed by a comprehensive examination of the student, focused on the thesis research.

**Ethics:** The Department of Civil Engineering is dedicated to upholding the highest standards of academic and research integrity. Plagiarism, and other forms of unethical conduct, are not tolerated. Students are referred to the Graduate Student Resources ([http://engineering.jhu.edu/graduate-studies/full-time-graduate-student-resources](http://engineering.jhu.edu/graduate-studies/full-time-graduate-student-resources)) webpage of the Whiting School of Engineering for these and other policies related to graduate students.

**Defense Committee:** A committee of at least 3 members administers the exam (typically the Ph.D. Thesis Committee). The Advisor, in consultation with the Department, selects the committee members, at least 2 of whom must be full-time faculty of the Civil Engineering Department. This should be done at the beginning of the semester in which the student plans to graduate. It is the student’s responsibility to keep the committee members apprised of all deadline dates.

**Scheduling and Pre-Defense:** The defense should be scheduled at least 3 weeks in advance through the Department’s Academic Coordinator. A complete written dissertation should be given to the committee at least 14 days in advance of the defense. Failure to meet this 2 week deadline will result in rescheduling the Ph.D. defense. The date and place of the defense, along with the thesis abstract, should be circulated 5-7 days prior to the defense.

**Post-Defense:** Completion of the Ph.D. requirements typically takes 4-8 weeks after a successful defense examination. All data and source codes related to the thesis should be properly archived according to requirements set forth by the Advisor. Any changes or additions specifically requested by the reviewers before or during the defense seminar should be incorporated into the thesis in consultation with the Advisor. A final copy of the thesis must then be made available to the reviewers for inspection no less than 48 hours before the deadline date for filing set by the Graduate Board. Upon approval, the student should submit a copy of the thesis and the Department’s “Certification for Advanced Degrees” form to the Department Administrative Assistant. In return, the Department will send to the Graduate Board Office or the
Whiting School of Engineering Graduate Committee the “Certification of Completion of Department Requirements for an Advanced Degree,” signed by the Department Chairman.

**Additional Information:** It is the responsibility of the student to be aware of requirements and deadlines. It is suggested that this information be obtained before the start of the semester of intended graduation. All students should plan the timing of the final defense accordingly (making sure to account for the 4-8 week period following the defense) to satisfy any deadlines related to upcoming graduation or exhaustion of funding.

University requirements for the thesis can be obtained from the Graduate Board (http://homewoodgrad.jhu.edu/academics/graduate-board/degree-candidacy) website. Information sheets entitled “Dissertation Requirements” are available to students and contain details on the form, cost, and timing for submitting the thesis. Doctoral Theses must be submitted to both the ETD (Library) and the Department of Civil Engineering. The deadline date for filing is set by the Graduate Board Office. This date also applies to filing with the Whiting School Graduate Committee and with the Department. A receipt of ETD approval must be sent to the department, Graduate Board/WSE Office of Academic Affairs (for M.S.E. students).

**Financial Aid**

A limited amount of financial assistance is available to Civil Engineering graduate students. This assistance is available in the form of teaching assistantships, research assistantships, and partial or complete tuition fellowships, including fellowships from the Joseph Meyerhoff Scholarship Fund, the Richard D. Hickman Endowment, and the Hoomes Rich Graduate Fellowship. Fellowships and Assistantships are awarded on a competitive basis and continued support is subject to the student’s performance and future availability of research or teaching assistantship funds.

For current faculty and contact information, go to http://engineering.jhu.edu/civil/faculty/

**Faculty**

**Chair**

Lori Graham-Brady
Professor

**Professors**

Robert A. Dairymple
Professor and Willard and Lillian Hackerman Chair in Civil Engineering: coastal engineering, water wave mechanics, fluid mechanics.

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.

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

**Associate Professor**

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

**Assistant Professors**

Stavros Gaitanaros
Assistant Professor: design and mechanics of cellular materials at the macro- and nanoscale.

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

Michael D. Shields
Assistant Professor: stochastic simulation, uncertainty quantification, computational stochastic mechanics.

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

**Lecturer**

Rachel H. Sangree
Lecturer, Program Chair EP Civil Engineering: structural engineering, historic structures.

