

# SCHOOL OF ENGINEERING AND APPLIED SCIENCE

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The School of Engineering and Applied Science (SEAS) was organized in 1884 as the Corcoran Scientific School of Columbia University, named in honor of William W. Corcoran, president of the University's Board of Trustees from 1869 to 1888. The School was among the first to accept women for degree candidacy in engineering. While the organization and offerings of the School have evolved over the years, throughout most of its history its programs have been characterized by an emphasis on principles guiding the advancement of technology.

The School offers the bachelor of arts, bachelor of science, master of engineering, master of science, doctor of engineering, doctor of philosophy, and the professional degrees of engineer and applied scientist through its six departments—Biomedical Engineering, Civil and Environmental Engineering, Computer Science, Electrical and Computer Engineering, Engineering Management and Systems Engineering, and Mechanical and Aerospace Engineering. In addition, the School offers several graduate certificate programs, as well as combined bachelor's/master's degree programs.

Research centers and institutes provide opportunities for students and faculty to strengthen ties with counterparts in government and industry and contribute to the development and harnessing of emerging technology. Extensive and varied laboratories and computing facilities support the academic programs. The School strongly supports co-curricular activities to broaden and deepen its students' overall educational programs, including an extensive array of internship opportunities at government laboratories and private companies in the Washington, D.C. area and elsewhere. Other co-curricular opportunities include engineering-type team competitions, research projects, and the SEAS student government organization, the Engineers' Council.

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## Undergraduate Programs

### University Regulations

All SEAS students are required to review the University Regulations (<http://bulletin.gwu.edu/university-regulations>) as outlined in the Bulletin, as they are responsible for understanding and adhering to this document.

### Advising

SEAS practices a hybrid advising system. Every entering undergraduate student is assigned a professional advisor to assist with the transition to the University. Faculty advisors are assigned at the end of the first year to counsel students on their programs of study, achievement and maintenance of satisfactory scholastic performance, professional development, and extracurricular activity as part of the educational process. Until all work required for the degree is completed, students must consult with their faculty advisors in all academic matters, including obtaining the advisor's approval of their program of study prior to registration for each academic semester and summer session. In addition, a student must consult their faculty advisor before they register for a course at another institution. The faculty advisor represents the student in all cases requiring faculty action. However, the faculty advisor may not deny entry into any course or activity to which the student is entitled under the regulations of the School. Students may consult other members of the faculty on an informal basis.

### Mathematics Placement

All incoming first-year students are required to take a math proficiency examination, administered through the mathematics department, which places students in either MATH 1220 or MATH 1231. Visit the math placement exam webpage (<https://math.columbian.gwu.edu/gw-mathematics-placement-test>) for more information.

### Makeup of Credit for Waived Courses

Waiver of a required course requires approval of the student's faculty advisor and department chair. If a course required by the SEAS curriculum is waived, the corresponding credits must be earned by satisfactory completion of a university-level academic course, either technical or nontechnical, approved by the student's faculty advisor. The grade earned will be used in determining the SEAS GPA only if the substituted course would normally be considered part of the student's curriculum.

### Scholarship Requirements

To be eligible for graduation a student in SEAS must have:

- A minimum overall GPA of 2.0.
- A minimum overall GPA of 2.0 in their SEAS program.
- A minimum GPA of 2.2 for technical courses\*
- Completed all degree and University General Education requirements.

\*See section on Technical GPA for more information about technical courses.

### Technical GPA

For applied science and technology, biomedical engineering, civil engineering, computer engineering, electrical engineering, mechanical engineering, and systems engineering majors, all technical courses taken during the fifth through eighth semesters as outlined by the 4-year curriculum sheet respective to each major and approved by the student's faculty advisor are counted towards the student's technical GPA.

As of Fall 2014, for Computer Science majors (BA and BS), all CSCI courses are counted towards the student's technical GPA. See *archived SEAS bulletin for prior curriculum year technical GPA requirements for Computer Science majors*.

Please note, if a student changes their major or curriculum year this may change the courses applied towards their technical GPA. Students should consult their faculty advisor before making any changes to their academic plans or curriculum.

### Incompletes

For more information see Incompletes under University Regulations (<http://bulletin.gwu.edu/university-regulations>). In addition, SEAS students must get an incomplete agreement in writing by completing a Request for an Incomplete form (<http://www.seas.gwu.edu/forms>) with the instructor.

### Pass/No Pass Grading System

SEAS students may not take required courses on the Pass/No Pass grading system. They may, however, take courses outside their required SEAS academic program on a P/NP basis.

### Academic Workload

SEAS adheres to all academic workload regulations outlined under University Regulations (<http://bulletin.gwu.edu/university-regulations>). In exceptional cases these limits may be exceeded with the faculty advisor's approval.

### Humanities and Social Science Requirement

With the assistance of the advisor, each student in a SEAS B.S. program chooses a set of elective courses in the humanities and social sciences. For most B.S. curricula, these normally consist of a minimum of 18 credits, divided equally between the humanities and social sciences. At least one of the humanities and two of the social science electives must be selected from a list of approved general education courses.

Since the SEAS curricula are, by necessity, oriented toward technical subjects, the humanities and social sciences electives should be courses that broaden the student's outlook. This includes courses in areas such as anthropology, economics, foreign languages, geography, history, literature, philosophy, political science, psychology, and sociology. A

full menu of courses is available on the SEAS website (<http://www.seas.gwu.edu/forms>).

In addition, when a foreign language is taken as part of the humanities requirement, the following rules apply:

- The foreign language studied may not be a native language of the student, unless the courses taken are literature courses.
- If the student has studied the language previously, he or she must first take a placement test given by the language department concerned and enroll in a course recommended by that department.
- The advisor must approve the program.

