CHEMICAL ENGINEERING, PH.D.

The Department of Chemical and Biological Engineering has a tradition of excellence dating back to 1905. For over a century, the program has consistently ranked as one of the best in the world. The department offers research opportunities in both traditional and emerging areas of research in chemical and biological engineering. These areas include energy-related science and technology, soft and hard materials science and engineering, systems engineering and optimization, catalysis, process control and design, nanotechnology, biotechnology, biomedical engineering, complex fluids, colloid and interfacial phenomena, atomic, molecular, and multiscale modeling, polymers (synthesis and processing), micro- and nano-electronics, environmental engineering and sustainability, reactor design, and atomic-scale design of surface reactivity. These areas of research are advanced by leveraging tools from the fields of applied mathematics, statistical mechanics, kinetics and catalysis, thermodynamics, and transport phenomena. The graduate courses are planned to train outstanding students for advanced work in research and development. Graduate students in the department are encouraged to participate in international research experiences, industry internships, and entrepreneurial activities.

Research in the department is highly interdisciplinary, capitalizing on programs of national prominence such as the NSF Materials Research Science and Engineering Center (MRSEC), the nation’s largest NIH-funded biotechnology training program, and the Computation and Informatics in Biology and Medicine training program. Interdisciplinary research opportunities are also available through the Materials Science Program, the Center for Nanotechnology, and the Rheology Research Center. Researchers in the department have access to state-of-the-art facilities for research, including facilities for nanofabrication and the life sciences.

ADMISSIONS

GRADUATE SCHOOL ADMISSIONS

Graduate admissions is a two-step process between academic degree programs and the Graduate School. Applicants must meet requirements of both the program(s) and the Graduate School. Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/admissions).

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Deadline</td>
<td>December 15</td>
</tr>
<tr>
<td>Spring Deadline</td>
<td>October 15</td>
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<tr>
<td>Summer Deadline</td>
<td>The program does not admit in the summer.</td>
</tr>
<tr>
<td>GRE (Graduate Record Examinations)</td>
<td>Required.</td>
</tr>
<tr>
<td>English Proficiency Test</td>
<td>Every applicant whose native language is not English or whose undergraduate instruction was not in English must provide an English proficiency test score and meet the Graduate School minimum requirements (<a href="https://grad.wisc.edu/apply/requirements/#english-proficiency">https://grad.wisc.edu/apply/requirements/#english-proficiency</a>).</td>
</tr>
<tr>
<td>Other Test(s) (e.g., GMAT, MCAT)</td>
<td>n/a</td>
</tr>
<tr>
<td>Letters of Recommendation</td>
<td>3</td>
</tr>
<tr>
<td>Recommendation Required</td>
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</tr>
</tbody>
</table>

Students with a strong background in chemical engineering or related field and a strong interest in research are encouraged to apply for admission. Most applicants accepted into the program have grade-point averages well above the Graduate School minimum of 3.0 on a 4.0 scale. All applicants are required to take the Graduate Record Exam (GRE) general test. Applications are evaluated on the basis of previous academic record, GRE scores, letters of recommendation, and personal statement. The Department of Chemical and Biological Engineering does not consider applications for a terminal M.S. degree; the department admits only to the Ph.D. An M.S. degree can be awarded post admission as an alternative to the Ph.D. degree. The M.S. degree is not a prerequisite for the Ph.D. degree.

Applicants with degrees in the physical or life sciences or other engineering fields are encouraged to apply for admission into the Ph.D. graduate program. These students should contact the chair of the graduate admissions committee to discuss their preparation for the graduate program. Students are not accepted for spring semester except when space is available. Fall applications and supporting materials must be received by December 15.

FUNDING

GRADUATE SCHOOL RESOURCES

Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information (https://grad.wisc.edu/funding) is available from the Graduate School. Be sure to check with your program for individual policies and processes related to funding.

PROGRAM RESOURCES

Students admitted to the graduate program are guaranteed financial support from the department in the form of research assistantships, teaching assistantships and fellowships. Support will continue as long as the student maintains satisfactory progress toward their degree.

REQUIREMENTS

MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum academic progress and degree requirements (http://guide.wisc.edu/graduate/#policiesandrequirementstext), in addition to the program requirements listed below.

MAJOR REQUIREMENTS

MODE OF INSTRUCTION
Mode of Instruction Definitions

Evening/Weekend: These programs are offered in an evening and/or weekend format to accommodate working schedules. Enjoy the advantages of on-campus courses and personal connections, while keeping your day job. For more information about the meeting schedule of a specific program, contact the program.

Online: These programs are offered primarily online. Many available online programs can be completed almost entirely online with all online programs offering at least 50 percent or more of the program work online. Some online programs have an on-campus component that is often designed to accommodate working schedules. Take advantage of the convenience of online learning while participating in a rich, interactive learning environment. For more information about the online nature of a specific program, contact the program.

