

University of Notre Dame
Department of Chemical and Biomolecular Engineering
Guide to Graduate Studies

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CHEMICAL AND BIOMOLECULAR ENGINEERING

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1. Introduction

The University of Notre Dame's graduate degree programs in the Department of Chemical and Biomolecular Engineering within the College of Engineering have as their mission "the development of individuals with the capability to initiate and conduct independent research in chemical engineering and aligned fields and with the preparation to contribute as professionals in those fields."

The management of the program follows five guiding principles:

1. To provide a graduate education that balances chemical engineering principles; an ability to conceive, execute, and report professional-quality research; and development of professional skills.
2. To provide meaningful evaluations and feedback to ensure the timely progress of students.
3. To support timely and appropriate outcomes for all students.
4. To recognize and celebrate excellent performance.
5. To innovate as the needs of the students, the department, and the professional community evolve.

The purpose of this guide is to lay out the general features and specific details of the graduate programs offered by the department. It supplements, but does not replace, the Graduate School Bulletin of Information. It is maintained and updated periodically by the Director of Graduate Studies (D.G.S) and the Graduate Administrator (GA) as the requirements and policies of the program evolve.

2. Requirements of the Ph.D. Program

2.1. Degrees offered and time to degree

The department offers one Ph.D. degree, Chemical Engineering. The department generally does not admit students directly into a Master's degree program, although a terminal Master's degree is available and is described below. The department admits students with undergraduate or Master's degrees in chemical engineering as well as students with undergraduate or Master's degrees in closely related disciplines.

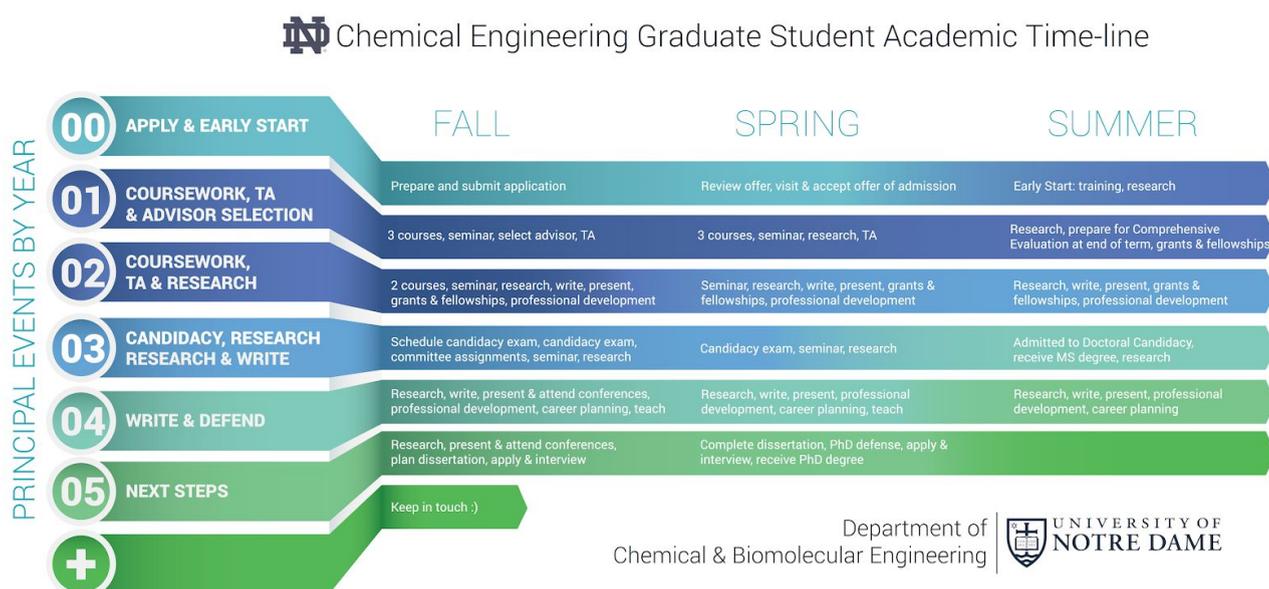


Figure 2.1.1: Typical timing and major events in pursuing a Ph.D. in Chemical Engineering).

Time to degree is determined by the progress of the student through the required components of the program and successful completion and defense of a dissertation. Exact timing is dependent on the nature of the research undertaken and the rate of the student's academic progress. Typical time to degree for students entering with an undergraduate degree is five years, with students entering with a Master's degree typically completing degree requirements in less time.

2.2. Coursework requirements

The Ph.D. degree in Chemical Engineering requires a minimum of 24 credit hours of graduate-level coursework (course number 6XXXX+, as specified by the [Registrar](#)), plus 36 hours of dissertation research (*CBE 68801, 68901*) and graduate seminar (*CBE 63001*) for a total of 60 credit hours.

There are four required graduate courses that are to be completed during the first academic year:

CBE 60542 Mathematical Methods in Engineering I
CBE 60544 Transport Phenomena I
CBE 60546 Advanced Chemical Reaction Engineering
CBE 60553 Advanced Thermodynamics

If any of these is not offered during the first academic year, a substitute core course will be designated by the Director of Graduate Studies. Students without an undergraduate background in Chemical Reaction Engineering may, with the permission of the D.G.S, substitute *CBE 60445* for *CBE 60546*.

In a typical program, a student will take 3 graduate courses in their first semester, 3 graduate courses in their second semester, and 1 graduate course in each of the following two regular academic semesters. In addition to the core courses listed above, students may choose from any of the graduate-level courses offering letter grades and offered by the department or, in consultation with their advisor and the Director of Graduate Studies, graduate-level courses from other departments related to chemical engineering principles broadly defined.

Unless offered as three-credit letter-graded course, a Directed Readings course may not count towards the graduate course requirements.