**Adjunct Professors**

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

Byung-Lip (Les) Lee

John A. Matteo
Adjunct Professor, Director of Design: structural engineering and architecture, historic structures.

Lucas de Melo
Adjunct Professor: geotechnical engineering.

**Assistant Research Professor**

Shahabeddin Torabian
Assistant Research Professor: thin-walled structures.

**Joint, Part-Time and Visiting Appointments**

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

Joshua M. Epstein
Joint Appointment: Professor: Department of Emergency Medicine: integrated computational modeling of social, behavioral, and biomedical dynamics, agent-based modeling.

Seth Guikema
Joint Appointment: Assistant Professor (DoGEE): probabilistic risk analysis, environmental life-cycle assessment.

Ayse Gurses

Thomas Dean Kirsch
Joint Appointment, Associate Professor: Department of Emergency Medicine, Department of International Health: disaster planning and response, wilderness medicine, health care management.

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

Courses

**EN.560.101. Freshman Experiences in Civil Engineering.**
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.**
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): R. Sangree
Area: Engineering, Quantitative and Mathematical Sciences.

**EN.560.201. Statics & Mechanics of Materials.**
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): R. Sangree
Area: Engineering.

**EN.560.202. Dynamics.**
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: Students must have completed Lab Safety training prior to registering for this class; (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): L. Graham-Brady
Area: Engineering.

**EN.560.206. Solid Mechanics & Theory of Structures.**
Application of the principles of structural analysis for statically determinate and indeterminate 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): M. Shields
Area: Engineering.

**EN.560.220. Civil Engineering Analysis.**
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.**
Prerequisites: EN.560.351 OR EN.570.351; Prerequisite: EN.560.206.
Corequisites: Corequisite: EN.570.351 or EN.560.351
Instructor(s): L. de Melo
Area: Engineering.

**EN.560.320. Structural Design I.**
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.**
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.
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.560.335. Computer Aided Drafting for Civil Engineers.
This course presents a tutorial on engineering drafting using AutoCAD software. Students will have the opportunity to explore AutoCAD while learning the rules and terminology associated with drafting. A term project will allow students to apply their acquired skills to an engineering drawing of their choosing.
Instructor(s): D. Ayhan
Area: Engineering.

EN.560.348. Probability & Statistics for Engineers.
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.
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.
Area: Engineering.

EN.560.380. Introduction to Ocean Wind Engineering.
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.

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.
Area: Engineering.

Building on the content in Preservation Engineering I: Theory and Practice, this course will begin with materials introduced at the start of the Industrial Revolution—namely with the beginning of the use of iron materials as major structural elements within buildings. The course will continue with the introduction of cast iron, wrought iron, and finally, structural steel members. After introducing iron materials the course will continue with the early use of reinforced concrete as a major structural material. The course will discuss the historic structural analysis methods associated with such materials and contrast such methods with more modern analytical approaches. It will also discuss concrete deterioration and repair methods. Concepts related to masonry facade investigation and repair will be presented along with the analytical methods associated with thin-shell masonry construction from the 19th and 20th centuries. The course will conclude with a review of the assessment and retrofit of historic foundations.
Instructor(s): E. Meade; J. Spivey
Area: Engineering.

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.

Provide an introduction to equilibrium problems involving systems. The course will start with an introduction to optimization theory followed by various introduction 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.
Instructor(s): S. Siddiqui
Area: Engineering.

Matrix methods for the analysis of statically 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.

The course provides an interdisciplinary overview of mathematical and computational models of human driven systems. It spans a wide range of topics including the spread of infectious diseases, the dynamics of revolution and civil violence, ethnic segregation, land use change, urban disaster preparedness, computational reconstruction of ancient civilizations, and more. The course prepares students to develop their own models—alone or in teams. The NetLogo modeling environment will be presented, although students are welcome to use any language. Students are assessed by class projects at the end of the course.
Instructor(s): E. Hatna; J. Epstein
Area: Engineering, Social and Behavioral Sciences.
EN.560.451. Civil Engineering Design I.
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.
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.

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 Engineering 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.