Hybrid: These programs have innovative curricula that combine on-campus and online formats. Most hybrid programs are completed on-campus with a partial or completely online semester. For more information about the hybrid schedule of a specific program, contact the program.

Accelerated: These on-campus programs are offered in an accelerated format that allows you to complete your program in a condensed time-frame. Enjoy the advantages of on-campus courses with minimal disruption to your career. For more information about the accelerated nature of a specific program, contact the program.

CURRICULAR REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirements Detail</th>
<th>Minimum Credit Requirement</th>
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</thead>
<tbody>
<tr>
<td>Minimum Credit Requirement</td>
<td>51 credits</td>
</tr>
<tr>
<td>Minimum Residence Credit Requirement</td>
<td>32 credits</td>
</tr>
</tbody>
</table>

Minimum Graduate Coursework Requirement: Half of degree coursework (26 credits out of 51 total credits) must be completed graduate-level coursework; courses with the Graduate Level Coursework attribute are identified and searchable in the university's Course Guide.

Overall Graduate GPA Requirement: 3.00 GPA required.

Other Grade Requirements: At least two of the core courses must be taken in the first semester of residence in the graduate program, and at least four core graduate courses must be completed with grades of B or better by the end of the second semester of residence. Students are expected to take a total of four courses in their first semester of residence. A student who receives one grade of BC or lower in a core course remains in the Ph.D. program, but must earn grades of B or better in the other four courses.

To qualify for the Ph.D. program, a graduate student’s GPA in four core CBE courses and grade on the prelim exam must sum to 6.0 or higher.

Language Requirements

Doctoral Minor/Breadth Requirements: Students must complete minor requirements, elective course requirements, and a teaching assistant requirement.

In addition to studies in chemical and biological engineering, the Ph.D. candidate is required to undertake a program of coursework in a field other than chemical and biological engineering. This requirement may be satisfied by a departmental minor (option A) or a distributed minor (option B).

The minor, whether Option A or B, is designed to represent a coherent body of work, and should not be simply an after-the-fact ratification of a number of courses taken outside the major department. To ensure coherence, the student must consult with his or her advisor. The Ph.D. Minor Agreement Form should be submitted for approval at an early date, before the student is halfway through the proposed course sequence.

REQUIRED COURSES

Students must complete at least six semester courses (totaling at least 18 credits) in the CBE department. These classroom courses shall be in the range numbered 500-899 and will not be laboratory courses, Independent Studies or Research. Grades of B or better are required in all CBE courses used toward degree requirements.

At least four of the six CBE courses shall be selected from these core graduate courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBE 620</td>
<td>Intermediate Transport Phenomena</td>
<td>3</td>
</tr>
<tr>
<td>CBE 660</td>
<td>Intermediate Problems in Chemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CBE 710</td>
<td>Advanced Chemical Engineering Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>CBE 735</td>
<td>Kinetics and Catalysis</td>
<td>2-3</td>
</tr>
<tr>
<td>CBE 781</td>
<td>Biological Engineering: Molecules, Cells &amp; Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

At least two of the core graduate courses must be taken in the first semester of residence in the graduate program, and at least four core graduate courses must be completed with grades of B or better by the end of the second semester of residence. Students are expected to take a total of four courses in their first semester of residence.

The requirement of four core CBE graduate courses shall not be met by substitution of other courses. Students matriculating with an M.S. degree from another university may, with department approval, use up to two courses from their M.S. work toward the requirement of six CBE graduate courses.

Students taking advanced courses outside the department in excess of minor requirements may, with department approval, use up to two of these courses toward the requirement of six CBE graduate courses. Seminar courses may not be used to satisfy CBE course requirements.

Elective course requirement: Students must complete at least one course totaling at least three credits. A B average is required. Pass/fail or audit courses may not be used for the elective course requirement. Courses...
used to satisfy the minor program may not be used for the elective course requirement. Advisor approval is required and secured through submission of the Ph.D. Elective Course Approval Form. Elective courses can be foreign language courses.

Teaching assistantship: Each student in the Ph.D. program is required to serve as a teaching assistant (TA) for two semesters. Under normal circumstances, each student should serve as a TA one semester of the second year and one semester of the third year. Requests for alternate arrangements, partial or full waiver of the requirement, should be submitted in writing to the graduate credentials committee.

POlICIES

GRADUATE SCHOOL POLICIES
The Graduate School’s Academic Policies and Procedures (https://grad.wisc.edu/acadpolicy) provide essential information regarding general university policies. Program authority to set degree policies beyond the minimum required by the Graduate School lies with the degree program faculty. Policies set by the academic degree program can be found below.