## Bachelor of Science Degree Programs

Students should consult the department concerned for total credit requirements for the degree programs. The listed curricula assume that all elective courses are offered for at least 3 credits. Credits for Lifestyle, Sport, and Physical Activity (LSPA) courses cannot be counted toward the degree.

## Bachelor of Arts Degree Programs

SEAS offers a Bachelor of Arts degree with majors in applied science and technology and in computer science. Each program provides a strong and level base for students who intend to make their careers in fields allied to science and technology or computer science. The curriculum requirements for these programs can be viewed under the Undergraduate tab in this section of the Bulletin. The listed curricula assume that all elective courses are offered for at least 3 credits. Credits for Lifestyle, Sport, and Physical Activity (LSPA) courses cannot be counted toward the degree.

## Special Programs

A number of combined 5-year degree programs are available to select SEAS students. These include a B.S./M.S. in civil engineering, mechanical engineering, and systems engineering; B.A. or B.S. and M.S. in computer science or in cybersecurity in computer science; B.S./M.S. in biomedical engineering, computer engineering, or electrical engineering; and B.S. in computer engineering, computer science, electrical engineering, or systems engineering and M.S. in engineering management. In addition, students may complete a 5-year degree in the following cross disciplines: B.S. in biomedical engineering and M.S. in computer engineering, B.S. in electrical engineering and M.S. in computer engineering, and B.S. in computer engineering and M.S. in electrical engineering.

## Double Major

Information on declaring and graduating with a double major is outlined under University Regulations. Students who complete the requirements for two SEAS majors may graduate with a double major, provided the majors are in different departments. SEAS students may also pursue a second major

in another school in the University but must adhere to any requirements outlined by that school or department. SEAS students must consult both their SEAS faculty advisor and an advisor in the department offering the second major. To officially declare a second major, students must complete a Declaration of Second Major (<http://www.seas.gwu.edu/forms>) form and have it signed by both their SEAS faculty advisor and the second major department advisor.

Students from other schools of the University may pursue a second major in one of the six SEAS departments. However, they must consult the department for both eligibility and curriculum requirements before planning to declare the second major. There is a limitation on how many courses may be double counted, which is outlined under University Regulations.

The degree is earned from the home school, and students must complete the major in their own school in order to graduate. In no case will a double major result in two degrees.

For more information see *Double Degrees* under University Regulations (<http://bulletin.gwu.edu/university-regulations>).

## Minors

SEAS offers to all students a variety of minors, including biomedical engineering, computer engineering, computer science, electrical engineering, operations research, and systems engineering. The School may require students to meet certain eligibility requirements to declare the minor. SEAS students may only declare a minor outside their department and must consult their faculty advisor before enrolling in a minor in another school of the University.

SEAS students who wish to declare a minor officially should complete a Declaration of Minor form (<http://www.seas.gwu.edu/forms>), which must be signed by both their SEAS faculty advisor and the minor department advisor. Depending on the student's major, additional credits beyond the minimum required for the minor may be required. Student from schools other than SEAS should email [seasadvising@gwu.edu](mailto:seasadvising@gwu.edu) for more information about requirements and eligibility criteria before requesting to declare a minor through the department.

## Graduate Programs Degree Programs

Fields of graduate study offered by SEAS include biomedical engineering, civil and environmental engineering, computer engineering, computer science, electrical engineering, engineering management, mechanical and aerospace engineering, systems engineering, and (at the M.S. level only) cybersecurity in computer science, telecommunications engineering, and regulatory biomedical engineering (M.Eng.). Degree requirements and representative areas of focus within each field are listed in this section of the Bulletin. In some fields, students may choose to focus their course work in other

specialties as well. For information on certificate, professional, and doctoral degree studies in a given field students should contact the relevant department.

Entrance requirements are outlined under individual degree programs. The following information pertains to all SEAS graduate and certificate programs.

## Transfer of Credit

With the approval of the student's advisor and department chair, graduate credit earned at a level of study equivalent to that being pursued at GW may be transferred, when applicable, to meet degree requirements of the School. For a master's or professional degree candidate, or a doctoral candidate whose highest earned degree is a master's, up to 6 credits may be transferred. For a doctoral candidate whose highest earned degree is a bachelor's, up to 24 credits may be transferred. In all cases, credits must have been completed with a minimum GPA of 3.0 at another accredited and recognized institution. The professional and doctoral degree programs require that the credit be earned no more than five years prior to admission to the GW program, and some departments require that it be earned more recently. Credit applied toward a previously earned degree may not be transferred. Transfer of credit regulations apply to courses taken as a non-degree student through GW's Office of Non-Degree Students; that is, up to 6 credits may be taken in non-degree status before applying for admission to degree status. For purposes of transfer of credit, SEAS graduate certificate programs are not considered prior degrees. At the discretion of the department concerned, the credits earned in a SEAS certificate program may be applied to a subsequent master's degree program.

## English Language Requirements for International Students

Applicants who are not citizens of countries where English is the official language or who do not hold a degree from a regionally accredited U.S. institution of higher learning are required to submit scores from the Test of English as a Foreign Language (TOEFL), the academic International English Language Testing System (IELTS), or the Pearson Test of English-Academic (PTE). Visit the SEAS Graduate Admissions website (<http://graduate.seas.gwu.edu/admissions-requirements>) for possible exemptions from this policy. The required minimum score for admission is 550 paper-based or 80 Internet-based on the TOEFL, an overall band score of 6.0 on the IELTS with no individual band score below 5.0, or a score of 53 on the PTE. The Department of Engineering Management and Systems Engineering requires a TOEFL score of 600 paper-based or 100 internet-based, or an overall band score of 7.0 on the IELTS with no individual band score below 6.0, or a score of 68 on the PTE. Applicants for graduate teaching assistantships must have a minimum score of 600 paper-based or 100 Internet-based on the TOEFL, an overall band score of 7.0 on the IELTS with no individual band score below 6.0, or a score of 68 on the PTE.