Introduction to analytical tools in the three major functional areas of systems engineering: design, analysis and control. Recommended Corequisite: EN.560.348 or equivalent course in probability theory. Restricted to Civil Engineering majors or by permission of instructor.
Area: Engineering.

EN.560.525. Independent Study.
Instructor(s): J. Guest; R. Dalrymple; S. Siddiqui; T. Igusa.

EN.560.526. Independent Study - Civil Engineering.
Instructor(s): B. Schafer; J. Mitrani-Reiser; L. Graham-Brady; R. Dalrymple; T. Igusa.

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

EN.560.536. Research in Civil Engineering.
Instructor(s): Staff.

EN.560.574. Research-Intersession.

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

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

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.
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): S. Gaitanaros.

Covers probabilistic computational modeling in civil engineering and mechanics: Monte Carlo simulation, sampling methods and variance reduction techniques, simulation of stochastic processes and fields, and expansion methods. Applications to stochastic finite element, uncertainty quantification, reliability analysis, and model verification and validation.
Instructor(s): M. Shields.

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.
Instructor(s): J. Guest
Area: Engineering.
Introduction to optimization theory and algorithms and their application to the design of structures, including structural systems, mechanisms, devices, and materials. Strong emphasis on topology optimization using finite element methods and design problems governed by solid and structural mechanics. Extensions to other physics and multiple physics are also introduced (e.g., fluids, heat transfer, optics, etc.). Course assumes familiarity with finite element methods and assumes no prior coursework in optimization.

Area: Engineering.

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): J. Mitrani-Reiser.

EN.560.640. **Advanced Systems Engineering: Concept, Design, Development and Integration.**
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.

EN.560.642. **Systems Modeling and Simulation.**
Students will learn to develop agent-based and systems dynamics models to simulate complex systems. Models with hierarchical and other structures will be examined, and applications will be chosen based on student interest.

EN.560.667. **Topology Optimization and Design for Additive Manufacturing.**
This course will discuss the computational design tool of topology optimization and its application to the design of “structures”, including structural systems, compliant mechanisms, multifunctional devices, and material architectures. Particular emphasis will be placed on the emerging trend known as Design for Additive Manufacturing (AM), and the role of topology optimization in guiding the design of parts to be fabricated by AM processes (3D printing, Selective Laser Sintering, etc.). The course will largely focus on design problems concerned with mechanical properties, with extensions to fluidic, thermal, optical, etc. properties also discussed. The course assumes some familiarity with finite element methods and assumes no prior coursework in optimization.

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

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): M. Shields.

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): M. Shields.

EN.560.724. **Cold-Formed Steel Structures.**
Practical introduction to the analysis, design, and experimentation of cold-formed steel members and structures. Followed by an in-depth treatment of the theories which underpin modern analytical and computational tools used in exploring cold-formed steel behavior, and an introduction to topics under current research.

EN.560.730. **Finite Element Methods.**
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.

EN.560.731. **Structural Stability.**

Instructor(s): B. Schafer.

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.
EN.560.770. Advanced Finite Element Methods and Multi-Scale Methods.
Addresses advanced topics in various areas of the finite element methodology. Covers a range of topics, viz. element stability and hourglass control, adaptive methods for linear and nonlinear problems, mixed and hybrid element technology, eigen-value problems, multi-scale modeling for composites and polycrystalline materials. Recommended Course Background: EN.530.730 or EN.560.730.

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.

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.

EN.560.826. Graduate Independent Study.
Independent Study
Instructor(s): T. Igusa
Area: Engineering.

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

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

Cross Listed Courses
Earth Planetary Sciences
AS.270.205. Introduction to Geographic Information Systems and Geospatial Analysis.
The course provides a broad introduction to the principles and practice of Geographic Information Systems (GIS) and related tools of Geospatial Analysis. Topics will include history of GIS, GIS data structures, data acquisition and merging, database management, spatial analysis, and GIS applications. In addition, students will get hands-on experience working with GIS software.
Instructor(s): X. Chen
Area: Engineering, Natural Sciences.

Geography Environmental Engineering
EN.570.351. Introduction to Fluid Mechanics.
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. Recommended Course Background: Statics, Dynamics, and AS.110.302
Instructor(s): M. Karweit
Area: Engineering.