MAJOR-SPECIFIC POLICIES

GRADUATE PROGRAM HANDBOOK
The Graduate Program Handbook (https://www.engr.wisc.edu/app/uploads/2016/01/CBE_Academic-Policies-8-17.pdf) is the repository for all of the program’s policies and requirements.

PRIOR COURSEWORK

Graduate Work from Other Institutions
With program approval, students are allowed to count graduate coursework from other institutions toward the Minimum Graduate Degree Credit Requirement and the Minimum Graduate coursework (50%) Requirement. No credits from other institutions can be counted toward the Minimum Graduate Residence Credit Requirement. Coursework earned ten years or more prior to admission to a doctoral degree is not allowed to satisfy requirements.

UW–Madison Undergraduate
A total of 7 undergraduate credits from the UW–Madison undergraduate degree may be counted toward coursework requirements. If those credits are numbered 300 or above, they may be counted toward the Minimum Graduate Degree Credit Requirement. If those credits are numbered 700 or above, they may be counted toward the Minimum Graduate coursework (50%) Requirement. No credits can be counted toward the Minimum Graduate Residence Credit Requirement. Coursework earned ten years or more prior to admission to a doctoral degree is not allowed to satisfy requirements.

UW–Madison Special
With program approval, students are allowed to count up to 15 credits of coursework numbered 300 or above taken as a UW–Madison Special student toward the Minimum Graduate Residence Credit Requirement, and the Minimum Graduate Degree Credit Requirement and the Minimum Graduate Coursework (50%) Requirement. Coursework earned ten years or more prior to admission to a doctoral degree is not allowed to satisfy requirements.

PROBATION
A student who receives more than one grade of BC or lower in core graduate courses will be placed in the M.S. program. Upon completion of the M.S. program, the student may petition the full faculty for readmission to the Ph.D. program.

ADVISOR / COMMITTEE
All students are required to conduct a fourth year research progress meeting with their thesis committee after passing the preliminary examination.

In consultation with the major professor, the student chooses an examination committee of five faculty members, including at least one, but not more than two, from outside the department. It is anticipated that three members of the prelim exam committee (the advisor and two faculty members in the same general research area) will serve on the final oral examination committee.

CREDITS PER TERM ALLOWED
15 credits

TIME CONSTRAINTS
The Graduate School requires that the final oral examination for the Ph.D. must be taken within five years of passing the preliminary exam or the student will be required to take another preliminary exam.

The CBE department expects students to complete their Ph.D. degree within five years. Any student unable to defend her or his thesis in this period must petition the faculty for an extension by July 1 of the fifth year, specifying reasons for the request and length of requested extension.

OTHER
Admitted students are offered research assistantships to support the pursuit of dissertation or degree research in chemical engineering. The stipend, after tuition and fees, is guaranteed for the duration of a student’s graduate studies provided satisfactory progress is made toward their degree. Support for students receiving external funding or other program opportunities are reviewed case by case. Although students can be awarded M.S. degrees, there is no direct admission to the M.S. program.

PROFESSIONAL DEVELOPMENT

GRADUATE SCHOOL RESOURCES
Take advantage of the Graduate School’s professional development resources (https://grad.wisc.edu/pd) to build skills, thrive academically, and launch your career.
PROGRAM RESOURCES

The CBE Graduate Program office coordinates on-going professional development workshops. Topics have included: life in industry, ethical decision making, intellectual property agreements, maintaining self-motivation, how to utilize software in creating figures, effective management of undergraduate researchers, effective management of your thesis advisor and individual development plans (IDPs).

Also, the Graduate School Office of Professional Development offers training opportunities for graduate students and this information is e-mailed to all of the CBE grad students on a regular basis. Examples of these training offerings include sharing of information about DELTA, dissertation writing, grant writing and job search strategies.

In order to foster effective teaching among our graduate students, all students are required to serve as a TA for two semesters. Before graduate students are allowed to TA, each must participate in the New Educator’s Orientation (NEO) training offered each semester. They are also encouraged to connect with the University’s DELTA program.

LEARNING OUTCOMES

1. Demonstrate an ability to synthesize knowledge from a subset of the biological, physical, and social sciences to help frame problems critical to the future of their discipline.
2. Conduct original research.
3. Demonstrate an ability to create new knowledge and communicate it to their peers.
4. Fosters ethical and professional conduct.

PEOPLE

Faculty: Professors Abbott, Dumesic, Graham, Huber, Klingenberg, Kuech, Lynn, Maravelias (assistant chair), Mavrikakis (chair), Murphy, Palecek, Pfleger, Rawlings, Root, Shusta, Yin; Associate Professors Reed and Swaney; Assistant Professors Van Lehn, and Zavala.

For interests and activities of faculty members, along with a list of selected publications for each, see the department’s faculty directory.