2.2.1. Seminar

All graduate students are required to register for *CBE 63001 Graduate Seminar*, every semester of the program. Graduate students are expected to attend all seminars unless explicitly excused by their advisor or instructor responsible for the course. Students are also required to participate in the journal club portion of the seminar course.

2.2.2. Language requirement

There is no language course requirement for the Ph.D. degree in Chemical Engineering. Students for whom English is not their native language are encouraged to take advantage of the university resources for developing their communications skills.

2.2.3. Transfer of credits

Up to 24 graduate credit-hours can be transferred in to Notre Dame from a Master's degree completed within the past five years from an institution approved by the department. However, of these credits a **maximum of 12 can be applied towards the 24-credit Ph.D. coursework requirement.**

Up to 6 credit hours can be accepted from another institution if no graduate degree has been earned. A required graduate course may be satisfied by a transferred course that covers substantially the same materials.

Courses taken as an undergraduate student before a Bachelor's degree is conferred cannot be transferred in as graduate credit even if they are graduate level, unless part of a completed B.S./M.S.

dual-degree program.

Requests for transfer of credit must be approved by the Director of Graduate Studies and must satisfy the Graduate School requirements for credit transfer.

The C.B.E. D.G.S must evaluate courses to determine if they can fulfill any of the four required or four electives in the Ph.D. program.

2.2.3.1. Process for transferring in credit from other institutions

Provide the following documents to D.G.S for evaluation:

C.B.E. Graduate Transfer Credit Review Request Form ([Appendix C](#))

Copy of the M.S. transcript with final course grades

Course syllabus or documentation of course content, in English or translated

Official graduate transcripts, showing degree conferral date (if applicable), must be on file with the ND Graduate School.

The transfer process can only take place after a student has successfully completed one semester at Notre Dame but usually takes place during the summer at the end of the student's first year.

2.2.4. Non-chemical engineering undergraduate degree

One of the expectations of a Ph.D. degree in chemical engineering is mastery of fundamental concepts of chemical engineering.

Students who enter the Ph.D. program without an undergraduate or Master's degree in chemical engineering are required to complete *CBE 60443 Separations*, with a grade of B+ or better. Additional modifications and additions to course requirements will be determined by the D.G.S on a case-by-case basis.

2.2.5. Minimum grade requirements

For Ph.D. students, graduate course grades awarded within the department have the following interpretation:

The grade of A indicates mastery of the course material, while A- denotes strong comprehension and understanding. A grade of B+ indicates acceptable performance. A grade of B or lower indicates some deficiencies, which, in the opinion of the course instructor, should be remedied if the student continues towards the Ph.D. degree. Grades of B- and lower indicate serious deficiencies. Remedies for deficiencies are typically determined at the time of the Comprehensive Examination by the examination committee in consultation with the D.G.S. Remedies may include repeating a course, demonstrating proficiency through a B+ or better in a similar course approved by the D.G.S, or other actions as deemed appropriate by the committee and concurred by the D.G.S.

All Ph.D. students must maintain a minimum GPA of 3.25 in C.B.E. and technical courses. Students with a GPAs that falls below 3.25 at the end of any semester will receive a notification from the department. Students who do not demonstrate progress towards meeting the GPA and/or minimum grade requirements will be dismissed from the program.

The department follows the *Extreme Under-performance* guidelines set by the [Academic Code of the Graduate School](#) (section 5.7) when a student's semester GPA drops below 3.0 for two consecutive semesters is subject to dismissal, as is a student with less than a 2.5 GPA in any one semester.

2.3. Teaching assistant requirement

Serving as teaching assistant (TA) is a required part of the academic program for a graduate degree in Chemical Engineering. The rationales for requiring TA work are that the experience contributes to the graduate student intellectual development, gives them valuable exposure to and experience in teaching

others, provides a dimension against which to be evaluated at the Comprehensive Exam, and helps the Department as a whole to meet its responsibilities for delivering courses to our students.

Students are expected to complete two semesters of a full TA assignment and two semester of a half TA assignment, typically in the first and second years, respectively. The time commitment for a full TA assignment, averaged over the semester, should be about 8 hours/week and for half-time assignments about 4 hours/week. These guidelines are established to ensure that the graduate students invest enough time in the TA duties to be worthwhile, while at the same time ensuring they have the time necessary to make satisfactory progress in the other parts of their graduate training.

Typical responsibilities within those 8 or 4 hour/week commitments include creating solutions to problem sets, grading homework and exams, holding office hours, managing tutorials, supervising laboratory, etc. Each instructor should use their own discretion as to how exactly the TA effort is distributed. Whatever the distribution, the instructor should strive to ensure that they are attending to the overall interests of the TAs as well as those of the students and the instructor in setting those responsibilities.

If an unanticipated conflict arises between TA and other duties, e.g. attending seminar or a class or a lab meeting, the instructor, advisor and TA will seek to find the best compromise for all parties involved (for instance, students are excused from seminar, or defer taking a particular class to avoid a conflict, or meeting times are moved). Ideally the compromise is worked out by the affected parties, but if necessary the D.G.S or Chair will intervene to broker a solution.

Because of the potential for conflict of interest and privacy requirements, students may not simultaneously be registered for and be assigned as a teaching assistant for a letter-graded given course.

Under some circumstances, for example for students whose undergraduate degree is not in chemical engineering, TA duties may be deferred.

Advisors are encouraged to suggest TA assignments that would be beneficial to their students. Final decisions on TA assignments are made by the Director of Graduate Studies and/or the Department Chair.

Students will receive a written evaluation of their performance as a TA at the end of the semester from the course instructor. These evaluations are one component of the Comprehensive Evaluation.

2.3.1. Graduate instructor

Students who have passed the Candidacy Examination and who desire more experience in the classroom may request to be a graduate instructor with the advice and approval of their advisor and the D.G.S and with agreement of the course instructor. Graduate instructors collaborate with the course instructor, who will be a regular faculty member, in teaching a course. Duties may include development and presentation of lecture materials, leading of discussions, preparation of homework and/or examination materials, or other activities that advance the developmental goals of the student. The faculty member will retain responsibility for the content and execution of the course and will be responsible for providing coaching and feedback to the graduate student instructor.

