

CHEMICAL ENGINEERING, PH.D.

The doctoral program in chemical engineering provides students with advanced education and training in a variety of technical topics, including biotechnology, environmental technologies, high-performance computing and simulations, electrochemical systems, renewable energy and storage, and clean water. Students work closely with faculty to perform hands-on research, develop original research articles and intellectual property, and make scientific presentations at national and international conferences. Students from this program will be prepared to enter a variety of careers, such as higher education, entrepreneurship, consulting, and industrial and government research.

Admissions

Admission is contingent upon recommendation by the graduate faculty of the Department of Chemical and Biological Engineering. Admission opportunities are available for students with undergraduate degrees in fields other than chemical engineering (e.g., chemistry, biomedical engineering, and other related fields).

See the Admission Criteria section of this catalog for more information.

Curricular Requirements

The minimum coursework for the Ph.D. degree is 60 hours, which includes 42 hours of coursework and 18 hours of dissertation research.

An overview of the curriculum is shown in the curricular table below, followed by a summary of the mandatory course requirements (core courses and seminar) and options for electives.

Curriculum Overview	Hours
Core Courses	
CHE 551 Adv Thermodynamics I	3
CHE 552 Transport Phenomena	3
CHE 554 Chemical Reaction Engr	3
Mathematics Core Elective	3
CHE 570 Chemical and Biological Engineering Research Techniques	1
CHE 595 Seminar	1
CHE 695 Seminar	1
Electives	27
Dissertation Research	18
Total Hours	60

Core Course Requirements

The department requires four "core" graduate courses, one research skill course and two seminar courses. The core courses must be taken at UA, unless the equivalent course credit is transferred from another domestic institution (with a grade of A- or higher). The four core courses are comprised of the three required CHE courses, plus one mathematical elective course, as well as research skill and seminar requirements.

Electives

27 Hours of electives may be any of the following:

Code and Title	Hours
CHE 512 Polymer Materials Engineering	3
CHE 514 Computer Methods in ChemE	3
CHE 516 Stem Cell Bioengineering	3
CHE 518 Tissue Engineering	3
CHE 540 Health Safety Chem Process Ind	3
CHE 545 Intro to Biochemical Engr	3
CHE 591 Special Problems	3
CHE 592 Special Problems (Newly Developed Elective Courses)	3
CHE 598 Non-Thesis Research	6
CHE 698 Non-Dissertation Research	6
Total Hours	36

Mathematics Core Elective

Three hours may be any of the following:

Mathematical Core Course Elective Options	Hours
CHE 553 Computation In Chem Engr	3
GES 500 Engineering Statistics	3
GES 554 Partial Diff Equations	3
ST 560 Statistical Methods	3
MATH 509 Data Analysis: Sec Teachers	3
MATH 510 Numerical Linear Algebra	3
MATH 541 Boundary Value Problems	3
MATH 551 Math Stats W/Applictn I	3
CHE 514 Computer Methods in ChemE	3

Graduate Seminar Requirements

The department requires that students take and pass the Graduate Seminars: CHE 595 seminar during the first part of the doctoral program of study (normally during the second semester of enrollment) and the CHE 695 Seminar in the latter part of the program (normally during the final semester of enrollment). These two hours of seminars count towards the coursework hours needed for graduation.

Seminar Course Requirement	Hours
CHE 595 Seminar	1
CHE 695 Seminar	1

Transfer Credit

Graduate School information on Transfer Credit.

Doctoral Plan of Study Requirement

Graduate School information on the Doctoral Plan of Study.

Comprehensive Exams

Doctoral Qualifier Exam

Once a student has completed all of the four core required graduate courses, the student is required to take the doctoral qualifier ("qualifier") exam as a first evaluation stage in the doctoral program. This qualifier exam is offered twice per year, immediately following the end of the spring semester (during the month of May) and immediately following the end of the fall semester (Dec/Jan). If significant extenuating

circumstances prevent the student from completing the qualifier during the required period, the student must submit a petition to the graduate committee to postpone the exam. The student needs to propose a time to complete the exam but no later than the following cycle.