Undergraduate and graduate international students whose TOEFL, IELTS, or PTE scores fall below established cut-off points are required to take one or more courses in the English for Academic Purposes (EAP) Program. Both undergraduate and graduate students receive credit for EAP courses; however, in most cases graduate EAP credits cannot be applied to a degree. Graduate students placed in EAP courses should anticipate additional tuition expenses as well as possible extension of time needed to complete their degree programs. For detailed information concerning this requirement, consult the English for Academic Purposes Program website.

## Grades

Information on grades and computing the grade-point average (GPA) is found under University Regulations (<http://bulletin.gwu.edu/university-regulations>).

## Incompletes

At the option of the instructor, the symbol of *I* (Incomplete) may be recorded if a student, for reasons beyond his or her control, is unable to complete the work of the course and if the instructor is informed of and approves such reasons before the date when grades must be reported. The symbol *I* may be recorded only if the student's prior performance and class attendance in the course have been satisfactory. Any course in which a student fails to complete the work of the course and does not provide the instructor with a satisfactory explanation before the date when grades must be turned in will be graded *F*. If acceptable reasons are later presented, the instructor may initiate an appropriate grade change. Although the *I* may remain on the record for a maximum of one year, the instructor should normally set a much briefer period within which the uncompleted work must be made up. The *I* cannot be removed by the student's reregistering for the course at GW or taking its equivalent elsewhere. An Incomplete that is not removed within one calendar year or at the time of the student's graduation, whichever occurs first, is automatically changed to an *F*. As of fall 2014, when the *I* is changed to a letter grade the *I* will be replaced by the letter grade on the transcript. As of fall 2014, when the *I* is changed to a letter grade the will be replaced by the letter grade on the transcript. Engineering Management and Systems Engineering students with two or more outstanding Incompletes are barred from further course enrollment; see Incompletes under University Regulations regarding continuous enrollment.

## Credit/No Credit Grading System

SEAS students may take SEAS courses under the credit/no credit grading system, but credit for such courses cannot be applied toward any degree program in SEAS.

## Educational Planner

In consultation with an academic advisor, each student must develop an Educational Planner through DegreeMAP that governs the student's degree requirements. The Educational Planner should be established soon after matriculation and must be completed before the end of the student's first

semester. The Educational Planner must be approved by the advisor..

## Residence and Continuous Enrollment

All work for the degree must be done in residence unless an exception is granted by the department chair. Students in a degree program are expected to be continuously enrolled in the School until the degree is conferred. To maintain continuous enrollment, students may register in one of the following categories. See Residence and Continuous Enrollment under University Regulations (<http://bulletin.gwu.edu/university-regulations>) for more information.

### Leave of Absence

This status is available to students who, with special permission, are attending classes at another institution; who have temporarily transferred out of the area, e.g., for military TDY; or who are having temporary medical problems. A leave of absence is usually limited to two semesters. See Leave of Absence under University Regulations (<http://bulletin.gwu.edu/university-regulations>) for more information.

### Continuing Research

Students who have completed their research credits, but are not yet ready to defend a thesis or dissertation, must register for 1 credit of SEAS 0920 (Continuing Research–Master’s) or SEAS 0940 (Continuing Research–Doctoral) each semester as appropriate.

## Examination Preparation

Students who are studying for a comprehensive or qualifying examination for the current or following semester, and are not taking any courses, must register for 1 credit of SEAS 0930 (Examination Preparation) as appropriate. A student who breaks his or her registration must apply for readmission to the degree program under whatever conditions and regulations are in force at that time.

## Master of Science

The M.S. degree is offered in the fields of biomedical engineering, civil and environmental engineering, computer engineering, computer science, electrical engineering, engineering management, mechanical and aerospace engineering, systems engineering, cybersecurity in computer science, and telecommunications engineering. Each field in turn encompasses several areas of focus. The course of study responds to the unique interests of the student, who designs an individual program in close consultation with an assigned advisor. In most areas, students follow a prescribed core and approved elective courses from within SEAS and from other schools of the University. Because engineering expertise includes a broad foundation in technology, engineering students may profit from study in other academic areas to sharpen their focus in practice. Students must satisfy, through

undergraduate studies or otherwise, either the prerequisites specified for the desired field or approved equivalents.

## Entrance Requirements

Admission to the Master of Science degree program requires an appropriate bachelor’s degree from a recognized institution and evidence of a strong academic background and capacity for productive work in the field selected. All applicants must submit scores from the Graduate Record Examination (GRE) general test, with the exception of applicants from SEAS undergraduate programs and those applying to special cohort and contract programs. In general, a minimum GPA of 3.0 (on a 4.0 scale) in the last 60 hours of undergraduate course work is recommended. Students must submit a statement of purpose and a minimum of two letters of recommendation, which may be from the student’s advisor, faculty member(s) from the institution where the highest degree was earned, and/or workplace supervisor. Visit the Graduate Admissions website (<http://www.gwu.edu/gradapply>) for more information.