2.4. Research advisor selection

Students are matched with a research advisor in the first semester of residency. The department strives to place every student with their preferred advisor while attending to the availability of projects and funding in any given research group.

The department chair sets the timetable for this procedure. During a designated period of approximately two weeks during the Fall Semester, the faculty post times during which they are available for individual meetings or group conferences with entering students and in which the faculty describe their research work and available projects. After meeting with all the faculty who are offering

projects, students submit their first, second, and third choices of research advisor to the departmental Chair. The Chair, on the basis of the choices submitted and available projects, then assigns the student to a research advisor. Every effort is made to assign each student his or her highest priority. However, in some instances, several students select the same advisor and thus a first choice cannot be assigned to all of them. While a typical student will have an open choice of research advisor, there are special circumstances in which a student is admitted with the explicit commitment of working on a specific research project or with a specific advisor. A significant number of research projects result from collaborations between faculty members. Thus, in some situations, a student may be jointly advised by two faculty members. During this advisor discernment process, students are urged to learn as much as they can about the projects. This involves meeting with those faculty they are most interested in, talking to students in that particular research group and attending group meetings, and other such activities.

The research advisor assists the student in identifying a suitable research problem that will be the focus of the dissertation. The advisor consults with the student on a regular basis concerning progress with research. In addition, the advisor will assist the student in designing a plan of study that will complement, but is not limited to, his/her area of research.

2.5. Research progress and support

Students are required to register for *CBE 68901*, Research, during the academic year and *CBE 67980*, Research, during the summer semester. Students must abide by Graduate School policies regarding maintenance of full-time status. These policies are listed in the [Academic Code of the Graduate School](#), which is available on the Graduate School website.

Students are expected to discuss expectations of the research group with their advisor and to seek and act on regular feedback on their performance. Students are strongly encouraged to complete and discuss with their advisor a self-assessment of progress report annually, typically at the end of the fall semester.

In cases in which research performance is not satisfactory, the advisor will assign a Unsatisfactory (U) grade in research and communicate that decision and rationale to the D.G.S. A student may, at the discretion of the advisor, be dismissed from a research group due to unsatisfactory performance. In this circumstance, the department will provide the student up to three months support during which time they must identify a new advisor or be dismissed from the graduate program. A student who receives a U in research in two semesters in succession will be dismissed from the graduate program effective immediately.

2.6. Spring admission

Most graduate students apply for and begin their graduate work in the fall semester. Students may occasionally apply for and be admitted for the spring semester, typically directly into a research group. The same coursework and TA expectations apply to these students.

2.7. Comprehensive evaluation

The purpose of the Comprehensive Evaluation is to assess whether a student is prepared to perform research at a level consistent with his or her degree objective and to provide feedback on performance and areas of particular need and opportunity for improvement. The evaluation is normally after the first academic year, typically at the start of the third semester in residence. The evaluation is carried out by a committee constituted by the D.G.S and includes the advisor, an examination chair, and at least one other regular faculty member. This committee is not the thesis committee.

The evaluation includes a review, based on the student's coursework, of his or her knowledge of chemical engineering fundamentals, results of the written and oral components of a research examination, an evaluation by the research advisor of the student's performance in research, and an evaluation of the student's performance as a teaching assistant. The D.G.S will be responsible for providing to the committee a summary of student grades and academic standing and completed teaching assistant evaluation forms.

2.7.1. Knowledge of chemical engineering fundamentals

The student's knowledge of chemical engineering fundamentals is judged by his or her performance in graduate courses taken by the time of the Comprehensive Evaluation.

If deficiencies should appear in the coursework evaluation while the other evaluation components appear satisfactory, specific remedies may be identified on an individual basis at the discretion of the faculty.

2.7.2. Teaching evaluation

Teaching assistantship duties are a required part of the academic program in Chemical Engineering. The evaluation is based on teaching assistant assessments in courses supported up to the point of the evaluation.

2.7.3. Research evaluation

The research evaluation consists of a written report, an oral examination, and advisor assessment of student performance in research. The primary criteria are the student's ability to (1) clearly describe a research objective, (2) demonstrate an understanding of the fundamental principles underlying the research and of the key research literature, (3) articulate a preliminary research plan, and (4) present preliminary results that support the plan.

The D.G.S will schedule and notify graduate students of the requirement and expectations of the examination and the date of the examination no less than six weeks before the examination. In preparing for the examination, the student may consult with the research advisor on general matters related to the report or presentation structure only. The research advisor may not consult on the detailed content of either the written report or oral presentation.

Guidelines for preparing the written report are included as [Appendix D](#). The written report will be provided to the D.G.S or their designee at a time to be specified but minimum of 1 week before the examination. The student will provide 6 hard-copies and a digital file (PDF only) by the deadline.

During the examination, the student makes an oral presentation, no more than 15 minutes in length, summarizing research objectives, plans, and preliminary results. This presentation is followed by a 30-minute period of questions from the examination committee, moderated by the committee chair.

2.7.4. Comprehensive evaluation results

Following the oral examination, the examination committee will discuss and evaluate the student's performance in all dimensions of the Comprehensive Examination. The results of this evaluation will be documented in a comprehensive evaluation report following the comprehensive evaluation form

provided to students ahead of the evaluations. The report will be drafted to both provide constructive feedback to the student from the committee and advisor as well as support the committee decision regarding the evaluation. This report will be returned to the D.G.S immediately following the examination and discussed by the advisor with the student as soon as possible after the end of the examination.