The nature of the qualifier exam is an assignment to independently write (and defend in front of a faculty committee) a research proposal in a field related to (but not directly overlapping) the student's dissertation topic. The faculty committee will be composed of the major advisor plus two other departmental faculty members. The proposal topic and the committee composition will be the responsibility of the student/advisor to determine. The student will provide a written copy of the proposal to the committee, and the student will defend the proposal in front of the committee during an oral presentation. The student will typically be given 2-3 weeks to complete the assignment. There are three different possible outcomes from the qualifier exam:

- a) **Pass** – Students take a “bypass” Plan II MS degree (after completing 30 hours) and continue in the doctoral program.
- b) **Conditional** - Students perform extra work based on the deficiencies identified by the committee. After reevaluation (within 2-3 months) by the committee, the student will pass or fail. No other extensions or reevaluations will be provided.
- c) **Fail** - The student may not continue as a doctoral student. The student is expected to work with the advisor to make a plan to finish any ongoing projects. Financial support beyond this point should not be expected by the student.

Ph.D. candidacy exam

The ChBE candidacy examination is a single examination consisting of two parts (written and oral), typically administered (1) one year after the qualifier exam and (2) after completing at least 30 hours of coursework (including transfer credits). The written document should be distributed to the committee at least one week prior to the oral exam.

Written Document Guidelines

The format of the written document emphasizes the research progress to date, understanding of the entire research project, and a detailed plan for future research. It should be a compact, carefully worded document (no more than 2 pages, single-spaced) including the following key information:

- **Significance:** significance of the work to provide suitable motivation for the dissertation project.
- **Novelty:** the novelty of the work should be clearly identified by comparing to what others have done in the field.
- **Progress:** Adequate progress toward identifying an important and impactful research problem, as well as a summary of the research progress to date.
- **Skills:** skill sets acquired, as well as those to be developed.
- **Plan:** A detailed research plan, along with a specific research strategy and methodology (including specific aims). For each aim, identify the research goals, experimental design, anticipated outcomes/ milestones, timetable for completion, etc.

Oral Exam Guidelines

Students should prepare a 30 min oral presentation (uninterrupted), but they should expect the entire examination to last up to 90 minutes to allow time for questions during and after the presentation (schedule exam for 2 hours). Students are expected to answer the questions from the committee without the help of the advisor.

The student will be evaluated on the scientific and technical comprehension, preliminary results to warrant continuation towards Ph.D. candidacy, the quality of the research plan, overall scholarly understanding of the research area, the ability to communicate clearly and effectively, and accomplishments to date.

The candidacy exam will be scored as **pass**, **conditional pass** (with conditions such as, “repeat within one semester,” “re-write document,” or “take other additional actions suggested by the committee”), and **fail**. The score will be a consensus of the committee. Students who fail the examination can still graduate with a Master's degree if all the requirements are met. However, if a student fails, there should be *no further financial support expected* beyond the end of the current semester, since the student would no longer be in the Ph.D. program.

Preliminary Defense Exam

The preliminary defense (“prelim”) exam normally takes place when ~80% of the dissertation research is completed. *The exam is scheduled based on the research progress, not a year after the candidacy exam.* If there is over a year between the candidacy exam and the preliminary exam, an annual review is required. However, the preliminary exam should be minimum 6 months before the defense time. The exact date should be coordinated between a student and his/her Ph.D. advisor. The prelim exam is a formal presentation to the dissertation committee that provides a summary of progress to date (research accomplishments, scholarly publications, conference presentations, etc.). The exam consists of a written document (normally 15 pages in length, plus references), as well as a presentation (normally 30-45 minutes in duration, followed by a period of questions from the committee). Representative examples of the prelim exam (format, expectations, etc.) can be obtained from the Graduate Program Director upon request. A copy of the written document must be provided to the committee a minimum of two weeks before the scheduled prelim exam. There are three different possible outcomes from the prelim exam:

- a) **Pass** – Students continue in the doctoral program and continue their research and dissertation progress.
- b) **Conditional** - Students perform extra work based on the deficiencies identified by the committee. After reevaluation (within 2-3 months) by the committee, the student will pass or fail. No other extensions or reevaluations will be provided.
- c) **Fail** - The student may not continue as a doctoral student. The student is expected to work with the advisor to make a plan to finish any ongoing projects. Financial support beyond this point should not be expected by the student.