## Special Programs

Admission to the 5 year B.S./M.S. combined degree program requires an appropriate bachelor’s degree from SEAS undergraduate programs recognized in the Regulations section. In general, a minimum GPA of 3.4 (on a 4.0 scale) is required. Students must submit a statement of purpose and a minimum of two letters of recommendation, which may be from the student’s advisor, faculty member(s) from the institution where the highest degree was earned, and/or workplace supervisor. Visit the Graduate Admissions website (<http://www.gwu.edu/gradapply>) for more information.

Completion of the program should occur within two semesters but can take up to four semesters after the conferral of their SEAS undergraduate degree.

## Graduation and Scholarship Requirements

To meet graduation requirements, courses specified in a student’s Educational Planner through DegreeMAP must be completed with a minimum GPA of 3.0. This is in addition to the requirements specified for graduation under University regulations. Courses specified upon admission as deficiency or prerequisite courses do not form part of the program of study. Students who receive two grades of *F* or three grades below *B–* are barred from further enrollment in graduate courses and will not be readmitted as a degree candidate. Students may not repeat for credit a course in which they have received a grade of *C–* or above, unless required to do so by the department chair. A written statement requiring a student to repeat such a course for credit must be submitted to the registrar by the department chair. See further graduation policies under University Regulations (<http://bulletin.gwu.edu/university-regulations>).

## Time Limits

Full-time students in the master’s program are allowed a maximum of three calendar years from the date of first

registration as a degree candidate in prerequisite or graduate courses to complete all degree requirements; this time limit excludes any time spent taking English for Academic Purposes courses only. Part-time students in the master's program are allowed a maximum of five calendar years. The time limit does not include any period of registration as an unclassified student before admission to degree candidate status or any period spent on approved leave of absence. Students on F1 or J1 visas and students with external funding may have different time limits. Students who do not complete degree requirements within the allowed time will have their degree candidate status terminated. They may be readmitted to degree candidate status under conditions specified by the department chair and approved by the dean.

## Master's Thesis

The master's thesis must demonstrate a student's ability to make independent use of the knowledge and discipline of thought acquired through graduate study, to undertake constructive work in a given field, and to communicate the results of the work in writing. Suitable work for which the student has professional responsibility may be considered, whether done on or off campus, provided no significant amount of work is completed without faculty supervision. An accepted thesis is the property of the University.

To register for the thesis course sequence, students must submit their advisor-approved thesis area to the appropriate department chair. At the beginning of the semester of expected graduation, students must submit their thesis title to the dean. Both submissions must be made on the appropriate form available in the Graduate Student Services Center. While registered in the thesis course sequence, students are entitled to the advice of the faculty member under whom the thesis is to be written. Students may consult with their advisors, but they have primary responsibility for their own thesis. Students defend their theses orally before a committee of SEAS faculty members.

The thesis in final form must be submitted by the stated deadline. In the event a thesis is unfinished on the date specified, the student must register for SEAS 0920 (Continuing Research - Master's). The overall time limit for earning the degree (see Time Limits, above) may not be exceeded. All theses must be submitted electronically and meet the formatting and other requirements set forth on GW's Electronic Theses and Dissertations Submission website (<http://library.gwu.edu/etds>). Additional information regarding thesis requirements and dates may be found under University Regulations (<http://bulletin.gwu.edu/university-regulations>).

## Master of Engineering (M.Eng.)

The M.Eng. degree is currently offered in the field of regulatory biomedical engineering (rBME). The Master of Engineering in Regulatory Biomedical Engineering (rBME) is an interdisciplinary program offered through the Department

of Biomedical Engineering (<http://bme.seas.gwu.edu>) in partnership with GW's School of Medicine and Health Sciences (<http://smhs.gwu.edu>). The new program addresses a pressing need for a graduate program to train engineers in the specific set of skills of regulatory science, biomedical innovation, and entrepreneurship. Students with training in engineering or physics and/or relevant industry/government experience study the fundamentals of biomedical engineering, global regulatory affairs, regulatory strategy in the development of devices and diagnostics, regulatory compliance, engineering patent law, medical measurements, and instrument design. In addition to coursework, students gain experience in SBIR/STTR grant applications and/or FDA Premarket Notification (510(k)) submissions for medical devices.

## Entrance Requirements

Admission to the Master of Engineering degree program requires an appropriate bachelor's degree from a recognized institution and evidence of a strong academic background and capacity for productive work in the field selected. All applicants must submit scores from the Graduate Record Examination (GRE) general test, with the exception of applicants from SEAS undergraduate programs and those applying to special cohort and contract programs. In general, a minimum GPA of 3.0 (on a 4.0 scale) in the last 60 hours of undergraduate course work is recommended. Students must submit a statement of purpose and a minimum of two letters of recommendation, which may be from the student's advisor, faculty member(s) from the institution where the highest degree was earned, and/or workplace supervisor. Visit the Graduate Admissions website (<http://www.gwu.edu/gradapply>) for more information.

## Graduation and Scholarship Requirements

To meet graduation requirements, courses specified in a student's Educational Planner through DegreeMAP must be completed with a minimum GPA of 3.0. This is in addition to the requirements specified for graduation under University regulations. Courses specified upon admission as deficiency or prerequisite courses do not form part of the program of study. Students who receive two grades of F or three grades below B- are barred from further enrollment in graduate courses and will not be readmitted as a degree candidate. Students may not repeat for credit a course in which they have received a grade of C- or above, unless required to do so by the department chair. A written statement requiring a student to repeat such a course for credit must be submitted to the registrar by the department chair. See further graduation policies under University Regulations (<http://bulletin.gwu.edu/university-regulations>).