2.7.5. Comprehensive evaluation outcomes

Results of the Ph.D. Comprehensive Evaluation are reported as a **PASS**, a **RESTRICTED PASS**, a **PASS TO A TERMINAL MASTER'S DEGREE**, or **FAIL**:

1. **PASS** indicates that student performance is judged to be satisfactory in all aspects of the evaluation.
2. **RESTRICTED PASS** indicates that the student has performed satisfactorily in most aspects of the evaluation, but with limited and specific deficiencies. As examples, deficiencies might consist of a particular course grade, a component of the research examinations, or the teaching evaluations. In the case of a RESTRICTED PASS, specific remedies are documented and outlined to the student, and might include as examples taking a specific course, retaking the research examination, or reviewing a portion of a graduate course. If carried through to the satisfaction of the examination committee, the RESTRICTED PASS then reverts to a PASS. If not, the RESTRICTED PASS revert to PASS TO A TERMINAL MASTER'S DEGREE.
3. **PASS TO A TERMINAL MASTER'S DEGREE** indicates that significant deficiencies exist in performance to date and that jeopardize the student's ability to complete and defend a Ph.D. degree. Sufficient performance is indicated to support the ability of the student to successfully complete a Master's degree. The student is moved into the Master's degree program and becomes bound by that program's expectations.
4. **FAIL** represents unsatisfactory progress towards the Ph.D. The student is dismissed from the graduate program.

2.8. Ph.D. committee

The Ph.D. committee is charged with providing guidance and oversight on the research and professional development progress of the student. Committees are typically assigned by the D.G.S in the beginning of the third year of the student's residence, who must abide by the rules established by the Graduate School. Typically, the committee will be comprised of the advisor and three other members, at least one of whom must be a C.B.E. faculty member. The advisor and student are encouraged to identify and recommend committee members to the D.G.S. who can provide effective feedback to the student, including potentially collaborators, faculty from other departments, and/or from other universities. Committee members must agree to serve on the committee. The student is encouraged to use the Committee as a resource for consultation on research and other dimensions of their Ph.D. program.

Under some circumstances it may become necessary to replace one of the members of the Ph.D. committee. The advisor and student will communicate requested changes to the D.G.S, who will review and approve as appropriate.

2.9. Ph.D. candidacy examination

Students successfully completing the Comprehensive Evaluation must complete the Ph.D. Oral Candidacy Examination in order to become a Ph.D. Candidate. The Ph.D. candidacy examination procedures are prescribed by the Graduate School, and these rules ultimately govern the examination. In C.B.E., the examination is used to enable the Ph.D. committee to assess the ability of the student to conceive, propose, defend, execute, and document graduate-level research and to provide feedback to the student on areas of strength and of developmental need.

C.B.E. graduate students must complete the oral component of the candidacy examination during the

3rd year of residency, no later than the second month (February, for students admitted in the fall) of the sixth semester. The student shall identify a date and time mutually agreeable to the advisor and the Ph.D. committee members and communicate that information to the C.B.E. Graduate Administrator. The D.G.S will approve petitions for extension beyond the deadline only under extenuating circumstances. Failure to complete the oral candidacy exam within the designated time frame may result in termination from the Ph.D. program.

2.9.1. Written candidacy report

The written candidacy report should demonstrate the ability to present and defend a well conceived research problem, to demonstrate significant progress towards addressing that research problem, ideally evidenced by the publication of a paper in the appropriate peer-reviewed literature, and a solid plan for bringing the research to a successful end. The student shall prepare their written candidacy examination document following the formatting guidelines outlined in the [Appendix E](#), which follow the general format of a National Science Foundation proposal. The document must be the work of the student and must be prepared without the aid of their advisor.

The document must be distributed to the committee in hardcopy and/or electronic format, as preferred by the committee members, at least one week prior to the oral candidacy examination date, along with a *curriculum vitae*.

2.9.2. Oral candidacy examination

The oral candidacy examination is open only to the student and the Ph.D. committee and shall last no less than 90 minutes in total. It consists of a presentation by the student of the research context, objectives, methods, results to-date, and proposal of work to be done to complete the Ph.D. The presentation shall be approximately 20-25 minutes in length. Following the presentation is a period of questions from the Ph.D. committee on specific details of the research objectives, results and plans and as well as general knowledge of the research field. Generally each committee member will in turn ask questions for approximately 10 minutes, ending with the advisor, and if necessary followed by a second round of questions. When all questions have been addressed to the satisfaction of the committee, the student is dismissed from the examination and the committee goes into discussion.

The committee discusses the performance of the student on both the written and oral components of the examination. The committee will vote following the guidelines prescribed by the Graduate School. The results of this evaluation are documented in a comprehensive evaluation report. The report will be drafted both to provide constructive feedback to the student from the committee and advisor as well as to support the committee decision regarding the evaluation. This report will be returned to the D.G.S immediately following the examination. The student will receive a copy of the report and the advisor will discuss the report and outcome with the student as soon as possible after the end of the examination.

2.9.3. Candidacy examination outcomes

The committee discusses and votes on the outcome of the examination. Collectively the committee reports the results of the Ph.D. Candidacy Examination to the D.G.S as a **PASS**, a **RECOMMENDED RETAKE**, or a **FAIL**:

1. **PASS** indicates student performance is judged to be satisfactory. A pass requires the affirmative vote of at least three of the four committee members. The outcome is reported to the Graduate School and the student is admitted to Ph.D. candidacy.
2. **RECOMMEND RETAKE** indicates that the student has not performed satisfactorily in at least one dimension of the examination but evidences the potential to pass the examination. The department chair must approve the retake, and the retake must be completed within 90 days of the original oral examination date. The outcome of the retake must be either pass or fail.

3. **FAIL** indicates that progress towards the student's declared degree objective is unsatisfactory. The student is terminated from continuation in the graduate program.

2.10. M.S. in Chemical Engineering degree for Ph.D. candidates

A student who has successfully presented and defended their Ph.D. candidacy work, who has completed five semesters in the Ph.D. Program, and who has prepared and submitted for publication a research paper in collaboration with his/her research advisor is eligible to receive a Master's Degree in Chemical Engineering. The paper must describe work in which the student has a primary (not supporting) role, must be submitted to a research journal or to the proceedings of a technical conference, and be subject to peer review.

