CHEMICAL ENGINEERING, PH.D.

Graduate study in the department may be directed toward the master of science or the doctor of philosophy in chemical engineering. The graduate courses are planned to train outstanding students for advanced work in research and development.

The Department of Chemical and Biological Engineering has a tradition of excellence dating back to 1905. For 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.

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.

Graduate students in the department are encouraged to participate in international research experiences, industry internships, and entrepreneurial activities.

For interests and activities of faculty members, along with a list of selected publications for each, see the department's faculty directory (http://directory. engr.wisc.edu/che/faculty).

FUNDING

Financial support for qualified graduate students is available in the form of research assistantships, teaching assistantships, and fellowships.

REQUIREMENTS

MINIMUM DEGREE REQUIREMENTS AND SATISFACTORY PROGRESS

To make progress toward a graduate degree, students must meet the Graduate School Minimum Degree Requirements and Satisfactory Progress (http://guide.wisc.edu/graduate/#policiesandrequirementstext) in addition to the requirements of the program.

DOCTORAL DEGREES

Ph.D.

MINIMUM GRADUATE DEGREE CREDIT REQUIREMENT

51 credits

MINIMUM GRADUATE RESIDENCE CREDIT REQUIREMENT

32 credits

MINIMUM GRADUATE COURSEWORK (50%) 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 (http://my.wisc.edu/CourseGuideRedirect/BrowseByTitle).

PRIOR COURSEWORK REQUIREMENTS: 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.

PRIOR COURSEWORK 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.

PRIOR COURSEWORK REQUIREMENTS: UW–MADISON UNIVERSITY 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.

CREDITS PER TERM ALLOWED

15 credits

PROGRAM-SPECIFIC COURSES REQUIRED

Students must complete at least six semester courses (totaling at least 18 credits) in the CBE department. 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>
</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.

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.

MINOR OPTION A
For Minor Option A, the student is required to complete at least 9 graduate credits in a single department. The program of coursework must be approved by the minor department. Departments may have specific course requirements for their minor and may require more than the 9-credit minimum. The student must meet the requirements of the minor department for satisfactory completion of the minor.

MINOR OPTION B
If the needs of the student would best be served by preparation not available as a departmental minor, the department may permit the student and the advisor to develop a special program in lieu of a departmental minor. To meet the requirements of this Minor Option B, the student must complete at least 9 graduate credits in two or more departments outside the major, in related courses selected for their relevance to the student’s particular area of concentration. The proposed program of coursework must be approved by the Department of Chemical and Biological Engineering.

OVERALL GRADUATE GPA REQUIREMENT
GPA of 3.0 or better is 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.

PROBATION POLICY
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.

A student who does not receive an aggregate score of 6.0 or higher in the qualifying process is placed in the M.S. program. Upon completion of the M.S. program, the student may petition the full faculty to be readmitted to the Ph.D. program.

Students placed in the M.S. program are expected to finish the M.S. program within five semesters of admission into the Ph.D. program.

ADVISOR / COMMITTEE
All students are required to conduct a four 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.

ASSESSMENTS AND EXAMINATIONS
A Ph.D. candidate who has met the grade requirements must complete a preliminary exam consisting of a written report and oral examination.

During the fall semester of the fourth year of the program, candidates will participate in a mandatory research progress meeting with their thesis committee.
The Ph.D. candidate defends a written thesis in a final oral examination.

**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 in within five years. Any student unable to defend his or her 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.

**LANGUAGE REQUIREMENTS**
No language requirements.

**ADMISSIONS**
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 Chemical & Biological Engineering department does not consider applications for a terminal M.S. degree; the department only admits to the Ph.D. 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 30.

**LEARNING OUTCOMES**

**KNOWLEDGE AND SKILLS**
- 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.
- conduct original research.
- demonstrate an ability to create new knowledge and communicate it to their peers.

**PROFESSIONAL CONDUCT**
- fosters ethical and professional conduct.

**PEOPLE**

**Faculty:** Professors Abbott, Dumesic, Graham, Huber, Klingenberg, Kuech, Lynn, Maravelias (Assistant Chair), Mavrikakis (Chair), Murphy, Palecek, Rawlings, Root, Shusta, Yin; Associate Professors Pfleger, Reed, Swaney; Assistant Professor Zavala