## Time Limits

Full-time students in the M.Eng. program are allowed a maximum of three calendar years from the date of first registration as a degree candidate in prerequisite or graduate courses to complete all degree requirements; this time limit excludes any time spent taking English for Academic Purposes courses only. Part-time students in the master's program are

allowed a maximum of five calendar years. The time limit does not include any period of registration as an unclassified student before admission to degree candidate status or any period spent on approved leave of absence. Students on F1 or J1 visas and students with external funding may have different time limits. Students who do not complete degree requirements within the allowed time will have their degree candidate status terminated. They may be readmitted to degree candidate status under conditions specified by the department chair and approved by the dean.

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## Graduate Certificates

### Entrance Requirements

Admission to SEAS certificate programs requires an appropriate bachelor's degree from a recognized institution and evidence of a strong academic background and capacity for productive work in the field selected. All applicants must provide an online application, statement of purpose, and resume and/or curriculum vitae. In general, a minimum GPA of 3.0 (on a 4.0 scale) in the last 60 hours credits of undergraduate course work is recommended. Certificate applicants are not required to submit letters of recommendation. Visit the Graduate Admissions website (<http://www.gwu.edu/gradapply>) for more information.

### Graduation and Scholarship Requirements

In order to receive the graduate certificate students must have a minimum GPA in courses specified in their Educational Planner through DegreeMAP. Courses specified upon admission as deficiency or prerequisite courses do not form part of the program of study. Students who receives two grades of *F* or three grades below *B-* are barred from further enrollment in graduate courses, and will not be readmitted as a candidate. Students may not repeat for credit a course in which they have received a grade of *C-* or above, unless required to do so by the department chair. A written statement requiring a student to repeat such a course for credit must be submitted to the registrar by the department chair. Additional information regarding graduation requirements may be found under University Regulations (<http://bulletin.gwu.edu/university-regulations>).

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## Professional Degrees

The SEAS professional degree programs are designed for those students who wish to pursue course work beyond the master's degree with emphasis on applied subject material rather than on basic research. Successful completion of the professional degree program leads to the degree of Engineer or of Applied Scientist.

For admission to the degree of Engineer, an applicant must have earned both a bachelor's and master's degree in an area of engineering. For the degree of Applied Scientist, an applicant must possess a master's degree in engineering,

computer science, natural science, or mathematics. Applicants who have an equivalent quantitative background may be considered as special cases by the respective departments.

### Entrance Requirements

For admission to the degree of Engineer, an applicant must have earned both a bachelor's and master's degree in an area of engineering. For the degree of Applied Scientist, an applicant must possess a master's degree in engineering, computer science, natural science, or mathematics. Applicants who have an equivalent quantitative background may be considered as special cases by the respective departments.

Entrance requirements may vary by department within SEAS. A minimum GPA of 3.0 in graduate work is usually required, although individual departments often set higher admission standards. Some programs have specified prerequisites. An applicant who has significant deficiencies in preparation may be required to take prerequisite courses, which do not count toward any part of the requirements for the professional degree. The Departments of Computer Science and Electrical and Computer Engineering require applicants for the professional degree to have had two years of professional experience after receiving the master's degree. For specific entrance and application requirements see Master's Degree.

### Graduation and Scholarship Requirements

The professional degree programs consist of a minimum of 30 credits in approved graduate-level courses beyond a master's degree. Programs of study are determined by established prerequisites and the requirements of the department in which the student wishes to enroll. The student's program must be approved by the faculty advisor and the department chair. Departments may require degree candidates to undertake and defend the results of a technical design project or development problem, or to prepare a comprehensive technical report to demonstrate the candidate's ability to make independent use of the knowledge and discipline of thought acquired through graduate study. When applicable, the student will be informed of this requirement by the faculty advisor at the time when the student's program is being formulated. The project may not account for more than 6 credits.

If a student studying for the professional degree receives two grades of *F* or three grades below *B-*, study is terminated and further enrollment prohibited. A student must have a minimum of GPA of 3.0 in order to receive the degree. The Department of Engineering Management and Systems Engineering requires a final GPA of at least 3.4.

### Time Limits

A full-time student in the master's program is allowed a maximum of three calendar years from the date of first registration as a degree candidate in prerequisite or graduate courses to complete all degree requirements. A part-time student is allowed a maximum of five calendar years. The time limit does not include any period of registration as an

unclassified student before admission to degree candidate status or any period spent on approved leave of absence. Students who do not complete degree requirements within the allowed time will have their degree candidate status terminated. Such students may be readmitted to degree candidate status under conditions specified by the department chair.

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## Doctoral Programs

### Doctor of Philosophy

The doctoral program is designed to prepare students for careers of creative scholarship by providing a broad but balanced background of knowledge and guidance in the performance of research. The program is divided into two stages: the first comprises a study of related fields of learning that support the general area of research concentration and culminates in a qualifying examination; the second, composed of original research and the presentation of findings in a written dissertation, culminates in a final examination.

### Entrance Requirements

Admission to the Ph.D. program requires an appropriate bachelor's or master's degree from a recognized institution, evidence of a strong academic or relevant professional background, course work designated by the department as pertinent to the field to be studied, and capacity for research. With the exception of applicants from SEAS B.S. and M.S. programs, applicants must submit scores from the Graduate Record Examination (GRE) general test. All applicants must submit a minimum of three letters of recommendation, at least one of which should be from the advisor and/or faculty members at the institution(s) from which a degree was earned. Students for whom the bachelor's is the highest earned degree must have a minimum GPA of 3.3 (on a 4.0 scale) in undergraduate work. Students for whom the master's is the highest earned degree, departmental requirements for the GPA in course work leading to that degree are as follows (on a 4.0 scale): Civil and Environmental Engineering, Electrical and Computer Engineering, and Mechanical and Aerospace Engineering—3.4; Computer Science, and Engineering Management and Systems Engineering—3.5. Consult the department concerned for field-specific admission requirements.