To provide the M.S. degree in a given semester, the student must provide evidence of completing the requirements for the M.S. degree to the D.G.S at least one week before the deadline for completing Master's degree work published by the Graduate School. The D.G.S will evaluate and approve requests.

Approved requests will be processed by the Graduate Administrator and submitted to the Graduate School.

2.11. Admission to Doctoral Candidacy

After a student has successfully completed the 24 course credits of the Ph.D. Degree and passed their Candidacy Examination they may be admitted to Doctoral Candidacy. The required form will be processed by the Graduate Administrator and submitted to the Graduate School.

2.12. Ph.D. in Chemical Engineering degree

Successful completion of the Ph.D. degree is dependent upon preparation and oral defense of a Ph.D. dissertation and must be approved by the advisor and Ph.D. committee following the guidelines published by the Graduate School.

2.12.1. Ph.D. dissertation document

The ultimate product the Ph.D. program is the Ph.D. dissertation, which is an extensive and comprehensive description of the research performed by the Ph.D. candidate. The dissertation is prepared following the formatting guidelines provided by the Graduate School and will generally include an Introduction chapter that reviews the field of research and introduces the contributions of the candidate, followed by chapters that describe distinct intellectual components of the research. These chapters may coincide with and substantially reproduce publications authored by the student, subject to copyright approval by the publishing agency.

The completed dissertation must be submitted to the Ph.D. committee **at least three weeks prior to the scheduled Ph.D. defense** in hardcopy and/or electronic format, as preferred by the committee members, along with a *curriculum vitae*. The committee members must sign a reader's report acknowledging that the research and written presentation are sufficient to defend before the committee. The reader's report must be returned to the C.B.E. Graduate Administrator no later than one week before the scheduled Ph.D. defense date. The readers may recommend changes to the dissertation to the candidate.

After the oral defense is passed and changes and corrections recommended by the advisor and committee are incorporated into the final text of the dissertation, the advisor signs the cover page and the dissertation is submitted to the Graduate School.

2.12.2. Ph.D. oral defense

The Ph.D. dissertation research must be presented and defended in front of the Ph.D. committee. The candidate may schedule the defense with the approval of their advisor. Deadlines for completing the dissertation defense in a given semester are published by the Graduate School. The student is

encouraged to discuss the deadlines and to initiate the preparation of necessary forms with the C.B.E. Graduate Administrator. The candidate shall identify a date and time mutually agreeable to the advisor and the Ph.D. committee members, provide a complete dissertation to the committee following the deadlines described above, and communicate the scheduled date to the C.B.E. Graduate Administrator. The C.B.E. Graduate Administrator will advertise the defense to members of the department and assist in identifying a venue for the defense. The D.G.S shall appoint a chair of the defense committee who is not the advisor.

The Ph.D. defense typically lasts no more than two hours and has an open and a closed component. The open component typically begins with an introduction of the candidate by the advisor, followed by an oral presentation by the candidate. The oral presentation shall provide a summary of the Ph.D. research, including its context, major results, and significance to the field, in a format accessible to the dissertation readers and researchers familiar with the research area. The presentation is typically 30 minutes in length. Following the presentation, the chair of the committee calls for questions from the audience to the candidate. After these questions are complete, the audience is excused.

Additional questioning by the committee is conducted in a closed session. Each committee member will, in turn, ask questions for approximately 10 minutes, ending with the advisor, and if necessary followed by a second round of questions. After questions have been addressed to the satisfaction the examination is completed, the chair excuses the candidate and calls for discussion, followed by a vote of committee members. At least three votes out of four are required to pass the oral defense. The chair of the committee provides a written report of the voting results to the graduate program administrator, who communicates the the results to the Graduate School, with a copy to the D.G.S.

2.12.3. Graduation and Commencement

Students must defend and submit their final dissertation to the Graduate School and complete all other Graduate School requirements before they can graduate. Only three graduation dates occur throughout the year, at the end of the fall, spring and summer semesters. To be on the graduation list a student must be registered in that semester, regardless of when they defended.

3. Requirements of the Master's Degree Program

3.1. Degrees offered and expected time to degree

The department offers one thesis Master's degree in Chemical Engineering. A student must be admitted to the department Master's or Ph.D. program before beginning coursework towards a graduate degree.

A student entering the M.S. program with an undergraduate degree in chemical engineering can expect to take approximately 18-24 months to complete the requirements for the M.S. degree. Thus a student will normally complete all of the requirements during the fourth semester of study. While this is the desired timing, the actual timing may be somewhat longer or shorter depending upon the nature of the research attempted and the student's academic progress.

A student entering the M.S. program with an undergraduate degree that is not in chemical engineering may expect to take some undergraduate courses (not all of which may count towards the M.S. degree) in addition to the requirements outlined below. Consequently, such a student may require additional time to complete the degree. In these cases, the exact program is tailored to the student's previous exposure to Chemical Engineering in consultation with the departmental Chairperson or Director of Graduate Studies.

3.2. Credit and coursework requirements

The M.S. degree in Chemical Engineering requires a minimum of 15 credit hours of coursework, plus 15 hours of thesis research (*CBE 68801*, *CBE 68901*) and graduate seminar (*CBE 63001*).

There are four required graduate courses that are taken during the first academic year, including

- *CBE 60542 Mathematical Methods in Engineering I*
- *CBE 60544 Transport Phenomena I*
- *CBE 60546 Advanced Chemical Reaction Engineering*
- *CBE 60553 Advanced Thermodynamics*

If any of these is not offered during the first academic year, a substitute core course will be designated. Students without undergraduate background in Chemical Reaction Engineering may, with the permission of the D.G.S, substitute *CBE 60445* for *CBE 60546*.