Final defense

The final defense is scheduled when the student's assigned dissertation projects are completed. The student is required to deliver an oral presentation (~45 min) publically and a dissertation following Graduate School guideline. A copy of the complete dissertation must be provided to the committee a minimum of two weeks before the scheduled defense time. the student is required to publically announce the defense date and location with an abstract.

Expectation :

- Fully understand the dissertation topic (overall picture and research details)
- Completed assigned research project (two first author research paper published or accepted)
- A well thought out future plan.

In order for the student to graduate, the committee must approve both the oral defense and the dissertation.

There are two different possible outcomes from the final defense:

- a) Pass – Students will graduate with a Ph.D. degree.
- b) Fail - The student may not obtain the Ph.D. degree.

Continuous Enrollment Policy

Graduate School information on Continuous Enrollment Policy.

Dissertation Requirements

Dissertation Committee Formation

Students should identify their committee and immediately after completing their qualifier exam. Since this exam is normally taken after the second semester in the program, the dissertation committee formation should be completed no later than the end of the third semester.

Dissertation Format

Dissertation format and submission procedures should follow Graduate School policies.

Time Limits for Degree Completion Requirements

Graduate School information on Time Limits.

Student Progress Requirement

Once the doctoral qualifier (comprehensive) exam is passed, doctoral students are required to form a dissertation committee and schedule required Ph.D. assessment exams with their dissertation committee accordingly. It is the *student's responsibility* to schedule and coordinate the exam date as suggested by the program requirements. If a formal exam (e.g., candidacy exam or preliminary exam) is not scheduled during that year, an annual review should be performed. It should be a formal presentation lasting approximately 20-30 minutes (a written document is not required). No more than 12 months should transpire between meetings that a student has with his/her dissertation committee.

Satisfactory progress, as judged by the dissertation committee is required for continued participation in the doctoral program. In certain cases, the committee will provide a probationary period with specific deliverables/outcomes identified, in order for the student to continue in the doctoral program.

Academic Misconduct Information

Graduate School information on Academic Misconduct.

Withdrawals and Leave of Absence Information

Graduate School information on Withdrawals and Leave of Absence.

Academic Grievances Information

Graduate School information on Academic Grievances.

Grades and Academic Standing

Graduate School information on Grades and Academic Standing.

Graduate School Deadlines Information

Graduate School information on Graduate School Deadlines.

Application for Graduation Information

Graduate School information on the Application for Graduation.

Financial Support

Normally, only Ph.D. students are considered for fellowships or other forms of financial support within the Department of Chemical and Biological Engineering. Financial support for graduate students may include teaching assistantships, research assistantships, scholarships, or combinations of these sources. Once a student is admitted into the Ph.D. program, the stipend level is specified, but the source of the financial support may vary during the course of study. By default, stipends for Master's students are not provided, so the stipend amount is not specified. As the source of student support may vary from semester-to-semester, the obligations of the student may also vary. These obligations will normally be communicated to the student at the beginning of the semester, but there may be some variance over the course of the semester.

Continuation of Financial Support

If the faculty advisor judges that the student's research or academic performance is insufficient during a given semester, the faculty member will provide a written warning that funding may be terminated at the end of the semester. If the student is unable to improve performance by the end of the semester, the faculty member (after approval from the Department Head confirming that adequate warning was provided to the student) may terminate the student's funding. If a faculty advisor terminates funding for a graduate student, there is no obligation from the department to provide any additional funding to the student. Alternately, if a student is not able to pass one of his/her mandatory exams (Ph.D. Qualifier Exam, Annual Review, Candidacy Exam, or Preliminary Exam), the faculty advisor and/or department are under no obligation to continue funding the student in any future semester. If the GPA of a student in a single semester falls below a 3.0, the advisor and/or department are under no obligation to continue funding the student in any future semester. In unusual circumstances, the financial support of a student may be terminated before the end of the semester, but this will only occur if the faculty advisor, Department Head, and Dean of Engineering support this decision.