### Graduation and Scholarship Requirements

Upon admission to the first stage of the program—study of related fields culminating in the qualifying examination—students are assigned a faculty advisor who directs his or her studies. In some departments, a faculty committee may be appointed instead of a single advisor. Programs of study are structured to include a major field and two minor or supporting fields. Consult the department concerned for requirements.

For students who enter the program with a master's degree, the formal program of study consists of a minimum of 30

graduate-level credits. For students who enter with a bachelor's degree only, the program of study consists of a minimum of 54 graduate-level credits. These credits include both course and dissertation research credit. Individual requirements may vary by department. In many cases, particularly when the student undertakes a doctoral program in a field other than that in which the earlier degree was earned, the program of study exceeds the minimum number of credits stated above. Departments may establish a tool requirement, such as an examination in a computer language. Consult the department concerned for specific curriculum requirements.

If a doctoral student receives two grades of *F* or three grades below *B–*, graduate study is terminated and further enrollment prohibited. Courses in which the student earned grades below *B–* are not included in the total credit requirement for the degree. Students who receive any grade below *B–* are required to review their programs of study with their advisors.

### Time Limits

In general, one year of full-time study is the minimum amount of time needed to prepare for the qualifying examination. Students should consult the individual department for specific timelines and regulations. In general, the qualifying examination must be completed within five years of the date of admission, unless specified otherwise by the department. The entire degree program must be completed within seven years, unless the department grants an extension. Approval of an extension is conditional on satisfactory progress. The time period for completion of the degree may be adjusted by the department for an approved leave of absence. A minimum of two years of full-time study and research should be expected. All time periods indicated here are increased by two years for students entering the doctoral program without a master's degree.

Full-time doctoral students must register for a minimum of 9 credits per semester until the minimum number of credits are completed, and 1 credit of SEAS 0940 (Continuing Research - Doctoral) each semester thereafter until satisfactory completion of the final examination. Part-time doctoral students usually register for a minimum of 6 credits per semester until the minimum number of credits is completed, and 1 credit of Continuing Research each semester thereafter until satisfactory completion of the final examination. No minimum course load is required during the summer

### Preliminary and Qualifying Examinations

The Department of Computer Science requires a preliminary examination that must be passed within four semesters of starting the program. It comprises material from the areas of algorithms and theory, and software and systems.

The Department of Electrical and Computer Engineering requires a preliminary examination that must be taken before completing 18 credits after initial registration. The examination is guided by, but not limited to, the core material of the GW



master's program. Specific details regarding the structure of the exam are available in the department.

To be admitted to the qualifying examination that is required of all doctoral students, students must have a minimum cumulative GPA of 3.2 in the Departments of Civil and Environmental Engineering and Computer Science, and of 3.4 in the Departments of Mechanical and Aerospace Engineering, Engineering Management and Systems Engineering, and Electrical and Computer Engineering.

The qualifying examination is the principal means of determining whether a student will qualify as a candidate for the doctoral degree and progress to the second stage of the program. Its purpose is to ascertain whether the student's background and intellectual development are adequate to support doctoral research in the central field.

Preliminary and qualifying examinations may be written or oral or both. Students should consult the departments for specific guidelines. The examinations are conducted on dates established by the departments and are administered by a faculty committee. Upon favorable report of the examiners following the qualifying examination, students are admitted to candidacy for the degree. Students then begin specialized study and research under the supervision of a designated member of the full-time faculty. At the discretion of the committee that prepared the examination, students who fail any part of the qualifying examination may be given a second opportunity to qualify for candidacy. Usually, the entire examination must be retaken. Students who fail to qualify for candidacy in a doctoral program of the School will be considered to have failed on a school-wide basis and will not be admitted to further doctoral study within the School.

## The Dissertation and Final Examination

Students admitted to candidacy for the degree of Doctor of Philosophy choose the faculty member under whom they wish to conduct research. The faculty member may accept or reject the request to serve as the student's director of research. The research area must be approved by the director, under whom the candidate conducts dissertation research throughout the remainder of the doctoral program. Students may consult other members of the faculty on an informal basis. In the Departments of Engineering Management and Systems Engineering and Civil and Environmental Engineering, students are required to present a written dissertation proposal to a committee of three full-time faculty members and to successfully defend the proposal in an oral defense prior to performing the bulk of their dissertation research. Work on the dissertation encompasses a minimum of 12 to 24 credits, depending on the department.

The dissertation should embody the results of extended original study and include material deemed worthy of publication in recognized scientific and engineering journals. Students are expected to attempt to have the results of the research published as soon as possible after they receive

the degree and to submit copies of the published material to the dean. The Department of Computer Science requires that at least one article be accepted for publication by a refereed conference or journal prior to completion of degree requirements. The Department of Engineering Management and Systems Engineering requires that an article be accepted for review by a refereed journal prior to completion of degree requirements. The Department of Electrical and Computer Engineering requires the submission of a paper to a refereed journal and its acceptance for publication prior to the completion of degree requirements. Credit must be given in the publication to the fact that the material is abstracted, summarized, or developed from a dissertation submitted to The George Washington University in partial fulfillment of the requirements for the Ph.D.

All dissertations must be submitted electronically and meet the formatting and other requirements set forth at GW's Electronic Theses and Dissertations Submission website (<http://library.gwu.edu/etds>). Regulations regarding the form of the dissertation and preparation of the abstract are available in department offices. The dissertation, with accompanying files, becomes the property of the University.