In the first semester, a student will typically complete 3 graduate courses and graduate seminar in the first semester and two graduate courses in the second semester.

3.2.1. Seminar

All graduate students are required to register for *CBE 63001*, Graduate Seminar, every semester of the program. Graduate students are expected to attend all seminars unless explicitly excused by their advisor or instructor responsible for the course. Students are also required to participate in the journal club portion of the seminar.

3.2.2. Language requirement

There is no language course requirement for the M.S. degree in chemical engineering. Students for whom English is not their native language are encouraged to take advantage of the university resources for developing their communications skills.

3.2.3. Non-chemical engineering undergraduate degree

One of the expectations of a Ph.D. degree in chemical engineering is mastery of fundamental concepts of chemical engineering. Students who enter the Ph.D. program without an undergraduate or Master's degree in chemical engineering are required to complete *CBE 60443 Separations*, with a grade of B+ or better. Additional modifications and additions to course requirements will be determined by the D.G.S on a case-by-case basis.

3.2.4. Minimum grade requirements

For M.S. students, graduate course grades awarded within the department have the following interpretation. The grade of A indicates mastery of the course material, while A- denotes strong comprehension and understanding. Grades of B or B+ indicate acceptable performance. B- indicates some deficiency. Grades of C and lower indicate serious deficiencies.

The department adheres to the requirements published in the Graduate School Bulletin of Information for minimum grade requirements. In summary, continuation in and graduation from a graduate degree program requires maintenance of at least a 3.0 cumulative GPA. A student whose semester GPA drops below 3.0 for two consecutive semesters is subject to dismissal, as is a student with less than a 2.5 GPA in any one semester.

A student whose semester GPA drops below 3.0 for two consecutive semesters will not be eligible for initiation or continuation of financial support.

3.3. Teaching assistant requirement

Teaching assistantship duties are required of all M.S. students in Chemical Engineering. The rationale and expectations for TA work are as prescribed above for students in the Ph.D. track.

3.4. Research advisor selection

Advisor selection follows the procedures outlined above for the Ph.D. students.

3.5. *Master's comprehensive evaluation*

This evaluation constitutes the Master's Examination required by the Graduate School. The evaluation consists of a coursework evaluation, a teaching evaluation, and a research evaluation. The research evaluation is based on a written and oral report following the same format as the Ph.D. Comprehensive Evaluation. Evaluation results are prepared, in consultation with the faculty, by the D.G.S and the research advisor, and consist of a grade of either PASS or FAIL. Generally this evaluation is done at the beginning of the third semester of study.

3.6. *Master's thesis preparation and defense*

Following the completion of required coursework, a M.S. student is expected to devote his/her full time to thesis research. Once approved by the advisor, the thesis is prepared following the Graduate School's formatting guide, which is available from the Graduate School's website. The D.G.S, usually on the basis of recommendations from the research advisor, assigns to the student a thesis committee consisting of the advisor and two thesis readers from the regular faculty. Copies of the thesis, bearing the signature of the advisor, are distributed to the readers at least one week in advance of the scheduled date for the oral defense.

Prior to scheduling the oral defense, the student should contact the C.B.E. Graduate Administrator to discuss scheduling requirements and to initiate the preparation of necessary forms. The defense is scheduled within the department for a time mutually convenient for the student and committee members. Following the oral defense, the readers indicate their approval of the thesis in the form of a reader's report that is submitted to the Graduate School by the Department. Once approved, the candidate submits to the Graduate School two signed copies of the thesis, which are verified for compliance with the style manual.

4. **Safety**

Safety is of paramount importance in all aspects of the department's operation. While knowledge of appropriate procedures is vital in the research and instructional laboratories, all members of the department should pay attention to conditions that may result in accidents or unsafe conditions, and actively participate to make a safe environment for everyone.

All members of the department should familiarize themselves with the [Laboratory Safety Manual](#), including the *Chemical Hygiene Plan* published by Risk Management. All students are required to successfully complete the appropriate mandatory safety trainings before they enter any laboratory on campus and maintain safety validation throughout the time they are in the graduate program. Failure to maintain safety compliance is grounds for dismissal from the program.

In general terms, there are several ways in which graduate students can improve their degree of personal safety. The first is to be aware of any potentially hazardous materials that may be in the laboratories. A Material Safety Data Sheet (MSDS) should be available wherever materials are located. Additionally, personnel should report any unusual sensitivities or allergies to the chemicals handled in the research or instructional laboratories to the advisor or instructor in charge, and appropriate precautions must be taken. For example, this might include the use of respirators, gloves, and hoods when handling particular compounds, or else completely avoiding possible exposure.

A second main area concerns laboratory routine. Many items of research equipment can be dangerous if not handled appropriately or if not maintained. Examples include high-pressure gas cylinders and regulators, high temperature furnaces, flammable or hazardous compounds, machinery, electrical equipment, and lasers. It is essential that students be familiar with the proper operation and maintenance of research equipment, as well as the handling of hazardous compounds. This is an area where graduate students must exercise prudent judgment. If a student does not believe they have the knowledge or training to perform their research in a safe manner, they must talk to their advisor before

engaging in any research activities.

Emergency phone numbers are posted by telephones in laboratories and offices. A list of hazardous materials and unattended experiments should be posted on the laboratory door with phone numbers for emergency personnel to contact when the need arises.

5. Financial support

The department typically provides stipend support during the first two semesters of residency, after which time the advisor is expected to provide for ongoing support throughout the completion of the thesis or dissertation research.

When a student is admitted with financial support, assuming satisfactory progress and with the approval of the advisor, every effort is made to continue financial support until the thesis is completed. Funding beyond six years requires approval by the department chair.

Satisfactory progress means that the student continues to maintain the minimal grade requirements and meets the deadlines for the indicated degree objectives. In particular, financial support may be suspended if the deadline for the Ph.D. Oral Candidacy Examination is not met.

The date for completing thesis or dissertation research is decided jointly by the advisor and the student, typically 2 to 3 months in advance of the date of the thesis defense. If financial support should terminate before that date, then the advisor provides the student a three-month written notice in advance of the anticipated termination date for financial support.

5.1. Internships and leaves of absence

Students are expected to work full time through completion of their graduate degree. They may not hold outside jobs or engage in activities that significantly deter from their full time duties as graduate students. Students requiring an extended leave due to personal or family circumstances should consult the leave of absence policies of the Graduate School.

The C.B.E. graduate program allows and encourages students to pursue internships or similar extended leave opportunities that contribute to their educational and professional development. Leaves must be approved by the advisor, and the Graduate Administrator must be notified of the leave. Students who receive a salary or stipend from the internship host institution may not simultaneously receive their graduate stipend.

6. Vacation

Each graduate student is eligible to take two weeks (ten business days) of vacation during each twelve-month period, in addition to University holidays of: Thanksgiving, Christmas Eve through New Years Day Celebration, Good Friday through Easter Monday, Memorial Day Observance, and Independence Day. Students are required to consult in advance with their advisors regarding specific days that they wish to take as vacation so that research can progress in a planned and coordinated manner.

If for unanticipated reasons a student must be away for time greater than allowed by the vacation policy, their stipend may be paused at the discretion of the advisor and in consultation with the D.G.S..

7. Health insurance

All graduate students are required to carry health insurance and are automatically enrolled in the Notre Dame student insurance plan unless proof of comparable coverage with an American-based insurance company is provided (see complete requirements on University Health Services website). The premium for the student health insurance plan is charged to your student account with the University.

The Graduate School provides a subsidy of the student's health insurance premium cost for full-time,

fully funded Ph.D. students who purchase the University student health insurance plan. See the University Health Services insurance website for more information.

<https://uhs.nd.edu/insurance-billing/insurance-plans-rates/>

If the student's stipend is ended before May 15, students may be responsible for the remaining premium amount of the policy term (Aug 15-Aug 14). Please see Academic Program Administrator with any questions.

8. Grievance procedures

In the event that a student has an unresolved complaint or grievance with the Department, he or she may appeal in writing to the Department Chair and/or the Director of Graduate Study (D.G.S). If the grievance is related to dismissal from the graduate program, then the student must file the written appeal within 14 days from the time notified of dismissal. To hear the appeal, the Department Chair will appoint a committee of three faculty members, who are unconnected factually with the case or the reasons for appeal, to investigate the complaint. If both the Department Chair and D.G.S are involved in the case, then the Dean of the College, or his/her designee, will appoint the committee. The person who appoints the appeals committee will also designate a chair for the committee.

The student's statement should indicate details on the nature of the problem, the date(s) the problem occurred, the grounds upon which the appeal is based, background information that the student considers important, and the relief requested.

The appeals committee will promptly and thoroughly investigate the appeal to determine whether the relief requested is warranted. The investigation may include interviews and/or written statements from the student, any student witnesses, faculty or staff members who may be able to provide pertinent information about the facts, as well as a review of any pertinent documents. In most situations, the appeals committee will complete the investigation in 30 business days (business days do not include weekends or employee holidays as recognized by the University). There may be some reports that cannot be investigated within 30 business days. In such cases, the chair of the appeals committee will communicate to the student that the investigation is going to take longer than 30 business days and will also include a statement indicating when the committee anticipates completing the investigation. The chair of the appeals committee will notify the student in writing of the decision of the committee.

If a student is unsuccessful in resolving a complaint at the department level, the student may choose to appeal to the Dean of the Graduate School, who will make a final determination. The student should not make such an appeal until after exhausting available procedures within the department. The Graduate School's grievance process can be found at:

http://graduateschool.nd.edu/assets/9047/info_appeal_procedure.pdf.

Issues of sexual or discriminatory harassment or disability-related grievances will be handled according to procedures outlined in *du Lac: A Guide to Student Life* at <https://dulac.nd.edu/>. Issues of academic fraud will be handled according to procedures outlined in the 'Academic Integrity' section of the Graduate School Bulletin at <https://graduateschool.nd.edu/about-the-graduate-school/print-materials/>.

A. Appendix A: MVGP

a. Mission

Offer a graduate program that provides lifelong skills for Ph.D. professionals while supporting the research and educational missions of C.B.E..

b. Vision

An ND C.B.E. graduate program known for innovation and excellence in graduate education, as evidenced by placing Ph.D. students in top academic and industrial positions.

c. Guiding principles

Graduate education that balances chemical engineering principles, ability to conceive, execute, and report academic-quality research, and development of professional skills

Processes that ensure timely progress, meaningful evaluation and feedback

Timely and appropriate outcomes for all students

Recognize and reward exceptional performance

Embrace program innovation in the pursuit of Mission and Vision

B. Appendix B: Ph.D. degree timeline

Typical required activities through Ph.D. degree.

a. Year 1

Orientation
Coursework
Advisor selection
Teaching assistant
Begin research
Fellowships
Ethics training
Comprehensive Report
Comprehensive Exam

b. Year 2

Coursework
Teaching assistant
Research

c. Year 3

Research
Candidacy examination

d. Year 4+

Research
Ph.D. dissertation and defense

C. Appendix C: Graduate transfer credit review request

C.B.E. Ph.D., Graduate Transfer Credit Review Request

Name: _____ ND ID number: _____

Up to 12 credits from graduate courses taken at other institutions can be used to fulfill C.B.E. Chemical Engineering PhD requirements.

Step 1)

Include all courses you would like transfer credit to fulfill

Institution where credits were earned: _____

Institution Location: _____

ND Course number (eg. CBE 6XXXX) of required course or CHEG PhD elective	Other institution's course number and name	Credit hours

Step 2)

Attach a copy of the course syllabus and the course catalog description for each course you are seeking to fulfill course requirements with.

Step 3)

Email form and attachments to the graduate academic program administrator, Nadia Casas at ncasas@nd.edu.