Upon acceptance of the dissertation by the research committee, the candidate is presented for the final examination. The final examination is oral and is open to the public. The candidate must demonstrate a mastery of the special field of study and of the materials and techniques used in the research. The committee of examiners may include qualified experts brought to the University especially to participate in the examination. The director of research usually serves as advocate for the candidate. Students should consult department regulations concerning the formation of the committee and scheduling of the examination. When the examining committee is convinced of the quality and originality of the candidate's contribution to knowledge as well as his or her mastery of the scholarship and research techniques of the field, the committee recommends the candidate for the degree of Doctor of Philosophy. Students completing their degree program should refer to the sections on Eligibility for Graduation and Participation in the Commencement Ceremony under University Regulations.

## Doctor of Engineering

The School of Engineering and Applied Science offers an off-campus Doctor of Engineering (D.Eng.) degree program. The Doctor of Engineering program addresses the widespread need for practitioners who can apply the knowledge they gain in the program of study within a business or technical environment, wherein the constant challenge is to create useful applications of the latest engineering principles and lead organizations that are occupied in this work.

The Doctor of Engineering degree currently is offered only in Engineering Management (EM).

## Doctor of Engineering in Engineering Management

The D.Eng. (EM) program demands that research be applied to the solution of a real-world problem using the latest engineering concepts and tools—in other words, research toward the D.Eng. program is applied, rather than basic. Its purpose is to empower students, who are likely to be practicing engineers, to create advanced, practice-based solutions.

Admission to the D.Eng.(EM) program requires: (1) bachelor's and master's degrees from accredited institutions in engineering, applied science, mathematics, computer science, business administration, or information technology; (2) a minimum of two college-level calculus courses passed with grades of C or better; and (3) a minimum graduate-level GPA of 3.5 (on a 4.0 scale).

The D.Eng. (EM) program consists of 45 credits divided into a classroom phase of 10 graduate-level, three-credit courses, and a research phase during which a practice-based case study is undertaken on a topic related to engineering management, chosen by the student and approved by the adviser. Research for the case study comprises 15 credits. Prospective students are advised to contact the Engineering Management and Systems Engineering Department for additional information.

### Transfer Between Degree Programs

Candidates for the professional or Doctor of Philosophy degree who are in good academic standing may, with the approval of the faculty advisor and department chair, transfer from one degree program to the other within their department if they meet the qualifications and requirements specified by the department. In the Department of Engineering Management and Systems Engineering, only one such transfer is permitted.

## UNDERGRADUATE

### Bachelor's programs

- Bachelor of Arts with a major in applied science and technology (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/bs-applied-science-technology>)
- Bachelor of Arts with a major in computer science (<http://bulletin.gwu.edu/engineering-applied-science/computer-science/ba>)
- Bachelor of Science with a major in biomedical engineering (<http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/bs>)
- Bachelor of Science with a major in civil engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/bs-civil-engineering>)
- Bachelor of Science with a major in civil engineering, environmental engineering option (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/bs-civil-engineering/environmental>)
- Bachelor of Science with a major in civil engineering, medical preparation option (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/bs-civil-engineering/medical-preparation>)
- Bachelor of Science with a major in civil engineering, sustainability engineering option (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/bs-civil-engineering/sustainability>)
- Bachelor of Science with a major in civil engineering, transportation engineering option (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/bs-civil-engineering/transportation>)
- Bachelor of Science with a major in computer engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/bs-computer-engineering>)
- Bachelor of Science with a major in computer science (<http://bulletin.gwu.edu/engineering-applied-science/computer-science/bs>)
- Bachelor of Science with a major in electrical engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/bs-electrical-engineering>)
- Bachelor of Science with a major in electrical engineering, energy option (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/bs-electrical-engineering/energy>)
- Bachelor of Science with a major in electrical engineering, medical preparation option (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/bs-electrical-engineering/medical-preparation>)
- Bachelor of Science with a major in mechanical engineering (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/bs-mechanical-engineering>)
- Bachelor of Science with a major in mechanical engineering, aerospace option (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/bs-mechanical-engineering/aerospace>)
- Bachelor of Science with a major in mechanical engineering, biomechanical option (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/bs-mechanical-engineering/biomechanical>)
- Bachelor of Science with a major in mechanical engineering, medical preparation option (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/bs-mechanical-engineering/medical-preparation>)
- Bachelor of Science with a major in mechanical engineering, patent law option (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/bs-mechanical-engineering/patent-law>)
- Bachelor of Science with a major in mechanical engineering, robotics option (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/bs-mechanical-engineering/robotics>)

- Bachelor of Science with a major in systems engineering (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/bs-systems-engineering>)

## Minors

- Minor in biomedical engineering (<http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/minor>)
- Minor in computer engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/minor-computer-engineering>)
- Minor in computer science (<http://bulletin.gwu.edu/engineering-applied-science/computer-science/minor>)
- Minor in electrical engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/minor-electrical-engineering>)
- Minor in mechanical engineering (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/minor-mechanical-engineering>)
- Minor in operations research (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/minor-operations-research>)
- Minor in systems engineering (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/minor-systems-engineering>)

## Combined programs

- Combined Bachelor of Science with a major in biomedical engineering and Master of Engineering in the field of regulatory biomedical engineering (<http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/combined-bs-meng-regulatory-biomedical-engineering/#text>)
- Combined Bachelor of Science with a major in civil engineering and Master of Science in the field environmental engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/combined-bs-ms-environmental-engineering>)
- Combined Bachelor of Science with a major in civil engineering and Master of Science in the field structural engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/combined-bs-ms-structural-engineering>)
- Combined Bachelor of Science with a major in civil engineering and Master of Science in the field transportation engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/combined-bs-ms-transportation-engineering>)
- Combined Bachelor of Science with a major in mechanical engineering and Master of Science in the field mechanical engineering (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/combined-bs-ms-mechanical-engineering>)