Step 4)

Official Transcripts: If not already on file with the Graduate School, have official transcript sent to Maureen Collins, 502 Main Building, Notre Dame, IN 46556

D. Appendix D: Guidance for written comprehensive report

The purpose of the comprehensive written report is for the student to demonstrate the ability to clearly describe a research objective, to demonstrate an understanding of the fundamental principles underlying the research and of the key research literature, to articulate a preliminary research plan, and to present preliminary results that support the plan. The proposed research is not expected to be formulated at the level expected for a Ph.D. dissertation but should evidence the ability to achieve that level of performance.

a. Formatting requirements

- i. The report will be judged in part based on its legibility and professional appearance. The report must conform to the following requirements:
 1. Title page must include: project title, student and advisor's names, and the date.
 2. Typeset at a font size of at least 11 point
 3. Margins in all directions of at least 1 inch
 4. No more than six lines of text per vertical inch
 5. Single column formatting
 6. Full justification
 7. Figures must conform to good presentation standards, include properly formatted titles, labels, and legend, and include a descriptive caption.
 8. Tables must conform to good presentation standards, be legible, and include a descriptive caption.
 9. Printed single-sided, stapled once in the upper left-hand corner

b. Report contents

Report should consist of no more than 5 pages of narrative text, excluding the title page, references, and figures and tables. Figures and tables must be included within the narrative and located as near as possible to the place you first refer to it (not after the references cited). The report will include the following sections:

c. Background

Discussion of the state of the art in the field of research, describing, for example, key problems to be solved, theories proposed, and results obtained by others to date. Cite leading references and provide full citations in references section. Include previous and ongoing work in this field in advisor's research group.

d. Proposed work

Objectives - State the specific objectives of the work and the differences with previous work in or outside of your group. Summarize the methods or theories to be used. Describe the expected significance of the work.

Research plan - Indicate and justify a research plan to attain the stated objectives. For experimental work, this plan may include a description of relevant instrumentation, procedures, and quantities to be measured. Similarly, for computational or theoretical work the plan will include a description of relevant models, necessary computational resources, quantities to be computed or described, and validation plans.

e. Preliminary results

Describe preliminary results obtained, including figures and tables as appropriate.

f. Career objectives (1 or 2 sentences)

g. References cited

Follow format appropriate for an American Chemical Society journal. Include title and doi for each cited work.

E. Appendix E: Guidance for candidacy written report

The following structure is adapted from the National Science Foundation proposal format, and the student is encouraged to consult the NSF Grant Proposal Guide for the description of terms used below. The written report should be no more than 15 pages in length inclusive of figures and tables but exclusive of title page and summary. The report will include the following components:

a. *Title page*

Include the project title, student and advisor names, and the date.

b. *Project Summary (1 page maximum):*

The summary will describe the project in terms that could be understood by someone who is not an expert in the field. The summary should be written in the third person and include a statement of objectives and methods to be employed. The **intellectual merit** and **broader impacts** of the proposed work should be clearly stated.

c. *Project Narrative (15 pages maximum)*

- Describe the context and general problem area to be addressed
- Summarize the state of the art in the field, including previous and current work in the student's research group, and explain how the proposed work will advance the present state of knowledge.
- Provide a clear statement of the work to be undertaken, as well as its objectives and its expected significance.
- Describe the methods and approaches to be applied
- Describe the results obtained to date
- Describe and justify planned future work
- Career objective (1 or 2 sentences)

d. *References cited*

- e. Follow format appropriate for an American Chemical Society journal. Include title and doi for each cited work.

f. *Printed copies*

- g. Printed copies should be printed single-sided and stapled in the upper left-hand corner.

F. Appendix F: Departmental graduate awards

a. Outstanding Paper

The Outstanding Paper Award is given annually in the spring semester to recognize a graduate student for a particularly significant or impactful piece of work published in the prior calendar year. The award is open to all graduate students who have first-authored a paper in that year. Students self-nominate but are encouraged to discuss their nomination with their advisor. The nomination package will include the full citation of the paper, the paper itself, a brief (one paragraph) statement of the significance of the work, and the student's specific intellectual contributions to conceiving, executing, and documenting the research. Nominations are typically due in December.

A committee appointed by the Department Chair and consisting of at least three faculty who are not affiliated with the nominated works will select the Outstanding Paper from the eligible submission. The recipient will be invited to present their work at a regular seminar in the spring semester and will receive an award set by the department chair recognizing their accomplishment.

b. Outstanding Candidacy

The Outstanding Candidacy Award is given annually in the spring semester to recognize a graduate student for a particularly notable performance in the Ph.D. candidacy examination. The award is open to all graduate students who have completed the candidacy examination by the second month of their sixth semester. Following the completion of the candidacy examination, committee members will discuss whether the examination performance is worthy of consideration for recognition and will report their decision with brief accompanying rationale to the D.G.S. The department chair or their designate, in consultation with relevant parties, shall select the awardee.

The recipient will be invited to present their candidacy work at a regular seminar in the spring semester and will receive an award set by the department chair recognizing their accomplishment.

c. Outstanding Dissertation

The purpose of the Outstanding Dissertation Award is to recognize a graduate student for an outstanding level of research accomplishment throughout the pursuit of their Ph.D., including originality, quality, and impact of work, to include number and quality of research papers and professional presentations. The Awardee is typically selected in February from among dissertations submitted within a given academic year, to include August, December, and May graduation dates. Nominations by advisors are provided to the Department Chair or their designee and are to include a student *curriculum vitae* and nomination letter. The chair shall appoint a committee of at least three faculty, excluding any advisors of the nominated students. The committee shall make a recommendation to the chair. The awardee will be recognized with a plaque and monetary award. The department shall endeavor to advertise the awardee and their accomplishment to departmental constituencies.

The Outstanding Dissertation Award winner will generally also be the departmental nominee for the college-wide Shaheen Award.