## GRADUATE

### Master's programs

- Master of Engineering in the field of regulatory biomedical engineering (<http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/regulatory-biomedical-engineering>)
- Master of Engineering in the field of cybersecurity policy and compliance (online) (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/cybersecurity-policy-and-compliance-meng/#text>)
- Master of Science in the field of biomedical engineering (<http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/ms>)
- Master of Science in the field of civil and environmental engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/ms>)
- Master of Science in the field of computer science (<http://bulletin.gwu.edu/engineering-applied-science/computer-science/ms>)
- Master of Science in the field of computer engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/computer-engineering>)
- Master of Science in the field of cybersecurity in computer science (<http://bulletin.gwu.edu/engineering-applied-science/computer-science/ms-cybersecurity>)
- Master of Science in the field of electrical engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/electrical-engineering>)
- Master of Science in the field of engineering management (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/engineering-management-ms>)
- Master of Science in the field of mechanical and aerospace engineering (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/ms>)
- Master of Science in the field of systems engineering (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/systems-engineering-ms>)
- Master of Science in the field of telecommunications engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/telecommunications-engineering>)

### Doctoral programs

- Doctor of Engineering in the field of engineering management (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/doctor-engineering-management>)
- Doctor of Philosophy in the field of biomedical engineering (<http://bulletin.gwu.edu/engineering-applied-science/biomedical-engineering/phd>)

- Doctor of Philosophy in the field of civil and environmental engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/phd>)
- Doctor of Philosophy in the field of computer engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/phd-computer-engineering>)
- Doctor of Philosophy in the field of computer science (<http://bulletin.gwu.edu/engineering-applied-science/computer-science/phd>)
- Doctor of Philosophy in the field of electrical engineering (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/phd-electrical-engineering>)
- Doctor of Philosophy in the field of engineering management (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/phd-engineering-management>)
- Doctor of Philosophy in the field of mechanical and aerospace engineering (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/phd>)
- Doctor of Philosophy in the field of systems engineering (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/phd-systems-engineering>)

[applied-science/engineering-management-systems-engineering/engineering-technology-management](http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/engineering-technology-management))

- Graduate certificate in enterprise information assurance (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/enterprise-information-assurance-certificate>)
- Graduate certificate in environmental engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/environmental-engineering>)
- Graduate certificate in e (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/environmental-energy-systems-management-certificate>)nvironmental and energy systems management
- Graduate certificate in geoenvironmental engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/geoenvironmental-engineering>)
- Graduate certificate in greenhouse gas management (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/greenhouse-gas-management-certificate>)
- Graduate certificate in high-performance computing (<http://bulletin.gwu.edu/engineering-applied-science/electrical-computer-engineering/certificate-high-performance-computing>)
- Graduate certificate in homeland security emergency preparedness and response (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/homeland-security-emergency-preparedness-response-certificate>)
- Graduate certificate in structural engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/structural-engineering>)
- Graduate certificate in systems engineering (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/systems-engineering-certificate>)
- Graduate certificate in transportation engineering (<http://bulletin.gwu.edu/engineering-applied-science/civil-environmental-engineering/transportation-engineering>)

## CERTIFICATES

At the discretion of the respective departments, credit earned in a certificate program may be applied to a subsequent master's degree program. Scholarship requirements are the same as those for the master's degree program. Details are available in the Office of the Dean.

- Graduate certificate in computer-integrated design in mechanical and aerospace engineering (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/certificate-computer-integrated-design>)
- Graduate certificate in computer security and information assurance (<http://bulletin.gwu.edu/engineering-applied-science/computer-science/certificate-computer-security-information-assurance>)
- Graduate certificate in emergency management and public health (<http://bulletin.gwu.edu/engineering-applied-science/engineering-management-systems-engineering/emergency-management-public-health-certificate>)
- Graduate certificate in energy engineering and management (<http://bulletin.gwu.edu/engineering-applied-science/mechanical-aerospace-engineering/energy-engineering-management>)
- Graduate certificate in engineering and technology management (<http://bulletin.gwu.edu/engineering->

## COURSES

### Explanation of Course Numbers

- Courses in the 1000s are primarily introductory undergraduate courses
- Those in the 2000–4000s are upper-division undergraduate courses that can also be taken for graduate credit with permission and additional work
- Those in the 6000s and 8000s are for master's, doctoral, and professional-level students

- The 6000s are open to advanced undergraduate students with approval of the instructor and the dean or advising office
- Applied Sciences (APSC) (<http://bulletin.gwu.edu/courses/apsc>)
- Biomedical Engineering (BME) (<http://bulletin.gwu.edu/courses/bme>)
- Civil Engineering (CE) (<http://bulletin.gwu.edu/courses/ce>)
- Computer Science (CSCI) (<http://bulletin.gwu.edu/courses/csci>)
- Electrical and Computer Engineering (ECE (<http://bulletin.gwu.edu/courses/ece>)) (<http://bulletin.gwu.edu/courses/ece>)
- Engineering Management and Systems Engineering ( (<http://bulletin.gwu.edu/courses/emse>)EMSE (<http://bulletin.gwu.edu/courses/emse>))
- Mechanical and Aerospace Engineering ( (<http://bulletin.gwu.edu/courses/mae>)MAE (<http://bulletin.gwu.edu/courses/mae>))
- School of Engineering and Applied Sciences ( (<http://bulletin.gwu.edu/courses/seas>)SEAS (<http://bulletin.gwu.edu/courses/seas>))